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A Progressive Consumption Tax: an Important Instrument for Stabilizing Business Cycles, or just an Exotic Idea?

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A progressive consumption tax: an important instrument for stabilizing business cycles, or just an exotic idea?

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Abstract

We introduce progressive consumption taxation into a real-business-cycle setup augmented with a detailed government sector. We calibrate the model to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2016). We investigate the quantitative importance of the presence of of progressive taxation of consumption expenditures for the stabilization of cyclical fluctuations in Bulgaria. We find the quantitative effect of such a tax to be very small, and thus not important for either business cycle stabilization, or public finance issues.

Keywords: business cycles, progressive consumption taxation, Bulgaria

JEL Classification Codes: E24, E32

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1 Introduction and Motivation

Taxing expenditure instead on income is an economic idea with some important intellectual history, e.g. Fisher and Fisher (1942), Kaldor (1955), and more recently, Seidman (1997a).[1] Even though such a reform in the US is in its theoretical stage, many European countries have organized the public finance model around indirect (consumption) taxation, rather than around direct (income) taxation. Bulgaria is one such example, where VAT revenue makes almost half of total tax revenue (Vasilev 2017d).

At the same time, it can be argued that a cyclical sales tax, and a progressive sales tax in particular (Seidman 1997a), may act as a built-in stabilizer for the economy, in the same way a progressive income tax could: by decreasing demand during expansions, and by increasing demand during downturns. The important difference between the two progressive taxes is that the latter is a tax on factors of production (supply), and not on a component of final demand. Such a progressive tax will only be levied on consumption, not investment.[2][3] So such a tax can encourage saving and investment, as it does not tax capital accumulation. In fact, a progressive consumption tax of the sorts already exists in certain countries, where luxury goods are levied with a higher VAT rate than the rest of the commodities.

We take this proposal seriously, and incorporate a progressive consumption tax in an otherwise standard real-business-cycle (RBC) model with a detailed government sector. In our paper, the treatment of progressiveness is slightly different from the luxury goods taxation idea above, and more in line with ad valorem tariffs in international trade. We think that the analysis of fiscal policy issues should be always performed in a general equilibrium setup. We calibrate the model for Bulgaria in the period 1999-2016, as Bulgaria provides a good testing case for the theory. We then proceed to quantitatively evaluate the effect of such a progressive consumption tax as a tool for business cycle stabilization, and the implications for public finances.To the best of our knowledge, this is the first study on the issue using

[1]Varga (2014) is the most recent theoretical treatment. Her analysis is partial equilibrium, and not based on intertemporally-optimizing consumers.

[2]A tax on investment is like a tax on capital, as it taxes the newly-created capital stock.

[3]Government also does not pay it - or pays it, and then reimburses itself, or subsidizes itself through the use of a lump-sum tax.

modern macroeconomic modelling techniques, and thus an important contribution to the field. Unfortunately, for reasonable degree of consumption tax progresivity, the quantitative effects are tiny. Such a tax is neither a good instrument for demand management over the cycle, or for raising additional tax revenue.[4]

The rest of the paper is organized as follows: Section 2 describes the model framework and describes the decentralized competitive equilibrium system, Section 3 discusses the calibration procedure, and Section 4 presents the steady-state model solution. Sections 5 proceeds with the out-of-steady-state dynamics of model variables, and compared the simulated second moments of theoretical variables against their empirical counterparts. Section 6 concludes the paper.

2 Model Description

There is a representative households which derives utility out of consumption and leisure. The time available to households can be spent in productive use or as leisure. The government taxes consumption spending using a progressive schedule, and levies a common proportional (”flat”) tax on all income, in order to finance wasteful purchases of government consumption goods, and government transfers. On the production side, there is a representative firm, which hires labor and capital to produce a homogenous final good, which could be used for consumption, investment, or government purchases.

2.1 Households

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

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + \gamma \ln(1-h_t) \right\} \tag{2.1}$$

whereE_0 denotes household's expectations as of period 0, c_t denotes household's private consumption in period t, h_t are hours worked in period t, $0 < \beta < 1$ is the discount factor,

[4]We do not propose abolishing all income taxation with a progressive consumption tax. Exploring this is left for future research.

