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Measuring the Effects of Risk Aversion Change on Households' Performance Using Endogenous Discount Factor Model

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Abstract

Given the importance of household time preference and risk aversion as macroeconomic variables that play a role in capital accumulation, growth and economic development and are one of the main roots of interest rates, they play an important role in the equilibrium of the economy and society. On the other hand, economic development, improvement of living standards and prosperity of society have always been among the most important issues faced by the planners of a country, and one of the conditions is to achieve higher economic growth in society. The existence of time preference and discount factor, which show the degree of patience of society in terms of consumption and the value of current consumption over future consumption. This article attempts to investigate the role of risk aversion in the presence of an endogenous discount factor on macroeconomic variables and household performance in the context of a DSGE model. The study of household data of the Iranian economy for the period 1998 to 2020 shows that given the fact that people in the community are sensitive to the decision to increase their expected desirability at a certain level of risk and care about it, increasing the risk aversion coefficient in the desirability function of the household leads to fluctuations and changes in the optimal path of the economic variables of the household and finally the change in allocations is adjusted to attribute the maximum expected return to its portfolio. Indeed, increasing risk aversion leads households to allocate their resources optimally between periods (present and future) by paying more attention to their time.

Keywords: Endogenous Discount Factor, DSGE Method, Households' Performance, Risk Aversion

JEL: C11, C26, D91, G11

1. Introduction

Macroeconomic behavioral models are based on the assumption that households have a fixed rate of time preference. In most studies, people with positive time preference are found to have lower savings levels. Based on the concept of time preference, the concept of impatience

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is used, and the degree of impatience of different people is different. People's impatience depends on things such as current income, the degree of risk aversion, and social conditions.

On the other hand, people's risk preference is one of the most important economic variables and has a great influence on economic decisions. Investment decisions, consumption, savings, and purchasing insurance are among the decisions in which risk preferences play an important role. Given the importance of risk preferences in the decision-making process, it is necessary and important to consider changes in the risk situation in the economy as a whole.

Intil the 1970s there was no study in finance that dealt with the identification of the decision-making process of investors and the design of their decision-making model in the capital market under conditions of uncertainty. Studies in this field show that risk aversion decreases when people increase their wealth. There is also a relationship between risk aversion and age, income, wealth, and education. As income, wealth, and education increase, risk aversion also increases, but as age increases, risk aversion decreases (Riley and Chow, 1992).

According to economic theories, the risk aversion parameter changes according to economic conditions and is not constant. When investors' risk aversion increases over time, it is reflected in a higher market price for taking risk, and when risk aversion in the economy decreases over time, the market price for risk decreases. Therefore, understanding the behavior of risk aversion is of great importance and utility. Moreover, calculating the risk aversion parameter and studying the trend of its changes over time can explain society's preferences and attitudes toward the country's economic conditions. Assuming that changes in people's attitudes can be considered as a factor in the occurrence of business cycles, studying the role of the risk aversion parameter and analyzing it can help predict the country's economic outlook. When the risk aversion parameter increases, the response of consumption, production, and investment to random shock patterns will increase. Increased risk aversion in the economy leads to higher risk premiums demanded by producers, and if policymakers do not pay attention to this problem, it may lead to a decline in investment and output.

It can be said that the main feature of this study is the estimation of time series on risk aversion in developed countries. In developing countries such as Iran, there is a deep gap between theoretical and experimental literature in this regard. Since it is important to study the impact of risk on household performance, this study, using economic concepts and a general equilibrium model, models risk aversion and the impact of its changes in the Iranian economy in an endogenous discount factor model and examines household behavior and performance. In the rest of the article, economic studies and literature in this field are first reviewed in the second part and then the model is explained and presented in the third part. The fourth part is devoted to calibration and presentation of the research results, and finally the fifth part deals with conclusions and suggestions.

2. Discussion of the relevant literature

Time preference means choosing between two time periods, and a person who has time preference pays less attention to future time when evaluating between present and future. The higher the time preference is, the less important the future time is to him, and

therefore the person will prefer the present to the future. The higher the time preference, the more resources are consumed instead of saved, and the less capital is accumulated. With less capital accumulation, economic growth is also delayed.

Fisher (1930), the father of interest rate theory, believes that all people are mortal and therefore prefer to consume the present rather than the future. Since the attractiveness of any point in time in the future must be multiplied by the probability of surviving at that point in time, and since the probability of survival decreases with age, an appropriate time discount rate should reflect this fact. A person may survive for a time, but his or her savings and investments will be lost due to various factors. Therefore, the social discount rate should also take into account such risks.

