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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

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Abstract

This paper provides a quantitative evaluation of the welfare effect of the introduction of proportional taxation in Bulgaria in 2008, an effect that operates through the grey economy channel. Using a general-equilibrium model, augmented with informal sector, a computational experiment is performed to evaluate the welfare gain from the adoption of proportional taxation. The lower effective tax burden in the new tax regime produces a relocation of people into the official sector, stimulates investment, and increases output and consumption. Finally, under the flat tax regime, the size of the informal sector is smaller, and quantitatively consistent with OECD (2009) and European Commission (2012) figures.

JEL classification: H22, J46, D51, D91, O41

Keywords: Taxation; Informal Sector; Labor reallocation; Welfare gains

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1 Introduction and Motivation

This paper explores the switch from a progressive tax schedule to a proportional (flat) tax regime on Jan. 1, 2008 in Bulgaria, and its welfare effects. In contrast to Vasilev (2015), here the focus falls on the "whitening-out" effect of taxation on the grey economy, and the mechanism at work that is operating through the official-unofficial sector households' labor decision. Using a calibrated micro-founded general-equilibrium model with informal sector a la Conesa *et al.* (2001), this study provides a quantitative evaluation of the effect resulting from the introduction of flat income taxation in Bulgaria in 2008.¹ Under proportional taxation system featuring a lower effective income tax rate than the corresponding rate under the progressive regime, a significant reallocation of labor from unregistered activities to the official sector is observed. In addition, since labor and capital are assumed to be complements in the production of registered output, the increase in official employment increases the marginal productivity of capital. In turn, that provides a strong incentive for households to increase capital accumulation, thus enhancing the productive capacity of the economy. The resulting increase in output then allows for higher consumption possibilities, which directly translate into significant welfare gains. As in Vasilev (2015), the model in this paper will abstract away from corporate profit and dividend taxation, and will exclusively focus on the effect of personal income taxation on labor and capital supply decisions.²

The paper aims to contribute to the debates in the public finance literature as well. After all, direct income taxation makes a significant share of total tax revenue,³ even for countries that have organized their taxation systems around indirect (consumption-based) taxation. Those countries, Bulgaria being a typical representative, usually lack sufficiently well-qualified tax administration and cannot depend on direct taxation as the major source of revenue for the government. In addition, a progressive income taxation (introduced for equity considerations) makes tax collection even more difficult. The problems of high marginal tax rates

¹Even 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.

²Still, it is important to have the same tax rate applied to labor and capital income - otherwise small business owners would declare their income to be the one that is levied with the lower tax.

³In Bulgaria, the share of personal income tax revenue out of total government revenue is approximately 10 %.

and progressivity itself were further exacerbated due to the wide-spread tax evasion and non-compliance, and to a certain extent the skilled-worker migration outflows in the early 1990s.

In contrast, the proportional ("flat") taxation is a much simpler tax system, which makes it more transparent, and much easier to administer. More specifically, a reduction in both the average and the effective rate generally has a (partial) "amnesty" effect: tax compliance is expected to improve as the incentive from operating in the unofficial sector is now lower. Labor services are reallocated to the official sector, and total tax revenue collected would increase as well. In addition, as the size of the grey economy decreases, a lower tax burden, combined with better transparency, would also encourage investment and increase welfare. Therefore, the Bulgarian personal income tax reform implemented in 2008 could be of significant importance for other transition and developing countries featuring a large unofficial sector, and who might wish to consider the adoption of proportional taxation as a tool to decrease the size of their grey economy. However, as Peichl (2014) notes, despite all the advantages, flat tax implementation "has mostly been restricted to the transition economy countries of Eastern Europe," with the date of adoption and rates documented in Table 1 on the next page. The pattern that emerges is that despite the existence of a group with the same tax rate chosen (10 %), there is a significant variety in the levels introduced in the other countries in the region. Therefore, the conclusions drawn from the discussion of the Bulgarian case should be taken with a degree of caution. Indeed, one tax rate does not fit all the countries in the sample.

