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An RBC Model with Epstein-Zin (non-expected-utility) Recursive Preferences: Lessons from Bulgaria (1999-2018)

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An RBC model with Epstein-Zin (non-expected-utility) recursive preferences: lessons from Bulgaria (1999-2018)

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Abstract

We introduce Epstein-Zin (1989, 1991) preferences 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 (1999-2018). We investigate the quantitative importance of the presence of "early resolution of uncertainty" motive for the propagation of cyclical fluctuations in Bulgaria. Allowing for Epstein-Zin preferences improves the model performance against data, and in addition this extended setup dominates the standard RBC model framework, *e.g.*, Vasilev (2009).

Keywords: Business fluctuations, Epstein-Zin preferences, Bulgaria

JEL Classification Codes: E32, E22, E37

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1 Introduction and Motivation

Consumer preferences featured by households play a crucial role in an economic model, being an important part of the set of model primitives, which is comprised of preferences, endowments, and technology. As argued in Backus *et al.* (2005), household preferences are an unchanging feature of a model in which rational optimizing agents could face a wide range of different circumstances, such as external environments, institutions, or policies. For each scenario, we derive consumers' optimal decision rules from the same underlying preferences. In addition, preferences describe the explicit objective specified in advance which allow us to evaluate the welfare effects of different policies or changes in the economic environment.

Furthermore, as pointed in Weil (1990), researchers should distinguish between risk aversion and the willingness to substitute consumption over time in their models. After all, the two parameters are distinct features of household's preferences, and should be parameterized separately from each other. However, in the usual formulation with time-separable preferences one is reciprocal of the other. This is a problem as in data both a low elasticity of inter-temporal substitution, and low risk aversion have been measured. Lastly, we want to be clear which channel exactly is the quantitatively important mechanism at play when it comes to the effect of macroeconomic policies.

In macroeconomics, the use of *generalized isoelastic utility functions*, which have constant (but unrelated) coefficients of risk aversion and elasticity of intertemporal substitution, have become increasingly popular.[1] In addition, such modelling strategy gives some flexibility to the model as well. Furthermore, those functions feature so-called recursive preferences, which have the following important advantage: that they can be used by researchers who want to focus on the trade-off between current-period utility and the utility to be derived from all future periods. Since an agent's actions today can affect the evolution of all opportunities in the future, summarizing the future consequences of these actions with a single index, *i.e.*, future utility (or "continuation value"), allows multi-period decision problems to be reduced to a two-period trade-off is between current utility and a certainty equivalent of

[1]Note that the elasticity of intertemporal substitution refers to deterministic consumption paths only. It is not well-defined in an environment featuring uncertainty.

random future utility, as shown in Epstein and Zin (1989, 1991). Importantly, with those preferences households would like the outcome of an uncertain event (lottery) to be revealed earlier, instead of later.

In this paper we will take this preference considerations seriously, and proceed to investigate the quantitative importance of the presence of that so-called "early resolution of uncertainty" motive for the propagation of cyclical fluctuations in Bulgaria. To this end, we introduce Epsten-Zin (1989, 1991) consumption preferences into a real-business-cycle setup augmented with a detailed government sector. We then calibrate the model to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2018). Allowing for Epstein-Zin preferences improves the model performance against data, and in addition this extended setup dominates the standard RBC model framework, *e.g.*, Vasilev (2009).[2]

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 tax on all income, in order to finance

[2]Following the work of Hall (1997), Nakajima and Rios-Rull (2005) provide a microfoundation for the marginal-rate-of-substitution shift showing that a representative agent model that features such a shock "can be viewed as a reduced form of a heterogeneous-agents economy with incomplete markets." On the other hand, Gourio (2012) provides a very appealing microfoundation for the discounting shock as he shows that time varying impatience parameters may be interpreted as a reduced form of a model that features a time varying probability of some economic disaster which plays a critical role in the agents' (relative) assessment of investment alternatives.