$0 < \gamma < 1$ is the relative weight that the household attaches to leisure.[5]

The household starts with an initial stock of physical capital $k_0 > 0$, and has to decide how much to add to it in the form of new investment. The law of motion for physical capital is

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

and $0 < \delta < 1$ is the depreciation rate. Next, the real interest rate is r_t, hence the before-tax capital income of the household in period t equals $r_t k_t$. In addition to capital income, the household can generate labor income. Hours supplied to the representative firm are rewarded at the hourly wage rate of w_t, so pre-tax labor income equals $w_t h_t$. Lastly, the household owns the firm in the economy and has a legal claim on all the firm's profit, π_t.

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

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ \ln c_t + \gamma \ln(1-h_t) \Big\} \tag{2.3}$$

s.t.

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

where where τ_t^c is the progressive tax on consumption, τ^y is the proportional income tax rate $(0 < \tau_t^c, \tau^y < 1)$, levied on both labor and capital income, and g_t^t denotes government transfers. The household takes the two tax rates $\{\tau_t^c, \tau^y\}_{t=0}^{\infty}$, government spending categories, $\{g_t^c, g_t^t\}_{t=0}^{\infty}$, profit $\{\pi_t\}_{t=0}^{\infty}$, the realized technology process $\{A_t\}_{t=0}^{\infty}$, prices $\{w_t, r_t\}_{t=0}^{\infty}$, and chooses $\{c_t, h_t, k_{t+1}\}_{t=0}^{\infty}$ to maximize its utility subject to the budget constraint.[6]

The progressivity of the consumption tax in this paper is captured by adopting the functional

[5] This utility function is equivalent to a specification with a separable term containing government consumption, e.g. Baxter and King (1993). Since in this paper we focus on the exogenous (observed) policies, and the household takes government spending as given, the presence of such a term is irrelevant. For the sake of brevity, we skip this term in the utility representation above.

[6] Note that by choosing k_{t+1} the household is implicitly setting investment i_t optimally.

form utilized in Vasilev (2016a, 2017e) for the progressivity of the income tax schedule:

$$\tau_t^c = \eta \left(\frac{c_t}{c} \right)^{\phi} \tag{2.5}$$

where $\eta > 0$ is the effective average consumption tax rate, and $0 < \phi < 1$ captures the degree of progressivity of the sales tax.

The first-order optimality conditions as as follows:

$$c_t \quad : \quad \frac{1}{c_t} = \lambda_t[1 + (1 + \phi)\tau(c_t)] \tag{2.6}$$

$$h_t \quad : \quad \frac{\gamma}{1 - h_t} = \lambda_t(1 - \tau)w_t \tag{2.7}$$

$$k_{t+1} \quad : \quad \lambda_t = \beta E_t \lambda_{t+1}[1 + (1 - \tau)r_{t+1} - \delta] \tag{2.8}$$

$$TVC \quad : \quad \lim_{t \to \infty} \beta^t \lambda_t k_{t+1} = 0 \tag{2.9}$$

where λ_t is the Lagrangean multiplier attached to household's budget constraint in period t. The interpretation of the first-order conditions above is as follows: the first one states that for each household, the marginal utility of consumption equals the marginal utility of wealth, corrected for the consumption tax rat, and taking into consideration the effect of the progressivity of the consumption tax, or "the extra burden of a tax," which acts like an inflation factor. The second equation states that when choosing labor supply optimally, at the margin, each hour spent by the household working for the firm should balance the benefit from doing so in terms of additional income generates, and the cost measured in terms of lower utility of leisure. The third equation is the so-called "Euler condition," which describes how the household chooses to allocate physical capital over time. The last condition is called the "transversality condition" (TVC): it states that at the end of the horizon, the value of physical capital should be zero.