The theoretical setup used in this paper to study the flat tax reform in Bulgaria will build on Conesa *et al.* (2001) by augmenting it with a sufficiently-detailed government sector to capture the distortionary effect of personal income taxation. The framework in the original paper builds on Hansen (1985) and Rogerson's (1988) work on indivisibilities, where hours worked per person is fixed, and the decision margin is the employment rate. Similarly, in this paper working time in the official sector will be contracted exogenously, and the only decision in the setup will be whether to participate or not in the official sector. That is, labor is indivisible in the official sector, and divisible in the grey economy. More specifically, each

Table 1: Personal Income Tax Rates in Flat-tax regimes

Country	Year of adoption	Before (%)	After (%)	2008 (%)	2012 (%)
Estonia	1994	16-35	26	22	21
Lithuania	1994	18-33	33	24	15
Latvia	1997	25/10	25	25	25
Russia	2001	12/20/30	13	13	13
Georgia	2005	12-20	12	12	20
Romania	2005	18-40	16	16	16
Kyrgyzstan	2006	10-20	10	10	10
FYROM	2007	15-24	12	10	10
Kazakhstan	2007	5-20	10	10	10
Mongolia	2007	10-30	10	10	10
Montenegro	2007	15-23	15	15	9
Czech Rep.	2008	12-32	15	15	15
Bulgaria	2008	20-24	10	10	10
Belarus	2009	9-30	12	12	12
Federation of Bosnia	2009	10-15	10	10	10

Source: Peichl (2014)

individual will face a two-stage decision: (i) whether or not to work full-time in the official labor market (the "participation margin" in the official sector), and (ii) conditional on not working in the registered economy, whether to work in the grey economy (the "participation margin" in the unofficial sector), and if so, how many hours to supply there (the "intensive margin" in the unofficial sector). The wage in the unofficial sector will be approximated by the minimum wage rate, while the rate in the official sector would correspond to the average wage rate in the economy.⁴ Note that in this setup the output from the underground economy would count towards total production. The unofficial sector technology is an alter-

⁴Given the lack of data on wages in the unofficial sector, it will be assumed that the most workers could earn there is the minimum wage. If that were not the case, those workers would have been better-off working in the official sector.

native (labor-intensive) way to produce goods and services.⁵ Thus, the model generates a quantitative estimate of the underground economy relative to the official sector, which can be compared to figures obtained in empirical studies, *e.g.* Charmes (2000), OECD (2009), and the European Commission (2012).

Fiscal policies, and in particular personal income taxation policies, are known to affect households' incentives to invest in physical capital, and their decisions to provide labor services to businesses in either the official or the informal sector. The analysis of the effect of tax policies within the framework of exogenous growth models is relatively recent, *e.g.*, King and Rebelo (1990). More recent treatments on the subject in the context of transition economies include Funke and Strulik (2006) on Estonia's 2000 income tax reform, and Azacis and Gillman (2010) on the tax reforms in Estonia, Latvia, and Lithuania. Those countries already adopted proportional taxation in the early 2000s, and by 2007 have realized significant welfare gains, and thus could be a useful benchmark when analyzing Bulgaria's 2008 income tax reform case as well.

The paper is organized as follows: Section 2 lays down the specifics of Bulgaria's 2008 income tax reform. Section 3 then proceeds to present the model setup. Section 4 describes the data used and the calibration procedure. Section 5 characterizes the model economy's long-run behavior. Section 6 evaluates the welfare cost of progressive income taxation, had it not been abolished, and performs several robustness checks. Section 7 concludes.

2 Bulgaria's 2008 income tax reform

Until Dec. 31, 2007, Bulgaria applied progressive income taxation on personal income.⁶ No tax was levied on low levels of income, and a significant number of tax incentives and tax deductions were available. The progressive tax brackets are reported in Table 2 on the next

⁵As Conesa *et al.* (2001) point out, "those are neither illegal goods or services, nor home produced ones; the importance of this unregistered production is that it is non-tradables."

⁶The description of the progressive tax system in Bulgaria in this section follows the structure used in Vasilev (2015).

page for monthly income levels in Bulgarian leva (BGN) in 2007.⁷

Table 2: Progressive Income Taxation in Bulgaria in 2007

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.

In 2008, a flat tax rate of 10% on personal income was introduced. At the same time, workers at the bottom of the income distribution, who were previously paying no taxes (due to the presence of certain deductions that were abolished in 2008), suddenly faced a positive tax rate. To compensate those low-income households, who were the main losers from this tax policy change, the (non-taxable) monthly minimum wage was increased: it went up in several steps starting with the raise from BGN 180 to BGN 220 in 2008, and eventually reaching BGN 360 as of Jan. 2015 (and expected to rise further to BGN 380 in mid-2015). That is, a minimum-wage worker in 2008 (2009) was going to pay at least 20% (22%) marginal tax rate under the old progressive system. Therefore, the end effect of Bulgaria's 2008 flat tax reform (coupled with appropriate increase in the minimum wage) represented a considerable increase in after-tax personal income, as compared to the pre-2008 tax regime.

Furthermore, as seen from Table 3 on the next page, the relative importance of personal income tax revenue has somewhat increased in terms of the share of total tax revenue collected, while the relative share of the revenues from taxed personal income as a share in output has been relatively flat. The absence of any increase in that component is due to the recent financial crisis than unravelled in 2008-09.