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 Household

There is a representative household, which maximizes a utility function, which features recursive preferences as in Epsten and Zin (1989, 1991) and Weil (1990):

$$V_t = \left[(1-\beta)[c_t^{\nu}(1-h_t)^{1-\nu}]^{\frac{1-\gamma}{\theta}} + \beta [E_t V_{t+1}^{1-\gamma}]^{\frac{1}{\theta}} \right]^{\frac{\theta}{1-\gamma}} \tag{2.1}$$

where

$$\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}, \tag{2.2}$$

and V_t is the value function as of period t, $0 < \nu, 1-\nu < 1$ are the utility weights attached to consumption and leisure, respectively; $[E_t V_{t+1}^{1-\gamma}]^{\frac{1}{\theta}}$ is the *risk-adjusted* expectation operator at of period t, 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.[3]

With Epstein-Zin preferences, the elasticity of intertemporal substitution (EIS), and the coefficient of relative risk aversion (CRRA) are separated. More specifically, $\gamma \geq 0$ is the parameter that controls risk aversion, while $\psi \geq 0$ is the IES.[4] Note that for values of $\gamma > 1$, and $\psi > 1$, the agent has a preference for "an early resolution of uncertainty" (Kreps and Porteus 1978, Weil 1990).[5] In other words, the household is averse to volatility in future utility, and more specifically, the recursive utility formulation adds curvature with respect

[3]Importantly, these preferences are stationary in the sense of Koopmans (1960).

[4]Therefore, this class of preferences responds to Hall's (1988) critique. In contrast, with other functional forms the elasticity of substitution and the coefficient of relative risk aversion are reciprocals of one another.

[5]Note that, as in Epstein and Zin (1991), early resolution of uncertainty requires

$$1-\gamma < 1-\frac{1}{\psi} \quad \text{or} \quad \frac{1}{\psi} < \gamma \tag{2.3}$$

For $\psi, \gamma > 1$ the condition above is satisfied.

to future risks.[6]

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

$$k_{t+1} = i_t + (1-\delta)k_t \tag{2.4}$$

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

$$\max_{\{c_t,h_t,k_{t+1}\}_{t=0}^{\infty}} V_t = \left[(1-\beta)[c_t^{\nu}(1-h_t)^{1-\nu}]^{\frac{1-\gamma}{\theta}} + \beta[E_t V_{t+1}^{1-\gamma}]^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}} \tag{2.5}$$

s.t.

$$(1+\tau^c)c_t + k_{t+1} - (1-\delta)k_t = (1-\tau^y)[w_t h_t + r_t k_t] + g_t^t + \pi_t \tag{2.6}$$

where τ^c is the tax on consumption, τ^y is the proportional income tax rate ($0 < \tau^c, \tau^y < 1$), levied on both labor and capital income, and g_t^t denotes government transfers. The household takes the two tax rates $\{\tau^c, \tau^y\}$, 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 maximize its utility subject to the budget constraint.[7] The constraint optimization problem

[6] As pointed out in Kaltenbrunner and Lochstoer (2010), investors with Epstein-Zin preferences also demand a premium for holding asserts, which are correlated with shocks to expected consumption growth. When households have preferences for early resolution of uncertainty, these shocks carry a positive price of "long-run risk" (Bansal and Yaron 2004). In applied work, this risk can be potentially defined using shocks to the continuation value, normalized by consumption, via shocks to the wealth-to-consumption ratio, or shocks to the expected future consumption growth.

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

generates the following optimality conditions:

$$
\begin{aligned}
V_t &: \; V_t - \left[(1-\beta)[c_t^{\nu}(1-h_t)^{1-\nu}]^{\frac{1-\gamma}{\theta}} + \beta[E_t V_{t+1}^{1-\gamma}]^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}} = 0 && (2.7)\\
c_t &: \; \nu\left[(1-\beta)[c_t^{\nu}(1-h_t)^{1-\nu}]^{\frac{1-\gamma}{\theta}} + \beta[E_t V_{t+1}^{1-\gamma}]^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}-1} \times \\
&\quad (1-\beta)c_t^{\frac{\nu(1-\gamma)}{\theta}-1}(1-h_t)^{\frac{(1-\nu)(1-\gamma)}{\theta}} = \lambda_t(1+\tau^c) && (2.8)\\
h_t &: \; (1-\nu)\left[(1-\beta)[c_t^{\nu}(1-h_t)^{1-\nu}]^{\frac{1-\gamma}{\theta}} + \beta[E_t V_{t+1}^{1-\gamma}]^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}-1} \times \\
&\quad (1-\beta)c_t^{\frac{\nu(1-\gamma)}{\theta}}(1-h_t)^{\frac{(1-\nu)(1-\gamma)}{\theta}-1} = \lambda_t(1-\tau^y)w_t && (2.9)\\
k_{t+1} &: \; \lambda_t = \beta E_t \lambda_{t+1}[1+(1-\tau^y)r_{t+1}-\delta] && (2.10)\\
TVC &: \; \lim_{t\to\infty} \beta^t \lambda_t k_{t+1} = 0 && (2.11)
\end{aligned}
$$

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, besides caring for the short-run (period t vs. period $t+1$ utility), the household cares also for the "long run", in the sense that the entire sequence of future consumption and leisure—captured by continuation values—directly affects the state of the economy in $t+1$. 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.

