Center for
Economic Theories and Policies
Sofia University St. Kliment Ohridski
Faculty of Economics and Business Administration

ISSN: 2367-7082

Bulgarian Economic Papers

A Real-Business-Cycle Setup with Habits in Leisure: Lessons for Bulgaria (1999-2022)

Aleksandar Vasilev

BEP 01-2025
Publication: January 2025

Online: http://www.bep.bg
Contact for submissions and requests: bep@feb.uni-sofia.bg

A Real-Business-Cycle Setup with Habits in Leisure: Lessons for Bulgaria (1999-2022)

Aleksandar Vasilev*

January 1, 2025

Abstract

Habits in leisure a la Kydland and Prescott (1982) are introduced into a real-business-cycle setup augmented with a detailed government sector. The model is calibrated to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2022). The quantitative importance of the presence of habits in leisure is investigated for cyclical fluctuations in Bulgaria, and the ability of this extension to address the wage-hours puzzle in particular. The quantitative effect of habits in leisure is found to be small, and often working in the wrong direction. Hours and wages vary much less than in data, wages are more pro-cyclical, and hours are counter-cyclical. Habits in leisure mechanism is thus not a good candidate to solve the hours-wages puzzle in business cycle literature.

Keywords: business cycles, habits in leisure, Bulgaria

JEL Classification Codes: E24, E32

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

1 Introduction and Motivation

The hours-wages puzzle is one unpleasant result in the real business cycle (RBC) literature, as pointed by Kydland and Prescott (1982) in their pioneering paper. In particular, the standard RBC model predicts strong cyclicality of wages, while in data wages are acyclical. In this paper, we introduce simple habits in leisure, i.e., hours worked in the previous period will carry a painful memory effect, which increases the disutility from work. We rationalize this mechanism as follows: most of the workers do full-time shifts, and varying hours is painful and unpleasant. Alternatively, we can think of the habit term as some kind of transaction cost - e.g., additional accounting cost, etc. In general, the RBC model is better at studying employment than unemployment. Furthermore, in Europe there is a higher degree of employment protection, and higher proportion of public employment (states are usually the biggest employers). In terms of job flows, individuals leaving one full-time job, are searching for another full-time job. When reaching retirement age, often effort is decreased, but not hours.

Net, going back to the original paper of Kydland and Prescott (1982), we add value by trying to rationalize their modelling choice with the "habits in consumption" analogy (e.g. Vasilev 2019). More specifically, the presence of consumption habits are shown to help the model improve its performance against empirical data. This, in this paper we not only revisit an older issue, but also link different literatures.For simplicity, in our model, the utility of leisure depends on not just current hours, but also on hours worked in the previous period (lagged hours). Of course, including more lags is possible: in the original paper, Kydland and Prescott (1982) have a "geometric decay effect" of past hours. However, beside the increase in the computational complexity, there are no significant changes in a quantitative sense.[1]

This habits-in-leisure mechanism is taken seriously, and this paper incorporates it into an otherwise standard real-business-cycle (RBC) model with a detailed government sector, where

[1]Yet another downside is that the model is introducing an ad hoc change in the primitives (preferences), which are not directly observable, and it is methodologically at least not so great approach to try to generate new results.

the latter is done for greater realism. The model is calibrated for Bulgaria in the period 1999-2018, as Bulgaria provides a good testing case for the theory. The paper then proceeds to quantitatively evaluate the effect of such a mechanism as a way to resolve the hours-wages puzzle in the business cycle literature. This is the first study on the issue, and thus an important contribution to the field. Unfortunately, for reasonable degree of habits in leisure, the quantitative effects are tiny, and often in the wrong direction. Hours and wages vary much less than in data, wages are more pro-cyclical, and hours are counter-cyclical. Habits in leisure mechanism is thus not a good candidate to solve the hours-wages puzzle in business cycle literature.

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, and levies a common proportional (”flat”) tax on labor and capital income 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 homogeneous 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

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

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, $0 < \gamma < 1$ is the relative weight that the household attaches to leisure. Parameter $0 < \phi < 1$ measures the disutility from varying hours worked in two adjacent periods. Borrowing heavily from the literature on consumption habits, we will refer to this process as "habits in leisure."[2]

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

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

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

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

s.t.