Next, we go one step deeper and decompose personal income tax revenue into its major sources. In Table 4 on the next page, the share of labor income from the personal income

⁷Since the introduction of the currency board arrangement in 1997, the lev is fixed to the Euro at the rate of 1 Euro = BGN 1.95583.

Table 3: 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)

tax is the largest (81%) component of personal income tax receipts has increases substantially over this short period: 10.97 percentage points growth in 2008, 8.41 in 2009, 0.30 in 2010, and 4.43 in 2011.⁸ Since it is hard to believe that people have suddenly become more laborious, an explanation based on the reallocation of workers from the grey to the official economy seems quite plausible given the data available.⁹

Table 4: 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 figures and their relevance for the effect from the adoption of flat income taxation, 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 incentive to operate in the official sector, and significantly more so than the effective tax rate under flat income taxation. Thus, substantial welfare benefits can be realized when the economy switches from progressive taxation to proportional income taxation with a single

⁸The 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.

⁹An alternative way to confirm the hypothesis that the increase in tax revenue is driven by improvements in tax compliance is to look at the implicit tax rate documented by the European Commission (2012): the rate before the introduction of the flat tax rate was 38.1 % vs. 24.4% for the years after.

low rate.

3 Model Setup

3.1 Description of the model:

There is a continuum of ex-ante identical agents ("households") distributed uniformly on the $[0, 1]$ interval. Each single-member household in the model economy is infinitely-lived, and there is no population growth.¹⁰ As in Conesa *et al.* (2001), each household maximizes the following utility function

$$\sum_{t=0}^{\infty} \beta^t [U(c_t) + V(l_t)], \quad (1)$$

where c_t is consumption at time t , and l_t denotes leisure enjoyed at time t . The parameter β is the discount factor, with $0 < \beta < 1$. The instantaneous utility function $U(\cdot)$ and $V(\cdot)$ are increasing in their arguments and satisfy the Inada conditions. Following Prescott (2002), a logarithmic specification, separable in consumption and leisure, was chosen:

$$U(c_t) + V(l_t) = \ln c_t + \alpha \ln(l_t), \quad (2)$$

where $\alpha > 0$ denotes the relative weight attached to the utility of leisure. Next, the household has an endowment of one unit of time in each period t , which is split between work in either the official, or the unofficial ("black market") sector and leisure, l_t , so that

$$h_{mt} + h_{bt} + l_t = 1, \quad (3)$$

where $h_{mt} \in \{0; \bar{h}\}$ is the indivisible time devoted to working in the official sector in period t , and $h_{bt} \in [0, 1]$ is the (divisible) time spent in the unofficial sector in period t . Also, $h_{bt} = 0$ whenever $h_{mt} = \bar{h}$, hence $0 \leq h_{mt} + h_{bt} \leq 1$. This assumption guarantees that each worker can only participate in one of the production sectors. The hourly wage rate in the official ("market") and the implicit unofficial ("black market") sectors is denoted by w_t^m and w_t^b ,

¹⁰As in Azacis and Gillman (2010), the model is a closed-economy one, which is a useful simplification. In a closed economy the return on capital is determined endogenously, and this assumption that cannot be relaxed so easily. However, under the assumption of a closed economy, the welfare gains from the introduction of a flat tax rate might be different from reality, as Bulgaria is a small open economy.

respectively.¹¹

Following the arguments in Rogerson (1988) and Hansen (1985), it can be easily shown that polar cases in which each household either works in the official, or in the unofficial sector, cannot not be equilibrium outcomes. Therefore, it must be the case that a proportion μ_t ($0 < \mu_t < 1, \forall t$) of the agents in the economy are working in the unofficial sector, while the rest, $1 - \mu_t$, will be supplying labor services in the official sector. Workers in the official sector will receive consumption c_{mt} , while those working in the unofficial sector will consume c_{bt} . Note that μ_t can be interpreted also as the probability of being chosen to work in the unofficial sector in period t . This probability is determined endogenously in the model, as workers would seek for the optimal balance between the net return from working across the sectors (at the margin).

In addition to the labor income generated, each household saves by investing i_t in physical capital.¹² As an owner of capital, the household receives gross interest income $r_t k_t$ from renting the capital to the firms; r_t is the before-tax return to private capital, and k_t denotes physical capital stock in the beginning of period t . Each household's physical capital evolves according to the following law of motion:

$$k_{t+1} = i_t + (1 - \delta)k_t, \quad (4)$$

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

Finally, the households owns all firms in the economy, and receive an equal share of total profit (π_t) in the form of dividends. The households' aggregate budget constraint is

$$(1 - \mu_t)c_{mt}^h + \mu_t c_{bt}^h + i_t^h \leq (1 - \tau_t)[r_t k_t^h + w_t^m h_{mt}^h] + \mu_t w_t^b h_{bt}^h + \pi_t^h, \quad (5)$$

where, as in Guo and Lansing (1998), tax schedule is represented by the following function:

$$\tau_t = \eta \left(\frac{y_t}{y} \right)^\phi, \quad (6)$$

¹¹The "wage rate" in the unofficial sector could also be interpreted as the opportunity cost of working in the unofficial sector.