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

$$\Pi_t = A_t k_t^{\alpha} h_t^{1-\alpha} - r_t k_t - w_t h_t, \tag{2.12}$$

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.*:

$$k_t \quad : \quad \alpha \frac{y_t}{k_t} = r_t, \tag{2.13}$$

$$h_t \quad : \quad (1-\alpha)\frac{y_t}{h_t} = w_t. \tag{2.14}$$

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:

$$g_t^c + g_t^t = \tau^c c_t + \tau^y [w_t h_t + r_t k_t] \tag{2.15}$$

Tax rates and government consumption-to-output ratio would be chosen to match the average share in data, and 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 $\{A_t\}_{t=0}^{\infty}$ average tax rates $\{\tau^c, \tau^y\}$, initial capital stock $\{k_0\}$, the decentralized dynamic competitive equilibrium is a list of sequences $\{c_t, i_t, k_t, h_t, V_t\}_{t=0}^{\infty}$ 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 the business cycle fluctuations in Bulgaria, we will focus on the period following the introduction of the currency board (1999-2018). Quarterly data on output, consumption and investment was collected from National Statistical Institute (2019), while the real interest rate is taken from Bulgarian National Bank Statistical Database (2019). The calibration strategy described in this section follows a long-established tradition in modern macroeconomics: 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 income tax rate introduced as of 2008. Similarly, the tax rate on consumption is set to its value over the period, $\tau^c = 0.2$. As in Herberger (2013), the realtive risk aversion parameter and the IES are set to $\gamma = 2$ and $\psi = 0.043$, respectively. Next, the relative weight attached to the utility out of consumption in the household's utility function, ν, 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	2.000	Relative risk aversion parameter	Set
ψ	0.043	Intertemporal elasticity of substitution	Set
δ	0.013	Depreciation rate on physical capital	Data average
τ^y	0.100	Average tax rate on income	Data average
τ^c	0.200	VAT/consumption tax rate	Data average
ρ_a	0.701	AR(1) persistence coefficient, TFP process	Estimated
σ_a	0.044	st. error, TFP process	Estimated

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 below. 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 uses of output - consumption, investment and government consumption also increase contemporaneously. 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