Ramsey (1928), in most of his studies points out that preference and the concept of impatience of individuals depend on the degree of risk aversion and the discount factor, which measures the level and value of consumption of households and communities at different times, is one of the most important parameters in the analysis of household behavior. Studying the changes in risk aversion during business cycles in the economy and its impact on consumption and other model variables can provide an accurate estimate and forecast of risk aversion across the economy. In addition, a person's impatience is affected by how much he or she expects to receive from the person's actual income and the distribution pattern of income over a lifetime, and indeed impatience depends on the relative abundance of nearer income compared to more distant or expected income.

Yoon (2017) used a model to study and estimate risk aversion, which plays an important role in economic models. In this empirical study, it was concluded that people who experienced a recession were more risk averse than people who experienced an upturn.

O'Donoghue and Somerville (2018) note that one of the indicators that plays an important role in most economic models is people's perception of risk. The risk aversion coefficient shows the tendency of households to transfer consumption between different time periods. As risk aversion increases, people demand higher returns to accept the same level of risk, and if the market does not have the elasticity to pay these returns to investors, investment in the economy will decline. The risk aversion that leads to insured demand is the result of the extensive economic literature in the field of insurance. Risk aversion plays a key role in financial investment and is a factor in the exchange of risk and return in the pricing of financial assets. Risk aversion is also important in the life cycle, where people are exposed to risks related to employment, income, asset returns, health, and so on.

Faccini et al. (2019) conducted a study to examine investors' risk aversion as an indicator to predict the activities of the U.S. economy. The results of their study showed that increasing relative risk aversion leads to a decrease in future economic activity. Regarding the relationship between risk aversion and business cycles, it can be said that there are more output fluctuations in economies where the private corporate sector is relatively larger and therefore exposed to higher risks.

Cohn and Lewellen (1975), Barro, (2000), Liqun, (2012) and Shane et al, (2002) have shown in their studies that the instability of the time preference rate can cause the problem of incompatibility. This problem arises from the evaluation of utility at different times

and usually causes the consumption rate to deviate from this choice. By adopting a savings plan, the household commits to a particular savings path and uses technical knowledge to achieve that outcome. Consumers, also aware that their tastes change, plan under the assumption that they will use the same taste at any given time in the future, and in this case they will choose a compatible program.

Also, several papers assume a model with an endogenous discount factor and use the Uzawa preferences. Cohn et al. (1975), Bergman (1985), Koopmans (1986), Lucas and Stokey (1984), Epstein (1987), Epstein and Hynes (1983), Judd (1985), Becker, Boyd, and Sung (1989), Mendoza (1991), Kollmann (1996), Schmitt-Grohe (1998), Fuhrer (2000) and Obstfeld (1990) use a preference specification that includes Uzawa's (1968) and applied Uzawa preferences to study an open economy's response to unanticipated and permanent terms of trade shock.

3. Explanation of the methodology and Model

Assume an open economy with Endogenous discount factor. It is considered that this economy populated by a large number of identical households with preferences that are described by the underneath utility function where $\beta_C < 0$, $\beta_H > 0$

$$E_0 \sum_{t=0}^{\infty} \theta_t U_t(CO_t, HO_t) \tag{1}$$

$$\theta_0 = 1, \theta_{t+1} = \beta(CO_t, HO_t)\theta_t, t \geq 0 \tag{2}$$

The equation of foreign debt, DB_t, is determined by

$$DB_t = (1 + R_{t-1})DB_{t-1} - Y_t + IN_t + CO_t + \Phi(KA_{t+1} - KA_t) \tag{3}$$

Where R_t explains the interest rate that households can borrow in international markets, Y_t denotes domestic output, CO_t explains consumption and HO_t denotes hours, IN_t denotes gross investment, and KA_t denotes physical capital. Also, $\Phi(.)$ is the function of capital adjustment costs and is granted to satisfy $\Phi(0) = \acute{\Phi}(0) = 0$. The role of capital adjustment costs in an open economy model typically is to avoid excessive investment volatility in response to variations in the domestic foreign interest rate differential.