¹²For simplicity, we shall assume that in this economy there are no financial assets and the public sector cannot issue debt.

where τ_t denotes the tax rate on total (capital and labor) registered income, *i.e.*, $y_t = r_t k_t^h + w_t^m h_{mt}^h$, and y is the steady-state level of household's income. In addition, $0 < \eta < 1$ and $0 \leq \phi < 1$, where ϕ measures the progressivity of the tax system, and η is the average effective tax rate in steady state.¹³ Superscript h is used to distinguish between per household and aggregate allocations.

Next, following Merz (1996), it will be assumed that households can pool income together and doing so, they will be able to equalize consumption across states, *i.e.*, $c_{mt} = c_{bt} = c_t$. Then the problem is recast into one of maximizing total expected utility

$$\sum_{t=0}^{\infty} \beta^t [\ln(c_t) + (1 - \mu_t)\alpha \ln(1 - \bar{h}) + \mu_t\alpha \ln(1 - h_{bt})], \quad (7)$$

s.t.

$$c_t + k_{t+1} - (1 - \delta)k_t = (1 - \tau_t)[r_t k_t + w_t^m(1 - \mu_t)h_{mt}] + \mu_t w_t^b h_{bt} + \pi_t. \quad (8)$$

The households acts competitively by taking prices $\{w_t^m, w_t^b, r_t\}_{t=0}^{\infty}$, income tax schedule τ_t , and chooses allocations $\{c_t, i_t, k_t, \mu_t, h_{bt}\}_{t=0}^{\infty}$ to maximize Eq.(7) s.t Eqs.(3)-(6),(8), and initial conditions for physical capital stock $\{k_0\}$.

The optimality conditions from the household's problem, together with the transversality condition (TVC) for physical capital are as follows:

$$c_t : c_t^{-1} = \lambda_t \quad (9)$$

$$k_{t+1} : \lambda_t = \beta \lambda_{t+1} \left[(1 - \delta) + \left(1 - (1 + \phi)\tau_t \right) r_{t+1} \right] \quad (10)$$

$$\mu_t : \alpha \left[\ln(1 - h_{bt}) - \ln(1 - \bar{h}) \right] = \lambda_t \left[\left(1 - (1 + \phi)\tau_t \right) w_t^m \bar{h} - w_t^b h_{bt} \right] \quad (11)$$

$$h_{bt} : \alpha(1 - h_{bt})^{-1} = \lambda_t w_t^b \quad (12)$$

$$TVC : \lim_{t \rightarrow \infty} \beta^t c_t^{-1} k_{t+1} = 0, \quad (13)$$

where λ_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.

¹³Notice 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").

Next, the Euler equation describes the optimal capital accumulation rule, and implicitly characterizes the optimal consumption allocations chosen in any two contiguous periods. Participation rate is chosen so that at the margin the net return from working in the official economy is equal to the net cost of doing so, measured in terms of labor income above the salary that would have been obtained in the grey economy. Hours in the grey economy are chosen so that the disutility of an hour work at the margin equals the return to labor in the unofficial sector. The last expression is the TVC, which ensures that the model equilibrium is well-defined by setting the value of the physical capital that remains at the end of the optimization horizon to zero, and thus rules out the possibility for explosive solution paths.

3.2 Stand-in Firm: market sector

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 labor $H_t^m = (1 - \mu_t)\bar{h}$. The production function is as follows

$$y_t = Ak_t^\theta (H_t^m)^{1-\theta}, \quad (14)$$

where A measures the level of total factor productivity, and $0 < \theta < 1$ denote the productivity of physical capital and $1 - \theta$ captures the productivity of labor.