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

where where τ^c is the tax on consumption, τ^y is the proportional income tax rate on labor and capital $(0 < \tau^c, \tau^y < 1)$, and g_t^t denotes government transfers. The household takes as given h_{-1}, the two tax rates $\{\tau^c, \tau^y\}$, 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

[2] More specifically, these are "internal" habits, as the household can react to its own past hours worked. Alternatively, we can model the habits as "external", where the household will react to the aggregate/average past labor hours worked. With external habits, the results will be quantitatively smaller, as the household takes past aggregate hours as given, and will not react to them.

maximize its utility subject to the budget constraint.[3]

The first-order optimality conditions as as follows:

$$\begin{aligned}
c_t &: \frac{1}{c_t} = \lambda_t(1+\tau^c) \\
h_t &: \frac{\gamma}{1-h_t-\phi h_{t-1}} + \beta\phi\frac{\gamma}{1-h_{t+1}-\phi h_t} = \lambda_t(1-\tau^y)w_t \\
k_{t+1} &: \lambda_t = \beta E_t\lambda_{t+1}[(1-\tau^y)r_{t+1}-\delta] \\
TVC &: \lim_{t\to\infty}\beta^t\lambda_t k_{t+1} = 0,
\end{aligned}$$

where λ_t is the Lagrangian 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 rate. 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, taking into consideration the presence of habits in 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.

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

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

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,

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

i.e.:

$$\begin{aligned} k_t &: \alpha \frac{y_t}{k_t} = r_t, \\ h_t &: (1-\alpha)\frac{y_t}{h_t} = w_t. \end{aligned}$$

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:

$$g_t^c + g_t^t = \tau^c c_t + \tau^y [w_t h_t + r_t k_t + \pi_t]$$

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.

2.4 Dynamic Competitive Equilibrium (DCE)

For a given process followed by technology $\{A_t\}_{t=0}^{\infty}$ tax rates $\{\tau^c, \tau^y\}_{t=0}^{\infty}$, and initial conditions for capital stock and hours $\{k_0, h_{-1}\}$, 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 in Bulgaria, we will focus on the period following the introduction of the currency board (1999-2022). Quarterly data on output, consumption and investment was collected from National Statistical Institute (2024), while the real interest rate is taken from Bulgarian National Bank Statistical Database (2024). 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 1999-2018. 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 labor and capital 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 income tax rate introduced as of 2008. Similarly, the average tax rate on consumption is set to its value over the period, $\tau^c = 0.2$.

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. Next, 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. The degree of habits in leisure is set to $\phi = 0.2$.[4] Finally, the process followed by the TFP process is 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.

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

[4] A relatively low value - lower than the parameter in the consumption habits literature - was chosen due to the normalization of the total time endowment to unity, and the steady-state value of hours worked being a third of total time. Computational experiments with alternative values, e.g. $\phi = 0.1$ and $\phi = 0.4$ did not yield very different results.

Table 1: Model Parameters

Parameter	Value	Description	Method
β	0.982	Discount factor	Calibrated
α	0.429	Capital Share	Data average
γ	1.220	Relative weight attached to leisure	Calibrated
δ	0.013	Depreciation rate on physical capital	Data average
τ^y	0.100	Average tax rate on labour and capital income	Data average
τ^c	0.200	VAT/consumption tax rate	Data average
ϕ	0.200	Strength of habits in leisure	Set
ρ_a	0.701	AR(1) persistence coefficient, TFP process	Estimated
σ_a	0.044	st. error, TFP process	Estimated

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.

5 Out of steady-state model dynamics: model simulation

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-

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

state. This transformation produces a first-order system of stochastic difference equations. Then we fully simulate the model to compare how the second moments of the model perform when compared against their empirical counterparts.

As in Vasilev (2017b), we run 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. The "Model" is the case with the habits in leisure mechanism, while the "Benchmark RBC" is a setup with no habits ($\phi = 0$). In addition, to minimize the sample error, the simulated moments are averaged out over the computer-generated draws. As in Vasilev (2016, 2017b, 2017c), both models match quite well the absolute volatility of output. By construction, government consumption in the model also varies as much as output. In addition, the predicted consumption and investment volatilities are too high. Still, the model is qualitatively consistent with the stylized fact that consumption generally varies less than output, while investment is more volatile than output. The model with habits in leisure produces smoother investment series (a move in the right direction), but a more slightly more volatile consumption series (a move in the wrong direction).

