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Assessment Real Business Cycle under Consumption and Leisure preferences on Iranian Economy in a (DSGE) Framework

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ABSTRACT

In this study, by making adjustments in real business cycle model, a dynamic stochastic general equilibrium model (DSGE) is designed for the Iranian economy in which business cycle can be showed characteristics of Iran's economy. The findings of this research show that leisure and consumption habits of parameters in the model can change consumption, leisure and produce more than before. The results show if the parameters the leisure habits of utility function are increases, it can would reduce production further.

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INTRODUCTION

In economic theory, the concept of habit formation has a long history as an alternative to the time-separable utility function employed in standard real business cycle models. It has been given consideration especially since Constantinides (1990) showed that it can solve the so-called equity premium puzzle, identified by Mehra and Prescott (1985).

Already Campbell and Deaton (1989) show that in practice consumption reacts slowly to shocks. Many neo-keynesian Structural Vector Auto regressions (SVARs) investigate the reactions of consumption to a monetary shock or to a change in interest rates. For example, Christiano, Eichenbaum and Evans (2005) demonstrate that after an expansionary monetary policy shock, the response of consumption is hump-shaped and reaches its peak after about six quarters. Yet, as Fuhrer (2000) points out, in standard real business cycle models consumption reacts immediately after shocks that change lifetime resources. To solve this puzzle of discrepancy between the empirical results of the Structural Vector Autoregressions on the one hand and the predictions of the real business cycle models on the other hand, habit formation in consumption has been introduced into the utility function of the Real Business Cycles models. Bouakez, Cardia and Ruge-Murcia (2005) develop a model with habit formation and capital adjustment costs. They compare the impulse-responses to a monetary shock in this model with those of a Vector Auto regressions (VAR) of order 2 and find that both predict a hump-shaped consumption response, although its peak occurs one period later in the model compared to the Vector Auto regression. However, this shows that habit formation improves the prediction of the Real Business Cycles model.

The first work on the microeconomic foundations of habit formation can be found in Dusenberry (1949). Overviews over habit formation in consumption are given by Deaton and Muellbauer (1980) and Deaton (1992). Yet, Mehra and Prescott (1985) show that for standard general equilibrium models micro- and macro economically reasonable values of the coefficient of relative risk aversion lead to an equity premium that is by far too small compared to the empirical value. More precisely, in their paper the authors find a value of 0.34 percent which is exceeded by the actual value of 6 percent by magnitude. This economic phenomenon is commonly known as the equity premium puzzle.

Lettau and Uhlig (2000) argue that introducing habit formation into consumption leads to a new problem. To be more specific the response of consumption to a shock in technology becomes far too small. The authors show that this consumption volatility puzzle can be solved by a model where technology shocks are highly persistent and labor is stochastic.

This paper aims at answering the economic question what implications does introducing habit formation into a standard real business cycle model have for the dynamics of the most important variables? What are the

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specific consequences of habit formation in leisure for these dynamics? We choose different calibrations of our parameters and examine the impulse responses of the variables. We first give an overview over the general dynamics of the model. After that, we scrutinize the specific implications for consumption and leisure choices of the representative household, examining the influences of the parameters of habit formation.

The methodological framework that used for the analysis of these dynamics is a real business cycle model. Habit formation for both consumption and leisure is modeled in a way that we can distinguish between a transitory and a persistent form, depending on the calibration of the parameters. Departing from a model with habit formation in consumption only, we review the general model dynamics as well as the dynamics of variables in model in particular, before examining a model with habit formation only in leisure. We compare the impulse-responses of consumption and production of this benchmark model to the model with habit formation in consumption and leisure, which has already been analyzed in literature.

The remainder of this paper is organized as follows. Section 2 lay out the basic structure of our economy model. Section 3 derives and discusses the model result and answer. Section 4 concludes.

The Model:

In this section, we describe the model, which is an extension of those ones analyzed by Lettau and Uhlig (2000) and Ljungqvist and Uhlig (2000). First we explain in detail the household's utility function as it represents the crucial hypothesis of our model. Then, we state the profit maximization problem of the firm before stating the market clearing conditions.

As usual, Superscripts $^{(d)}$ and $^{(s)}$ denote demand and supply, respectively.