The representative firm acts competitively by taking prices $\{w_t^m, r_t\}_{t=0}^\infty$, and chooses $k_t, H_t^m, \forall t$ to maximize firm's static profit:

$$\pi_t = Ak_t^\theta (H_t^m)^{1-\theta} - r_t k_t - w_t^m H_t^m. \quad (15)$$

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

$$r_t = \theta \frac{y_t}{k_t}, \quad (16)$$

$$w_t^m = (1 - \theta) \frac{y_t}{H_t^m}. \quad (17)$$

3.3 Stand-in Firm: unofficial sector

Each worker in the unofficial sector has access to an individual production function that uses only labor, given by Bh_t^γ . As in Conesa *et al.* (2001), the labor intensive specification for the production process in the unregistered economy seems to be an adequate approximation to reality. Each firm in the unofficial sector will then hire labor h_{bt} in every period to maximize static profit

$$\max_{h_{bt}} Bh_{bt}^\gamma - w_t^b h_{bt}. \quad (18)$$

With free entry, there are zero profits, hence the implicit wage in the unofficial sector equals

$$w_t^b = Bh_{bt}^{\gamma-1}. \quad (19)$$

3.4 Government sector

The government collects tax revenue from registered labor and capital income to finance government expenditure, which are then spent on wasteful government consumption $\{g_t^c\}_{t=0}^\infty$. The government budget constraint is then

$$\tau_t \left[r_t k_t + w_t^m (1 - \mu_t) \bar{h} \right] = g_t^c. \quad (20)$$

Government takes prices $\{w_t^m, r_t\}_{t=0}^\infty$ and allocations $\{k_t, \mu_t\}_{t=0}^\infty$ as given. The income tax schedule $\{\tau_t\}_{t=0}^\infty$ will vary with income, while 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 Competitive Equilibrium

Given the initial conditions for the state variable k_0 , a Decentralized Competitive Equilibrium (DCE) is defined to be a sequence of prices $\{r_t, w_t^m, w_t^b\}_{t=0}^\infty$, allocations $\{c_t, i_t, k_t, \mu_t, h_{bt}, g_t^c\}_{t=0}^\infty$, income tax schedule $\{\tau_t\}_{t=0}^\infty$ such that (i) expected utility is maximized; (ii) the stand-in firm in the unofficial sector maximizes profit every period; (iii) wage rate in the unofficial sector is such that profits in the grey economy are zero every period; (iv) government budget is balanced in each time period; (iv) all markets clear.

4 Data and model calibration

The model is calibrated to Bulgarian data at quarterly frequency. The period under investigation is 1993-2012 where 1993-2007 is the period when taxation was progressive, and starting from 2008 a flat income tax rate of 10 % for both labor and capital income was introduced. The chapter follows a standard approach in the quantitative macroeconomics literature. 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 Bulgarian economy for the progressive taxation regime period.

Quarterly data on the output, household consumption, private fixed investment shares in output, employment rate, the average wage rate, and the minimum wage rate was obtained from the National Statistical Institute (NSI). Following Ganev (2005), capital income share is set to its average value $\theta = 0.429$, and the labor income share is $1 - \theta = 0.561$. Following Conesa et al. (2001), parameter γ of the grey economy production function is chosen under the assumption that the labor intensity of the production function in the unofficial sector in Bulgaria is the same as in the the production function used in the official sector, i.e., $\gamma = 0.571$. Next, using Ganev's (2005) estimate that the annual depreciation rate on physical capital is 5 %, in our quarterly model that corresponds to $\delta = 0.0125$. Ganev's (2005) annual estimates of the average capital stock to output over the 1992-2007 are then converted to quarterly ones, thus obtaining that $K/Y = 13.964$. This gives us sufficient information to calibrate the discount factor from the steady-state Euler equation:

$$\beta = \frac{1}{1 + [1 - (1 + \phi)\tau]\theta\frac{y}{k} - \delta} = 0.986 \quad (21)$$

The relative weight on leisure in the household's utility function, parameter α , will be set to match the steady-state participation rate in the registered sector in Bulgaria over the period $1 - \mu = 0.467$ (NSI).¹⁴ Also, given the lack of data on average number of hours worked for Bulgaria, we assume a typical household will work on average $\bar{h} = 1/3$ in the official sector, which is consistent with the estimates in Ghez and Becker (1975) of the fraction of time spent working.

¹⁴The low participation rate is consistent with the experience of Soviet and post-Soviet Baltic states, as documented in Smith (2011).

In order to calibrate the scale parameter of the production function used in the grey economy, B , we also follow Conesa et al. (2001). Technology in the underground sector is assumed to be such that workers working full time in the grey economy would earn the minimum wage, as those are mainly workers with no qualification; the implicit assumption is that underground activities do not require any skills. Thus B will be set to match the ratio between the (average) market wage and the minimum wage (for total hours 1/3 worked in the unregistered sector). In Bulgarian data, $w^m/w^b = 2.51$, where data only for the period 2000-13 was available. Still, this value is in line with other EU countries. Normalizing steady-state output to unity, we can solve for B :¹⁵

$$B = \frac{(1 - \theta)y}{(1 - \mu)\bar{h}^\gamma(w^m/w^b)} = 0.912. \quad (22)$$

Given that the level of total factor productivity can be normalized to unity, $A = 1$, as this parameter has only a level effect in the model, it turns out the grey economy is approximately 9 percentage points less productive than the official sector, which is an adequate approximation.