When we construct the marginal rate of substitution expression, we obtain

$$\frac{\gamma c_t}{1 - h_t} = \frac{(1 - \tau)w_t}{1 + (1 + \phi)\tau(c_t)}. \tag{2.10}$$

Therefore, the progressivity of the consumption tax rate is like an increase in the (progressivity of the) tax on labor, thus affecting indirectly labor supply, and the wage rate. However, given that the consumption tax is a tax on final demand, it may be less distortionary to raise a certain amount of tax revenue, at least along the transition path.[7]

2.2 Firm problem

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

$$\Pi_t = A_t k_t^{\alpha} h_t^{1-\alpha} - r_t k_t - w_t h_t, \tag{2.11}$$

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

$$k_t \;:\; \alpha \frac{y_t}{k_t} = r_t, \tag{2.12}$$

$$h_t \;:\; (1-\alpha) \frac{y_t}{h_t} = w_t. \tag{2.13}$$

In equilibrium, given that the inputs of production are paid their marginal products, $\pi_t = 0$, $\forall t$.

2.3 Government

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

$$g_t^c + g_t^t = \tau_t^c c_t + \tau^y [w_t h_t + r_t k_t] \tag{2.14}$$

[7] In this paper we abstract away from administration costs and evasion issues. We abstract away from inequality aspects of progressive taxation as well. In the model, the consumption tax schedule is akin to ad valorem tax on imports in international trade literature, the difference is that the tax is being levied on domestically consumed final goods. Furthermore, many countries even have multiple, differentiated VAT rates.

Income tax rate and government consumption-to-output ratio would be chosen to match the average share in data, and consumption taxation is progressive. Finally, government transfers would be determined residually in each period so that the government budget is always balanced.[8]

2.4 Dynamic Competitive Equilibrium (DCE)

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

3 Data and Model Calibration

To characterize business cycle fluctuations with an endogenous depreciation rate in Bulgaria, we will focus on the period following the introduction of the currency board (1999-2016). Quarterly data on output, consumption and investment was collected from National Statistical Institute (2017), while the real interest rate is taken from Bulgarian National Bank Statistical Database (2017). The calibration strategy described in this section follows a long-established tradition in modern macroeconomics: first, as in Vasilev (2016), the discount factor, $\beta = 0.982$, is set to match the steady-state capital-to-output ratio in Bulgaria, $k/y = 13.964$, in the steady-state Euler equation. The labor share parameter, $1 - \alpha = 0.571$, is obtained as in Vasilev (2017d), and equals the average value of labor income in aggregate output over the period 1999-2016. This value is slightly higher as compared to other studies on developed economies, due to the overaccumulation of physical capital, which was part of the ideology of the totalitarian regime, which was in place until 1989. Next, the average income tax rate was set to $\tau^y = 0.1$. This is the average effective tax rate on income between 1999-2007, when Bulgaria used progressive income taxation, and equal to the proportional

[8] It should be evident that the progressivity of consumption taxation does not affect tax revenue in the steady state.

income tax rate introduced as of 2008. Similarly, the average tax rate on consumption is set to its value over the period, $\eta = 0.2$. Following Vasilev (2016a, 2017e), we set the degree of progressivity equal to $\phi = 0.43$.[9]

Next, the relative weight attached to the utility out of leisure in the household's utility function, γ, is calibrated to match that in steady-state consumers would supply one-third of their time endowment to working. This is in line with the estimates for Bulgaria (Vasilev 2017a) as well over the period studied. Net, the steady-state depreciation rate of physical capital in Bulgaria, $\delta = 0.013$, was taken from Vasilev (2016). It was estimated as the average quarterly depreciation rate over the period 1999-2014. Finally, the processes followed by TFP processes and energy prices, are estimated from the detrended series by running an AR(1) regression and saving the residuals. Table 1 below summarizes the values of all model parameters used in the paper.

Table 1: Model Parameters

Parameter	Value	Description	Method
β	0.982	Discount factor	Calibrated
α	0.429	Capital Share	Data average
$1-\alpha$	0.571	Labor Share	Calibrated
γ	0.873	Relative weight attached to leisure	Calibrated
δ	0.013	Depreciation rate on physical capital	Data average
τ^y	0.100	Average tax rate on income	Data average
η	0.200	VAT/consumption tax rate	Data average
ϕ	0.430	Degree of progressivity, consumption taxation	Set
ρ_a	0.701	AR(1) persistence coefficient, TFP process	Estimated
σ_a	0.044	st. error, TFP process	Estimated

[9] This corresponds to the degree of progressivity of the income tax schedule during the period 1993-2007 in Bulgaria.