Table 3: Business Cycle Moments

	Data	Model with habits in leisure	Benchmark RBC ($\phi = 0$)
σ_y	0.05	0.05	0.05
σ_c/σ_y	0.55	0.87	0.82
σ_i/σ_y	1.77	2.16	2.35
σ_g/σ_y	1.21	1.00	1.00
σ_h/σ_y	0.63	0.27	0.28
σ_w/σ_y	0.83	0.68	0.86
$\sigma_{y/h}/\sigma_y$	0.86	0.68	0.86
$corr(c, y)$	0.85	0.91	0.90
$corr(i, y)$	0.61	0.80	0.83
$corr(g, y)$	0.31	1.00	1.00
$corr(h, y)$	0.49	-0.37	0.59
$corr(w, y)$	-0.01	0.99	0.96

With respect to the labor market variables, the variability of employment (hours) predicted by the model with leisure is lower than that in data, but the difference with the benchmark RBC model is tiny.[5] In both setups, hours very too little. Next, with habits in leisure, wage variability is much lower than that in data; the standard RBC model dominates along this dimension.

Next, in terms of contemporaneous correlations, both model systematically over-predicts the pro-cyclicality of the main aggregate variables - consumption, investment, and government consumption. This, however, is a common limitation of this class of models. Along the labor market dimension, the contemporaneous correlation of employment with output is of th wrong size when habits are present. The dependence on past hours in utility makes labor supply counter-cyclical, which comes at odds with date. Technically, hours are a state (predetermined) variable when there are habits in leisure. The standard RBC model again

[5] This is 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.

does a better job, though predicting a bit too strong pro-cyclicality of hours. With respect to wages, both model predicts too 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. Still, the presence of habits in leisure seems to accentuate the pro-cyclicality of wages, which brings the model further away from data.

Conclusions

Habits in leisure a la Kydland and Prescott (1982) are introduced into a real-business-cycle setup augmented with a detailed government sector. The model is calibrated to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2022). The quantitative importance of the presence of habits in leisure is investigated for cyclical fluctuations in Bulgaria, and the ability of this extension to address the wage-hours puzzle in particular. The quantitative effect of habits in leisure is found to be small, and often working in the wrong direction. Hours and wages vary much less than in data, wages are more pro-cyclical, and hours are counter-cyclical. Habits in leisure mechanism is thus not a good candidate to solve the hours-wages puzzle in business cycle literature.

References

Bulgarian National Bank. 2024. Bulgarian National Bank Statistics. Available on-line at www.bnb.bg. Accessed on Aug. 28, 2024.

Hodrick, Robert and Edward Prescott. 1980. ”Post-war US business cycles: An empirical investigation.” *Unpublished manuscript* (Carnegie-Mellon University, Pittsburgh, PA).

Kydland, F., and Prescott, Edward C. 1982. ”Time to Build and Aggregate Fluctuations,” *Econometrica*, vol. 50(6), pp. 1345-1370.

National Statistical Institute. 2024. Aggregate Statistical Indicators. Available on-line at www.nsi.bg. Accessed on Aug. 28, 2024.

Vasilev, A. (2019) "Are habits in consumption important for the propagation of business cycle fluctuations in Bulgaria?," *Central European Journal of Economic Modelling and Econometrics*, Vol. 11(3): 133-151.

Vasilev, A. (2017a) "Business Cycle Accounting: Bulgaria after the introduction of the currency board arrangement (1999-2014), *European Journal of Comparative Economics*, 14(2): 197-219.

Vasilev, A. (2017b) "A Real-Business-Cycle model with efficiency wages and a government sector: the case of Bulgaria," *Central European Journal of Economics and Econometrics*, 9(4): 359-377.

Vasilev, A. (2017c) "A Real-Business-Cycle model with reciprocity in labor relations and fiscal policy: the case of Bulgaria," *Bulgarian Economic Papers* BEP 03-2017, Center for Economic Theories and Policies, Sofia University St. Kliment Ohridski, Faculty of Economics and Business Administration, Sofia, Bulgaria.

Vasilev, A. (2017d) "VAT Evasion in Bulgaria: A General-Equilibrium Approach," *Review of Economics and Institutions*, 8(2): 2-17.

Vasilev, A. (2016). "Progressive taxation and (in)stability in an endogenous growth model with human capital accumulation," *Journal of Economics and Econometrics* 59(2): 1-15.

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