Next, we can use the marginal rate of substitution between consumption and hours in the unofficial sector (evaluated at \bar{h}), we can express α as

$$\alpha = \frac{1 - \bar{h}}{c} B \gamma \bar{h}^{\gamma-1}. \quad (23)$$

In order to solve for that parameter, we need to substitute consumption out from the feasibility condition¹⁶

$$c = 1 - \delta k + \mu B \bar{h}^\gamma. \quad (24)$$

Hence

$$\alpha = \frac{1 - \bar{h}}{1 - \delta k + \mu B \bar{h}^\gamma} B \gamma \bar{h}^{\gamma-1} = 0.513. \quad (25)$$

¹⁵In this way we can solve for the steady-state recursively, instead of solving for all variables jointly. Another advantage is that we can obtain the big ratios directly.

¹⁶For computational simplicity, steady-state output has been normalized to unity.

Following Conesa *et al* (2007), we compute the average effective tax rate $\eta = 0.14$ for the progressive tax, and $\eta = 0.11$ for the flat tax.¹⁷ Next, the (gross) degree of progressivity, $1 + \phi$, was computed as the ratio of the marginal to the average tax rate. 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.¹⁸ Table 5 below summarizes the values of all model parameters, and the next section provides the computed values of the model variables in the steady-state.

Table 5: Model Parameters

Param.	Value	Definition	Source
β	0.986	Discount factor	Calibrated
θ	0.429	Capital income share	Data Average
γ	0.571	Labor intensity underground production	Set
$1 - \mu$	0.467	Participation rate, official sector	Data average
δ	0.013	Depreciation rate of physical capital	Set
α	0.513	Relative weight on leisure in utility function	Calibrated
η	0.110	Average effective income tax rate (flat)	Data average
η	0.140	Average effective income tax rate (progressive)	Data average
ϕ	0.430	Progressivity parameter (prog.)	Set/Calibrated
ϕ	0.000	Progressivity parameter (flat)	Data average
A	1.000	Steady-state level of total factor productivity	Calibrated
B	0.912	Scale parameter underground production function	Calibrated

¹⁷More specifically, the average effective tax rate is approximated by the average amount of tax actually paid, divided by total income. Since the model is an infinitely-lived agents one, and the level of social contributions has not changed substantially, (except for the 3 percentage points cut in social security contributions in the last quarter of 2007, which was quickly reversed shortly after) the model will abstract away from those "taxes".

¹⁸For the three tax brackets, $\phi = 0.43, 0.57, 0.70$, respectively. Robustness checks are performed in later sections of the paper to evaluate how welfare effect of the tax reform depends on the degree of progressivity of the previous regime.

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 6 below.

Table 6: Data Averages and Long-run solution (progressive taxation regime)

	Description	BG Data	Model
c/y	Consumption-to-output ratio	0.674	0.685
i/y	Fixed investment-to-output ratio	0.201	0.175
g^c/y	Gov't consumption-to-output ratio	0.176	0.140
k/y	Physical capital-to-output ratio	13.96	13.96
$w^m(1 - \mu)\bar{h}/y$	Labor share in output	0.571	0.571
rk/y	Capital share in output	0.429	0.429
\bar{h}	Share of time spent working in the official sector	0.333	0.333
μ	Employment rate in the grey economy	0.217	0.533
$1 - \mu$	Employment rate in the official sector	0.467	0.467
$\mu B\bar{h}^\gamma/y$	Size of the grey economy relative to the official sector	0.268	0.260
\tilde{r}	After-tax net return to physical capital	0.010	0.013

As seen from the tabulated values, the model captures relatively well both the consumption- and investment ratio. In addition, the parsimonious model does a relatively good job at matching the after tax net return to capital, which is given by $\tilde{r} = \left(1 - (1 + \phi)\tau\right)r - \delta$. Lastly, government consumption-to-output ratio is also quite well-captured: since $r_t k_t + w_t^m(1 - \mu_t)\bar{h} = y_t$, it follows from the balanced government budget constraint that $g^c/y = \tau$.