Household:

Consider an infinitely-lived representative household that maximizes his intertemporal utility as follows:

$$\max_{\{C_t;L_t;K_t\}} E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t - V_{t-1})^{1-\gamma}-1}{1-\gamma} + \chi \frac{(L_t - U_{t-1})^{1-\eta}-1}{1-\eta}\right] \quad (1)$$

Subject to the constraints

$$C_t + I_t = W_t N_t^{(s)} + D_t K_{t-1}^{(s)} + \Pi_t \quad (2)$$

$$L_t + N_t^{(s)} = 1 \quad (3)$$

Which have to be fulfilled in each period t. $0 \leq \beta \leq 1$ discount factor , C_t and L_t represent the individual household's consumption and leisure in period t, respectively. γ and η stand for the curvatures of consumption and leisure, respectively. The representative household can allocate his time endowment, normalized to 1, to supplied labor $N_t^{(s)}$ and leisure L_t. χ measures the importance of the leisure part of the utility function relative to the consumption part and is assumed to be given and constant. W_t stands for real wage, D_t for dividends on capital chosen in period t−1 and Π_t for profit in period t, which is redistributed to the representative household.

Also, Capital chosen in period t − 1 and lent in period t, denoted by $K_t^{(s)}$, is the sum of capital lent in period t−1, depreciated by a fraction of δ, and of investment in period t, denoted by It:

$$K_t^{(s)} = (1-\delta)K_{t-1}^{(s)} + I_t \quad (4)$$

U_t and V_t are the habit stocks of past average consumption and leisure.

More specifically, they are recursively given by

$$V_{t-1} = (1-\phi_C)\alpha_C C_{t-1}^{(a)} + \phi_C V_{t-2} \quad (5)$$

$$U_{t-1} = (1-\phi_L)\alpha_L L_{t-1}^{(a)} + \phi_L U_{t-2} \quad (6)$$

Where $C_t^{(a)}$ $L_t^{(a)}$ denote aggregate average consumption and leisure in period t, respectively. The specifications of the utility function and of the process for V_t are closely related to those in the model by Ljungqvist and Uhlig (2000). The process of U_t is similar to that of V_t. Note that α_C and α_L describe the overall importance of habit formation in consumption and leisure, respectively, in the utility function. This implies $V_{t-1} = 0$, which means that habit formation in consumption does not play any role any more in the utility function. ϕ_C and ϕ_L, by contrast, describe the persistence of the habit with respect to following periods. For instance, if ϕ_C is close to 0, consumption before period tis very unimportant f or the utility in period t, whereas

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consumption in period t − 1 is very important. If, in contrast to that, Φ_C is closer to 1, lagged consumption of all periods plays a role for consumption habit.

Using V_{t-1} and U_{t-1} rather than V_t and U_t in the utility function suggests that in period t, the values of V and U, to which the household compares consumption and leisure he is about to choose, are already given, as they have been chosen in period t-1. Thus, the utility function contains a catch ing-up term rather than a keeping-up term in consumption and leisure, as in the latter case, the utility function would contain V_t and U_t instead of V_{t-1} and U_{t-1}.

Note that, in our context of external habit formation, the individual household is assumed to be atomic, which implies that he takes the sequences of V_t and U_t as given in the maximization problem.

Given initial values, the household chooses $\{C_t, L_t, k_t\}$, t = 0,1,2,... to maximize in each period the expectation of the discounted sum of its utility flows subject to the capital accumulation equation and the budget constraint. The problem can be written in its recursive form, with the optimal solution satisfying the following Bellman equation

$$V(k_t, \Omega_t) = \max_{\{C_t, L_t, k_t\}} \{u(C_t, L_t) + \beta E_t[V(k_{t+1}, \Omega_{t+1})]\}$$

with respect to constraints (2) and (6), where Ω_t, is the information set upon which expectations formed in period t are conditioned. The first-order conditions for this problem

$$(C_t - V_{t-1})^{-\gamma} - \lambda_t = 0 \quad (7)$$

$$-\chi\left(1 - N_t^{(s)} - U_{t-1}\right)^{-\eta} + \lambda_t W_t = 0 \quad (8)$$

$$\beta E_t[\lambda_{t+1}\{D_{t+1} + 1 - \delta\}] - \lambda_t = 0 \quad (9)$$

$$W_t N_t^{(s)} + [1 - \delta + D_t]K_{t-1}^{(s)} - K_t - C_t = 0 \quad (10)$$

where λ_t is the Lagrangian multiplier associated with the household's budget constraint. Equations (7) and (8) equate the marginal rate of substitution between consumption and labour to the real wage. Equation (9) stipulates that the current marginal utility of consumption is equal to the difference between the current marginal utility of consumption and the optimal intertemporal wealth allocation. Equation (10) is household's budget constraint.