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

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	0.648	0.674
i/y	Investment-to-output ratio	0.201	0.175
k/y	Capital-to-output ratio	13.96	13.96
g^c/y	Government consumption-to-output ratio	0.151	0.151
wh/y	Labor income-to-output ratio	0.571	0.571
rk/y	Capital income-to-output ratio	0.429	0.429
h	Share of time spent working	0.333	0.333
$\bar{r}$	After-tax net return on capital	0.014	0.016

5 Out of steady-state model dynamics

Since the model does not have an analytical solution for the equilibrium behavior of variables outside their steady-state values, we need to solve the model numerically. This is done by log-linearizing the original equilibrium (non-linear) system of equations around the steady-state. This transformation produces a first-order system of stochastic difference equations. First, we study the dynamic behavior of model variables to an isolated shock to the total factor productivity process, and then we fully simulate the model to compare how the second moments of the model perform when compared against their empirical counterparts.

5.1 Impulse Response Analysis

This subsection documents the impulse responses of model variables to a 1% surprise innovation to technology. The impulse response functions (IRFs) are presented in Fig. 1 and on the next page. As a result of the one-time unexpected positive shock to total factor productivity, output increases upon impact. This expands the availability of resources in the economy, so used of output - consumption, investment, and government consumption also increase contemporaneously. The impulse responses are almost identical to the responses in a model with a constant consumption tax rate. The progressivity in the sales tax acts in the same way as an increase in risk aversion, but the quantitative effect is very small.

At the same time, the increase in productivity increases the after-tax return on the two factors of production, labor and capital. The representative households then respond to the incentives contained in prices and start accumulating capital, and supplies more hours worked. In turn, the increase in capital input feeds back in output through the production function and that further adds to the positive effect of the technology shock. In the labor market, the wage rate increases, and the household increases its hours worked. In turn, the increase in total hours further increases output, again indirectly.

Over time, as capital is being accumulated, its after-tax marginal product starts to decrease, which lowers the households' incentives to save. As a result, physical capital stock eventually returns to its steady-state, and exhibits a hump-shaped dynamics over its transition path. The rest of the model variables return to their old steady-states in a monotone fashion as