Next, the share of the grey economy predicted by our simple model is very close to the estimate by Nenovsky and Hristov (2000), who compute that share to be 0.268 using monetary methods.¹⁹ More recent study by the European Commission (2012) estimates the share

¹⁹Enste (2002) calculate the average share of the grey economy in Bulgaria over the 1994-95 period to be 0.327, while Nenovsky and Hristov (2000) compute that share to be 0.268 over the 1997-99 period. Ahumada et al. (2009) obtain a conservative range of 0.122-0.175 for the share of the unofficial sector for the period 1998-2007.

of the shadow economy to be 34.5 % of GDP in 2005, three years before the introduction of proportional taxation of personal income in Bulgaria (and down to 31.9 % two years after the adoption of the flat tax regime).

Since no time series for the share of workers employment in the unofficial sector exist, Charmes's (2000) estimate for the transition economies, $\mu = 0.217$, was adopted in this paper. This is also very close to the lower bound of the estimated range by the European Commission (2012) for undeclared labor (22-30 %). The model overstates that ratio, since it assumes that whoever is not employed in the official sector finds full-time job in the grey economy. Bulgaria is very likely to exhibit a much higher share of labor employed in the grey economy compared to Central European countries, so it can be safely concluded that the model performs well along this dimension of data. In addition, being a neoclassical model, it is a model of employment, as it emphasized time allocated to work and does not model unemployment explicitly. Thus our estimate of μ needs to be corrected for both unemployment and out-of-labor-force population to get an even closer fit to data. For example, if we consider the upper bound for the unofficial labor reported by the European Commission (2012), 30 %, and add the average of 10.34 % unemployed, and say the same amount of discouraged workers (given the low participation rate in Bulgaria), the resulting fraction, 51% is not that far away the predicted figure by the model. However, some caution should be exercised with any such corrections, as some of the unemployed individuals might be already employed in the grey economy. In such instances, due to the double-counting, the correction would be biased in the direction of "overcorrecting" the true level of unofficial employment.

Note that with the particular calibration, the average effective tax rate and the degree of progressivity of the tax system do not affect the participation rate, as those parameters were taken as given in the model. In addition, the calibration of the model was done under the assumption that all workers in the grey economy dedicate \bar{h} of their time in the unofficial sector. This will all be relaxed in the welfare analysis in the next section. In particular, keeping discount factor and depreciation rate constant, a lower effective tax rate and no progressivity will raise the after-tax real interest rate. In turn, that would increase capital stock, and lower the employment rate in the unofficial sector, relocate that labor toward the

official sector, and ultimately increase consumption.

6 Welfare Analysis

We will now consider the hypothetical (counterfactual) scenario in which Bulgaria starts in 2008 but did not adopt flat income tax rate. To this thought experiment, we will contrast the observed scenario with flat income taxation since 2008. This would allow to evaluate the asymptotic (steady-state to steady-state) effect of the difference in taxation, holding model parameters unchanged.²⁰ Note that the participation rate in the grey economy, μ , will vary as we change the tax regime. Table 7 below produces the results obtained for both the old and new steady-state, and compares them to Bulgarian data over the 2008-13 period (flat tax regime).

Table 7: Data Averages and Long-run solution

	Description	Data	Model (progr.)	Model (flat tax)
c/y	Consumption-to-output ratio	0.674	0.685	0.808
i/y	Fixed investment-to-output ratio	0.201	0.175	0.182
g^c/y	Gov't consumption-to-output ratio	0.176	0.140	0.110
k/y	Physical capital-to-output ratio	13.96	13.96	14.04
$w^m(1 - \mu)\bar{h}/y$	Labor share in output	0.571	0.571	0.571
rk/y	Capital share in output	0.429	0.429	0.429
\bar{h}	Share of time spent working in the official sector	0.333	0.333	0.333
μ	Employment rate in the grey economy	0.217	0.533	0.212
$1 - \mu$	Employment rate in the official sector	0.467	0.467	0.788
$\mu B\bar{h}^\gamma/y$	Size of the grey economy relative to output	0.268	0.260	0.103
\tilde{r}	After-tax net return to physical capital	0.010	0.013	0.014
λ	Asymptotic Welfare gain	-	-	0.180

²⁰This long-term approach was preferred in order to abstract away from the effect of the financial crisis. After all, the tax reform in Bulgaria was introduced in the same year the financial crisis unravelled, so computation of the transition path was ruled out.

After the adoption of proportional taxation, there are two effects: first, we have a decrease in the effective tax burden, and second, all tax progressivity disappears. Both effects lead to the reallocation of hours to the official sector, thus lowering the share of people employed in the grey economy. Informal employment, as well as the size of the grey sector relative to the registered output shrinks by more than half. More specifically, the decrease in the grey economy share is approximately 60 percent. This amount of shrinkage, however, is supposed to happen over the long-term. Still, studies by the European Commission (2012) document a fall in the share of the grey economy from 34.5 percent of GDP in 2005 to 31.9 percent of GDP in 2012, which can be used at least in part as an evidence of the efficiency of the flat tax reform in reducing the unofficial economy. Furthermore, in the year after the introduction of the fiscal reform, NSI reports a decrease in the unemployment rate falls from 6.9 % to 5.6%, and an increase employment rate from 61.7% to 64%. Unfortunately, the financial crisis that unravelled afterwards affects the behavior of the labor market.