Firm:

Sum of its profit flows conditional on the information available at time zero:

$$\max_{\{K_{t-1}^{(d)}; N_t^{(d)}\}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \lambda_t \Pi_t\right]$$

Where the instantaneous profit function is given by

$$\Pi_t = Y_t - W_t N_t^{(d)} - D_t K_{t-1}^{(d)}$$

Taking into account the standard Cobb-Douglas function of the form:

$$Y_t = Z_t\left(K_{t-1}^{(d)}\right)^{\theta}\left(N_t^{(d)}\right)^{1-\theta} \quad 0 \le \theta \le 1$$

$K_{t-1}^{(d)}$ is demanded capital, $N_t^{(d)}$ is demanded labor and θ is the capital share, which is assumed to be constant. Z_t is an exogenous shock in technology, that is, total factor productivity (TFP). The stochastic sequence of $\log(Z_t)$ is given by an autoregressive process of order 1, AR(1):

$$ln(Z_t) = (1 - \rho_Z)\ln(\bar{Z}) + \rho_Z log(Z_{t-1}) + \varepsilon_{Zt} \qquad Z > 0$$

Where $\rho_Z \in (-1,1)$ describes the persistence of the technology shock and ε_{Zt} is a serially uncorrelated shock that is normally distributed with zero mean and standard deviation σ_Z and $\bar{Z}$ is some constant.

The firm's discount factor is given by the stochastic process $\beta^t \lambda_t$, where λ_t denotes the marginal utility of real wealth. In equilibrium, this factor represents a pricing kernel for contingent claims. The first-order conditions are derived from the following Bellman equation:

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$$V\left(K_{t-1}{}^{(d)},N_t{}^{(d)},\Omega_t\right)=\max_{\{K_{t-1}{}^{(d)},N_t{}^{(d)}\}}\{\lambda_t\Pi_t+\beta E_t[V(K_t{}^{(d)},\Omega_{t+1})]\}$$

The first-order conditions with respect to $K_{t-1}{}^{(d)}, N_t{}^{(d)}$ are, respectively, given by:

$$D_t=\theta Z_t\left(K_{t-1}{}^{(d)}\right)^{\theta-1}\left(N_t{}^{(d)}\right)^{1-\theta}=\theta\frac{Y_t}{K_{t-1}} \qquad (11)$$

$$W_t=(1-\theta)Z_t\left(K_{t-1}{}^{(d)}\right)^{\theta}\left(N_t{}^{(d)}\right)^{-\theta}=(1-\theta)\frac{Y_t}{N_t} \qquad (12)$$

Market clearing:

In equilibrium, all markets are cleared, that is:

$$C_t+I_t=Y_t \qquad (13)$$

$$N_t=N_t{}^{(s)}=N_t{}^{(d)}$$

$$K_{t-1}=K_{t-1}{}^{(s)}=K_{t-1}{}^{(d)}$$

Model results and answer:

Following the purpose of this paper and examining assessment real business cycle under consumption and leisure preferences on Iranian economy in a dynamic stochastic general equilibrium framework is an intricate task. Due to the complex structure of the model and interdependent reactions of economic variables this cannot easily be solved by hand. However, there are various computer based tools available which will help finding some answers.

After having derived the equilibrium characterizing equations in the previous section, we present and calculate further results in this part. For this model setups we provide a list of equations which will be examined with the help of the Toolkit program (Uhlig (1997)).

Then we reorganize the equations in matrix notation using three general vectors x_t, y_t and z_t and apply Matlab to generate impulse response functions in a first calibration.

Baseline calibration in order to use numerical methods to qualify and quantify the model results some initial parameter values need to be defined. Table 1 on the following page gives an overview over the parameter values and steady state values assumed to calibrate the model. It also gives an indication of the sources used for the calibration.

Note that the curvature parameters (γ and η) as well as the habit importance parameters (ϕ_C and ϕ_L) and the habit persistence parameters (ϕ_C and ϕ_L) are not yet fixed here, but in the different sections of the dynamics analysis.

Table 1: Parameter values and steady state values assumed in the benchmark Model.