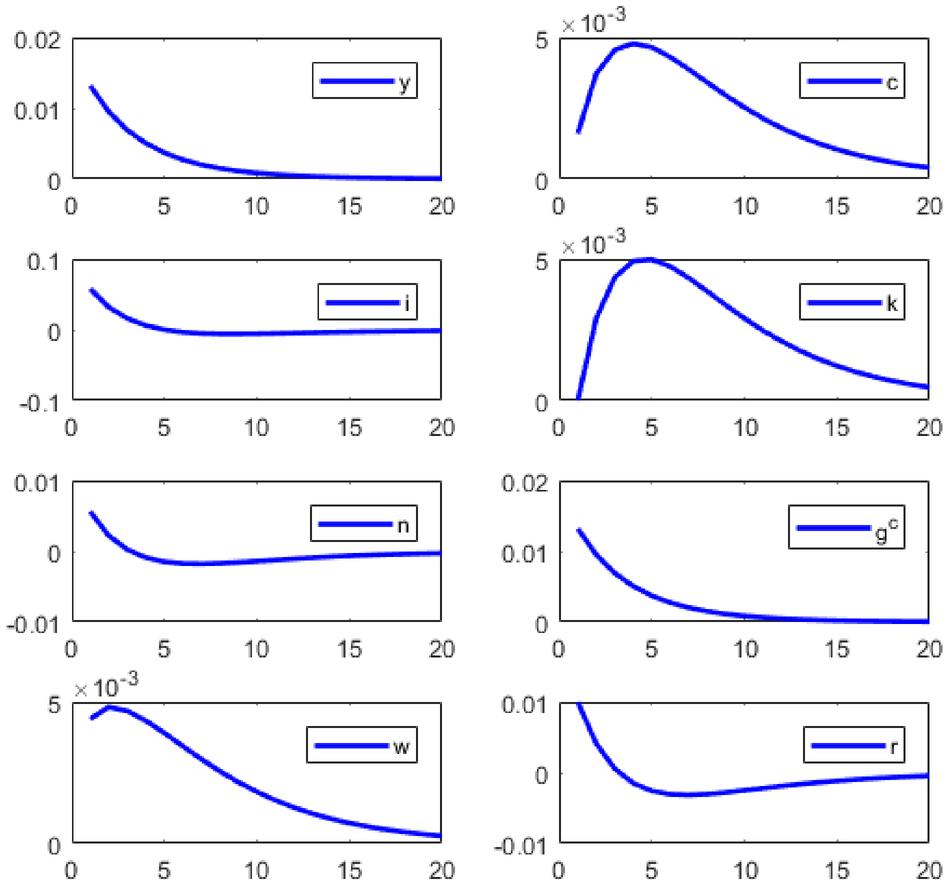

Figure 1: Impulse Responses to a 1% surprise innovation in technology

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 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.[8] 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. However, the model with Epstein-Zin preferences significantly overestimates the variability in consumption, and to a certain extent the volatility in investment. 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	0.97
σ_i/σ_y	1.77	2.22
σ_g/σ_y	1.21	1.00
σ_h/σ_y	0.63	0.28
σ_w/σ_y	0.83	0.81
$\sigma_{y/h}/\sigma_y$	0.86	0.81
$corr(c,y)$	0.85	0.83
$corr(i,y)$	0.61	0.76
$corr(g,y)$	0.31	1.00
$corr(h,y)$	0.49	0.25
$corr(w,y)$	-0.01	0.95

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

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 approximately the same as in data. This is yet another confirmation that the perfectly-competitive assumption, e.g. Vasilev (2009), does not describe very well the dynamics of employment. Next, in terms of contemporaneous correlations, the model over-predicts the pro-cyclicality of investment, and government consumption. This, however, is a common limitation of this class of models. In addition, along the labor market dimension, the contemporaneous correlation of employment with output, and unemployment with output, is poorly matched. 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. For the sake of brevity, we present only results for the model with consumption habits. 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	0.953	0.894	0.826
	(s.e.)	(0.000)	(0.029)	(0.056)	(0.082)
Data	$corr(n_t, n_{t-k})$	1.000	0.484	0.009	0.352
Model	$corr(n_t, n_{t-k})$	1.000	0.953	0.894	0.826
	(s.e.)	(0.000)	(0.029)	(0.056)	(0.082)
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	0.902	0.840
	(s.e.)	(0.000)	(0.026)	(0.051)	(0.074)
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	0.901	0.838
	(s.e.)	(0.000)	(0.027)	(0.052)	(0.075)
Data	$corr(c_t, c_{t-k})$	1.000	0.971	0.952	0.913
Model	$corr(c_t, c_{t-k})$	1.000	0.959	0.909	0.851
	(s.e.)	(0.000)	(0.025)	(0.069)	(0.089)
Data	$corr(i_t, i_{t-k})$	1.000	0.810	0.722	0.594
Model	$corr(i_t, i_{t-k})$	1.000	0.949	0.886	0.812
	(s.e.)	(0.000)	(0.031)	(0.058)	(0.084)
Data	$corr(w_t, w_{t-k})$	1.000	0.760	0.783	0.554
Model	$corr(w_t, w_{t-k})$	1.000	0.958	0.901	0.849
	(s.e.)	(0.000)	(0.025)	(0.047)	(0.069)

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 Epsten-Zon preferences 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.

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	$corr(n_t, (y/n)_{t-k})$	0.022	0.010	-0.001	-0.516	-0.191	-0.170	-0.149
	(s.e.)	(0.329)	(0.285)	(0.233)	(0.288)	(0.288)	(0.225)	(0.261)
Data	$corr(n_t, w_{t-k})$	0.355	0.452	0.447	0.328	-0.040	-0.390	-0.57
Model	$corr(n_t, w_{t-k})$	0.022	0.010	-0.001	-0.516	-0.191	-0.170	-0.149
	(s.e.)	(0.329)	(0.285)	(0.233)	(0.288)	(0.288)	(0.225)	(0.261)

6 Conclusions

We introduce Epsten-Zin (1989, 1991) preferences 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 (1999-2018). We investigate the quantitative importance of the presence of "early resolution of uncertainty" motive for the propagation of cyclical fluctuations in Bulgaria. Allowing for Epsten-Zin preferences improves the model performance against data, and in addition this extended setup dominates the standard RBC model framework, *e.g.*, Vasilev (2009).

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