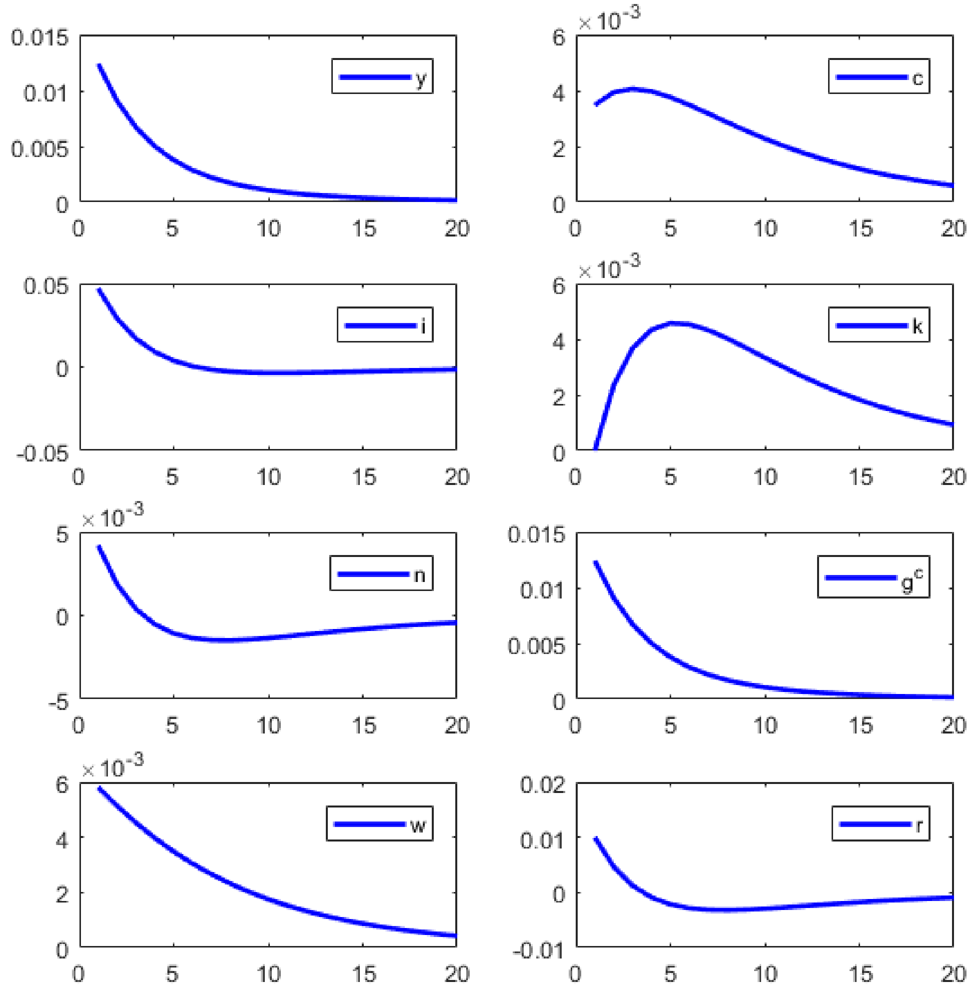

Figure 1: Impulse Responses to a 1% surprise innovation in technology

the effect of the one-time surprise innovation in technology dies out.

5.2 Simulation and moment-matching

As in Vasilev (2017b), we will now simulate the model 10,000 times for the length of the data horizon. Both empirical and model simulated data is detrended using the Hodrick-Prescott (1980) filter. Table 3 on the next page summarizes the second moments of data (relative volatilities to output, and contemporaneous correlations with output) versus the same moments computed from the model-simulated data at quarterly frequency.[10] To minimize the sample error, the simulated moments are averaged out over the computer-generated draws. As in Vasilev (2016, 2017b, 2017c), the model matches quite well the absolute volatility of output and investment. By construction, government consumption in the model varies as much as output. In addition, the predicted consumption and investment volatilies are too high. The increse in consumption variability could be attributed to the progressive consumption tax. Still, the model is qualitatively consistent with the stylized fact that consumption generally varies less than output, while investment is more volatile than output.

Table 3: Business Cycle Moments

	Data	Model
σ_y	0.05	0.05
σ_c/σ_y	0.55	0.98
σ_i/σ_y	1.77	2.24
σ_g/σ_y	1.21	1.00
σ_h/σ_y	0.63	0.29
σ_w/σ_y	0.83	0.81
$\sigma_{y/h}/\sigma_y$	0.86	0.81
$corr(c,y)$	0.85	0.81
$corr(i,y)$	0.61	0.82
$corr(g,y)$	0.31	1.00
$corr(h,y)$	0.49	0.26
$corr(w,y)$	-0.01	0.96

With respect to the labor market variables, the variability of employment predicted by the model is lower than that in data, but the variability of wages in the model is very close to that in data. This is yet another confirmation that the perfectly-competitive assumption, e.g. Vasilev (2009), as well as the benchmark calibration here, does not describe very well the dynamics of labor market variables. Next, in terms of contemporaneous correlations, the model systematically over-predicts the pro-cyclicality of the main aggregate variables - consumption, investment, and government consumption. This, however, is a common limitation

[10] The model-predicted 95 % confidence intervals are available upon request.

of this class of models. Along the labor market dimension, the contemporaneous correlation of employment with output is too low. With respect to wages, the model predicts strong cyclicality, while wages in data are acyclical. This shortcoming is well-known in the literature and an artifact of the wage being equal to the labor productivity in the model.

In the next subsection, as in Vasilev (2016), we investigate the dynamic correlation between labor market variables at different leads and lags, thus evaluating how well the model matches the phase dynamics among variables. In addition, the autocorrelation functions (ACFs) of empirical data, obtained from an unrestricted VAR(1) are put under scrutiny and compared and contrasted to the simulated counterparts generated from the model.