Parameter	Meaning	Value	Source or reason
θ	Capital share	0.412	Shahmoradi(1999)
β	discount factor	0.99	Uhlig (1997)
δ	depreciation rate	0.042	Amini(2005)
ρ_z	Autocorrelation of technology shock	0.72	Kavand(2009)
σ_z	standard deviation of productivity innovations	0.045	Kavand(2009)
$\bar{z}$	Steady state of technology shock	1	Normalization
$\bar{N}$	Steady state employment level	1/3	Hansen (1985)
γ	Curvature of consumption	1.5	Bhattacharjee (2005)
η	Curvature of leisure	2.17	Taii(1997)
χ	Parameter of leisure importance relative to consumption	0.05	Walsh(2003)
α_C	Overall importance of consumption habit	differs	
α_L	Overall importance of leisure habit	differs	
ϕ_C	Persistence of consumption habit	0.5	
ϕ_L	Persistence of leisure habit	0.5	

The log-linearized model can be written as a rational expectation (LRE) system in the form of:

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$$0 = Ax_t + Bx_{t-1} + Cy_t + Dz_t$$
$$0 = E_t[Fx_{t+1} + Gx_t + Hx_{t-1} + Jy_{t+1} + Ky_t + Lz_{t+1} + Mz_t]$$
$$z_{t+1} = Nz_t + \varepsilon_{t+1}\ ;\ \ E_t[\varepsilon_{t+1}] = 0$$

Where $x_t = \{k_t, v_t, u_t\}$ is the endogenous stste vector, $y_t = \{c_t, y_t, n_t, l_t, i_t, r_t\}$ is the other endogenous vector, and $z_t = \{z_t, \varepsilon_v, \varepsilon_u\}$ is a vector of exogenous stochastic processes underlying the system. Now, Matlab creates impulse response functions and computes the recursive equilibrium law of motion according to Uhlig (1997)

$$x_t = Px_{t-1} + Qz_t$$
$$y_t = Ry_{t-1} + Sz_t$$

Such that the equilibrium described by the matrices *P; Q;R* and *S* is stable.

Simulation results:

The results of the RBC simulation with respect to volatility and correlations are partially good. Thus the predicted value of GDP standard deviation is 0.056, while the real value is 0.053. Standard deviations of consumption and investment are as good, as there are not some significant differences between simulated value and real value.

Actual and simulation data	Autocorrelation coefficients						Standard deviation	
	Actual value			Simulation value			Actual value	Simulation value
	Lag 0	Lag 1	Lag 2	Lag 0	Lag 1	Lag 2		
Output	1	0.68	0.31	1	0.53	0.16	0.053	0.056
Consumption	1	0.64	0.16	1	0.65	0.12	0.045	0.046
Investment	1	0.69	0.13	1	0.70	0.43	0.244	0.234
Labor	1	0.84	0.66	1	0.56	0.24	0.036	0.014

Impulse responses:

Here we provide the results of our calculations and present diagrams showing impulse responses of the various economic variables. Moreover, the graphs will be interpreted with the help of the underlying equations, examining effects on real variables of a technology and consumption and leisure habits shock.

Technology shock:

Figure (1) shows the responses of all considered variables and their propagation over a horizon of eight years. It shows the corresponding impulse-responses of the different variable-deviations from their respective steady states to a one percent deviation in technology. A one percent increase in technology, i.e. a one percent positive deviation from steady state, directly affects productivity and causes output to rise. In fact it rises about 1.1 percent. In general the results are in line with standard theoretical and empirical findings, representing a positive (negative) reaction of labor (leisure) to a technology shock. The 0.3 (-0.1) percent increase (decrease) of labor (leisure) can be seen from figure 1. Also for capital, will be a little more than0.4 percent above the steady state. But for consumption, taking increase by more than 0.2 percent deviation from a steady state and will be removed of this deviation before the first year.

Consumption habit shock:

In the second set of results includes analysis of consumption habits shock. In this part we show How different variables economic respond to this shock. These results are display the variables after the seventh year come back to steady sate position. Figure (2) show that One percent increase in consumption habits shock, ie a positive deviation from a steady state, increased consumption only about 0.45 percent positive deviation from the steady state. Because increased consumption is related to habits formation in consumption. This increased consumption will be because decrease in the investment, as investment doesn't grows, capital of course does, too. A percent consumption habits shock effects positive on output and negative on leisure. As the results show that if the more important habit formation in consumption is (ie $\alpha_c = 0/5$ become$\alpha_c = 0/75$), the more the instant deviation of consumption, production and leisure from their steady state become and the more time those take for C_t,Y_t and L_t to reach their steady state.