In addition, given that labor and capital are assumed to be complements in the Cobb-Douglas production function for registered output, capital stock increases in the new steady state. In turn, output, consumption and investment are also higher under the new tax regime with proportional taxation. Lastly, given the relative abundance of physical capital under the new regime, the after-tax return to capital is lower after the adoption of proportional taxation.

Next, as in Lucas (1990), total discounted welfare was computed under both the progressive and proportional income taxation regimes. Parameter λ will be used to denote the "compensatory variation," *i.e.*, the additional consumption (18%) gained in the steady-state, measured in percentage points, from the switching to the steady-state under the proportional taxation system. Alternatively, that parameter could be regarded as measuring how much consumption needs to be increased under the counterfactual (progressive taxation) regime, to make the household as well off as it is under the new tax regime featuring proportional taxation. If we assume that it takes six years (from 2008 to 2012) to reach the new steady-state in the model, the per-year welfare gain will be then 3.6%. Our predicted gain seems to be in the plausible range obtained in previous studies: for example, Azacis

and Gillman (2010) find similar welfare gains 2.2 – 3% for the case of the flat tax reform in the Baltic countries during 2000-07.²¹

Next, series of robustness checks are performed to demonstrate that the model predictions do not change qualitatively when we vary some of parameter values. Table 8 below summarizes the compensatory variation figures when the tax progressivity parameter ϕ from the two higher income brackets was used. As expected, higher tax progressivity generates a larger welfare gain when proportional taxation is adopted, ranging between 18 – 19.5 percentage points of additional consumption gained depending on the level of progressivity.

Table 8: Welfare effect as a function of tax progressivity ϕ

Degree of tax progressivity	Welfare Gain (%)
$\phi = 0.43$	18
$\phi = 0.57$	18.72
$\phi = 0.70$	19.47

The final robustness check performed in the model framework was as in Vasilev (2015) to take the top marginal tax rate (22%) under the progressive regime as a better determinant for investment decisions, and use it instead of the progressive tax schedule when computing the compensatory variation relative to the case with the flat tax. Results are reported in Table 9 below:

Table 9: Welfare effect with $\tau = 0.24, \phi = 0$ (top marginal tax rate)

Compensatory variation - benchmark case (%)	18.00
Compensatory variation - top marginal tax rate (%)	33.77

As expected, the gain is significantly larger in this case; it is almost double relatively to the benchmark computational experiment. This is because the top marginal tax rate used in this exercise creates a much larger distortion in the Euler equations for physical capital stock. This results in a lower after-tax return to both factors of production (since capital and labor

²¹On the other hand, Funke and Strulik (2006) find much smaller welfare gains using also an exogenous growth model to study the effect of the Estonian 2000 income tax act.

are complements in the Cobb-Douglas production function) and decreases their respective steady-state values. In addition, the proportion of workers employed in the official economy decreases, as they move in the unofficial sector, which increases the size of the grey economy relative to measured GDP. Thus, in the absence of the 2008 income tax reforms and under the extreme assumption that the top marginal tax rate is the most important driving force for investment decisions, welfare is substantially decreased.

7 Conclusions

This paper provided a quantitative evaluation of the welfare effect of the introduction of proportional taxation in Bulgaria in 2008, an effect that operates through the grey economy channel. Using a micro-founded general-equilibrium model, augmented with informal sector, a computational experiment was performed to evaluate the welfare gain from abolishing the progressive taxation regime and switching to a single (flat) tax rate. The lower effective tax burden in the new tax regime led to the relocation of people into the official sector, stimulated investment in physical capital, and increased output and consumption. Finally, under proportional taxation, the size of the informal sector was three times smaller, and quantitatively consistent with estimates obtained in other studies, *e.g.* OECD (2009), European Commission (2012) figures. Robustness checks were also performed to demonstrate that the results obtained in this study are not sensitive to the choice of model parameters.

The limitations of the study should also be properly acknowledged. Given that the flat tax in Bulgaria was introduced in the same year the financial crisis unravelled, presenting sufficient evidence clearly linking the effect of the tax reforms to macroeconomic outcomes remains a challenge. A possible venue for further research on the Bulgarian case could be the micro-simulations, as in Paulus and Peichl (2009), who use a Computable General Equilibrium (CGE) model to study the potential distributional effects of certain flat tax reforms in Western Europe.

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