5.3 Auto- and cross-correlation

This subsection discusses the auto-(ACFs) and cross-correlation functions (CCFs) of the major model variables. The coefficients empirical ACFs and CCFs at different leads and lags are presented in Table 4 below against the averaged simulated AFCs and CCFs.[11]

As seen from Table 4 above, the model compares relatively well vis-a-vis data. Empirical ACFs for output and investment are slightly outside the confidence band predicted by the model, while the ACFs for total factor productivity and household consumption are well-approximated by the model. The persistence of labor market variables are also relatively well-described by the model dynamics. Overall, the model with habits in consumption generates too much persistence in output and both employment and unemployment, and is subject to the criticism in Nelson and Plosser (1992), Cogley and Nason (1995) and Rotemberg and Woodford (1996b), who argue that the RBC class of models do not have a strong internal propagation mechanism besides the strong persistence in the TFP process. In those models, e.g. Vasilev (2009), and in the current one, labor market is modelled in the Walrasian market-clearing spirit, and output and unemployment persistence is low.

[11]Following Canova (2007), this is used as a goodness-of-fit measure.

Table 4: Autocorrelations for Bulgarian data and the model economy

		k			
Method	Statistic	0	1	2	3
Data	$corr(u_t, u_{t-k})$	1.000	0.765	0.552	0.553
Model	$corr(u_t, u_{t-k})$	1.000	0.957	0.906	0.849
	(s.e.)	(0.000)	(0.027)	(0.052)	(0.075)
Data	$corr(n_t, n_{t-k})$	1.000	0.484	0.009	0.352
Model	$corr(n_t, n_{t-k})$	1.000	0.957	0.906	0.849
	(s.e.)	(0.000)	(0.027)	(0.052)	(0.075)
Data	$corr(y_t, y_{t-k})$	1.000	0.810	0.663	0.479
Model	$corr(y_t, y_{t-k})$	1.000	0.955	0.901	0.840
	(s.e.)	(0.000)	(0.028)	(0.055)	(0.079)
Data	$corr(a_t, a_{t-k})$	1.000	0.702	0.449	0.277
Model	$corr(a_t, a_{t-k})$	1.000	0.954	0.900	0.836
	(s.e.)	(0.000)	(0.0269	(0.055)	(0.080)
Data	$corr(c_t, c_{t-k})$	1.000	0.971	0.952	0.913
Model	$corr(c_t, c_{t-k})$	1.000	0.958	0.908	0.851
	(s.e.)	(0.000)	(0.026)	(0.051)	(0.074)
Data	$corr(i_t, i_{t-k})$	1.000	0.810	0.722	0.594
Model	$corr(i_t, i_{t-k})$	1.000	0.952	0.892	0.821
	(s.e.)	(0.000)	(0.030)	(0.057)	(0.082)
Data	$corr(w_t, w_{t-k})$	1.000	0.760	0.783	0.554
Model	$corr(w_t, w_{t-k})$	1.000	0.957	0.907	0.850
	(s.e.)	(0.000)	(0.026)	(0.051)	(0.075)

Next, as seen from Table 5 below, over the business cycle, in data labor productivity leads employment. The model, however, cannot account for this fact. As in the standard RBC model a technology shock can be regarded as a factor shifting the labor demand curve, while holding the labor supply curve constant. Therefore, the effect between employment and labor productivity is only a contemporaneous one.

Table 5: Dynamic correlations for Bulgarian data and the model economy

		k						
Method	Statistic	-3	-2	-1	0	1	2	3
Data	$corr(n_t,(y/n)_{t-k})$	-0.342	-0.363	-0.187	-0.144	0.475	0.470	0.346
Model	$corr(n_t,(y/n)_{t-k})$	-0.014	-0.029	-0.051	-0.771	-0.294	-0.247	-0.208
	(s.e.)	(0.338)	(0.293)	(0.239)	(0.194)	(0.250)	(0.293)	(0.332)
Data	$corr(n_t,w_{t-k})$	0.355	0.452	0.447	0.328	-0.040	-0.390	-0.57
Model	$corr(n_t,w_{t-k})$	-0.014	-0.029	-0.051	-0.771	-0.294	-0.247	-0.208
	(s.e.)	(0.338)	(0.293)	(0.239)	(0.194)	(0.250)	(0.293)	(0.332)

6 Conclusions

We introduce progressive consumption taxation into a real-business-cycle setup augmented with a detailed government sector. We calibrate the model to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2016). We investigate the quantitative importance of the presence of of progressive taxation of consumption expenditures for the propagation of cyclical fluctuations in Bulgaria. We find the quantitative effect of such a tax to be very small, and thus not important for either stabilizing the business cycle, or public finance issues.

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