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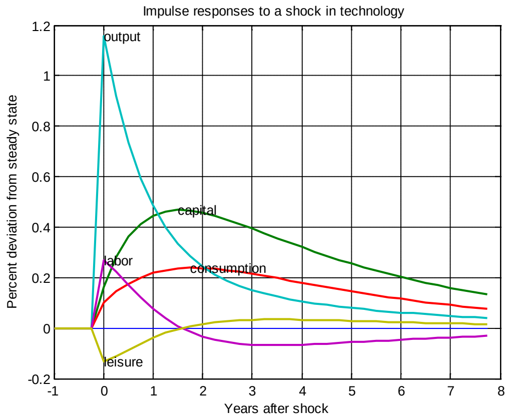

Fig. 1: General short-run dynamics of a model with habit formation.
Calibration:$\alpha_L = \alpha_C = \phi_L = \phi_C = 0.5$

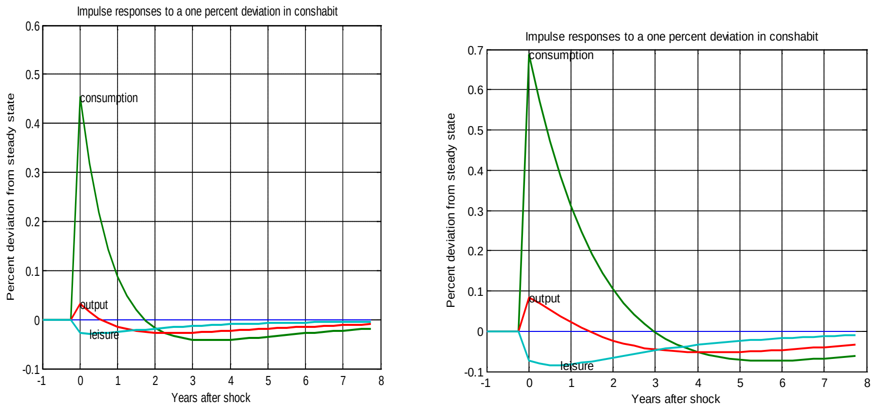

Fig. 2: General short-run dynamics of a model with habit formation for consumption, output and leisure
Calibration:$\alpha_L = \alpha_C = \phi_L = \phi_C = 0.5$ (Right), $\alpha_C = 0.75$(left)

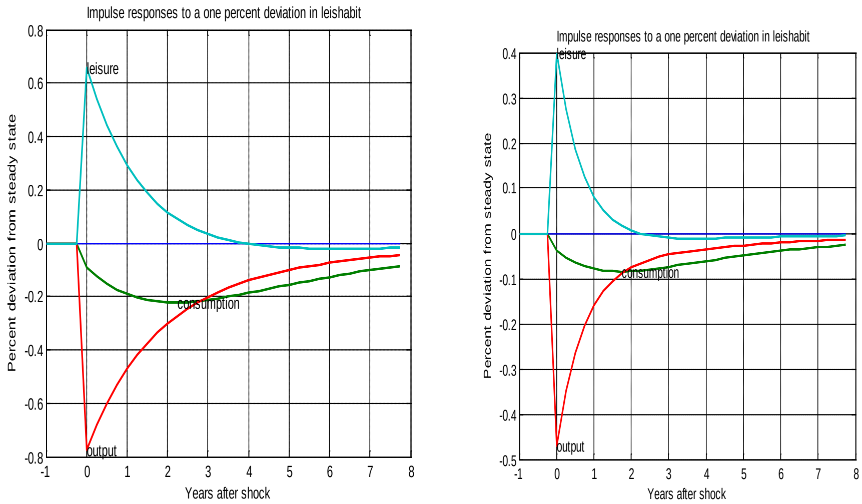

Fig. 3: General short-run dynamics of a model with habit formation for consumption, output and leisure.
Calibration:$\alpha_L = \alpha_C = \phi_L = \phi_C = 0.5$ (Right), $\alpha_L = 0.75$(left)

Leisure habits shock:

In the third set of results includes analysis is leisure habits. The economic variables are different respond to the leisure habits shock. Figure(3) show that one percent of leisure habits shock increased leisure only about 0.4 percent positive deviation from the steady state. Because, it can be seen that the peak of leisure-deviation from its steady state is upper for higher values of α_L. For$\alpha_L = 0.5$, a percent of leisure habits shock reduces the

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consumption -0.1 percent deviation from steady state, and output approximately -0.45 percent deviation from a steady state. The figure (3) shows that whatever leisure habits important become in the utility function, ie the more $\alpha_L = 0.5$ become $\alpha_L = 0.75$the value of leisure increases from the steady state and also production and consumption value will reduce. the other words, if in the economy leisure habits for households to be very important, each shock of these types, can increases leisure to further.

Conclusion:

The results suggest that in the short run, habit formation is of more important. Consumption and production deviates later and more slowly from their steady state when parameter habit formation is increased into consumption. We have shown that, when habit formation is increased into the model, the differences in the reactions of leisure, output and consumption are mainly due to habit formation in consumption and leisure.

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