A production function defines output in which capital and labor are its inputs. In fact, a linearly function that catches capital and labor services as inputs. The production function and the stock of capital, respectively are given by

$$Y_t = A_t F(KA_t, HO_t) \tag{4}$$

$$KA_{t+1} = (1 - \delta)KA_t + IN_t, \delta \in (0,1) \tag{5}$$

Where δ denotes the depreciation rate of physical capital and A_t is an exogenous stochastic productivity shock. In the following, households select processes $\{CO_t, HO_t, Y_t, IN_t, KA_{t+1}, DB_t, \theta_{t+1}\}_{t=0}^{\infty}$ to maximize the utility function. As well as, Assuming the Non-Ponzi game condition, the household's maximization problem and the first-order conditions, the following equations are established:

$$\lambda_t = \beta(CO_t, HO_t)(1 + R_t)E_t\lambda_{t+1} \tag{6}$$

$$\lambda_t = U_c(CO_t, HO_t) - \mu_t\beta_c(CO_t, HO_t) \tag{7}$$

$$\mu_t = -E_t U(CO_{t+1}, HO_{t+1}) + E_t\mu_{t+1}\beta(CO_{t+1}, HO_{t+1}) \tag{8}$$

$$-U_H(CO_t, HO_t) + \mu_t\beta_H(CO_t, HO_t) = \lambda_t A_t F_H(KA_t, HO_t) \tag{9}$$

$$\lambda_t[1 + \acute{\Phi}(KA_{t+1} - KA_t)] = \beta(CO_t, HO_t)E_t\lambda_{t+1}[A_{t+1}F_K(KA_{t+1}, HO_{t+1}) + 1 - \delta + \acute{\Phi}(KA_{t+2} - KA_{t+1})] \tag{10}$$

the productivity shock and the its law of progress is given by:

$$ln\ (A_t) = \rho_A\, ln\big(A_t(-1)\big) + \epsilon_{At} \quad (11)$$

besides a set of processes $\{DB_t, CO_t, Y_t, IN_t, KA_{t+1}, \mu_t, \lambda_t\}_{t=0}^{\infty}$, the study uses the following functional forms for technology and preferences:

$$U(CO, HO) = \frac{(CO - \frac{HO^{\omega}}{\omega})^{1-\gamma} - 1}{1-\gamma}$$
$$\beta(CO, HO) = (1 + CO - \omega^{-1} HO^{\omega})^{\psi}$$
$$F(KA_t, HO_t) = KA^{\alpha} HO^{1-\alpha}$$
$$\Phi(x) = x^2 \qquad \Phi > 0$$

Using the specific functional form for the trade-balance and the current account are given by:

$$TB_t = Y_t - CO_t - IN_t - \Phi(KA_{t+1} - KA_t) \quad (12)$$

$$CA_t = DB_{t-1} - DB_t \quad (13)$$

4. Calibration and description of the results

This study, based on fundamental concepts whose method is based on modeling, uses the following concepts to represent and solve the model.Based on the literature of models for economies, to solve and simulate the pattern, the research model used the parameter values listed in Table 1.

Table 1. Calibration parameters

Parameter	Description	Value	Source
δ	Depreciation rate	0.0139	Izadi (2018)
γ	Risk Aversion	2	Marzban et al. (2016)
Φ	Capital Adjustment Cost	7.6	Izadi and Marzban (2019)
a	Capital share	0.44	Izadi (2018)
ω	Frisch-elasticity	2.5	Izadi and Sayareh (2019)
ρ_A	Autocorrelation TFP	0.59	Izadi (2021)
ϵ_t	Standard Deviation TFP	0.0164	Izadi (2021)
ψ	Elasticity of the Discount Factor	0.16	Izadi and Marzban (2016)
$\overline{DA}$	The Steady-State Level of Foreign Debt	0.47	Marzban et al. (2018)

Source: author's view

Table 2 shows that a risk averse person becomes less desirable as the risk increases. In fact, risk is a bad good for them with a negative expectation, which reduces the expectation of their portfolio. The mean value of the utility variables as shown in Table 2 also shows this decrease. There are also variations in the consumption, debt and discount factor variables, which depend on the degree of risk aversion of the household and, consequently, on the determination of the household portfolio.

Table 2. Effect of changing Share of health care expenditures on Moments of Simulated Variables

Variable		CO_t	Y_t	DB_t	U_t	TB_t	CA_t	θ_t
Mean	γ=0.5	0.7267	1.1130	0.4700	0.3550	0.0062	0.0000	0.9615
	γ=1.5	0.7267	1.1130	0.4700	0.3015	0.0062	0.0000	0.9615
	γ=2.5	0.7267	1.1130	0.4700	0.2583	0.0062	0.0000	0.9615
Std. Dev.	γ=0.5	1.2795	1.5994	23.919	1.6489	1.0729	1.0145	0.0353
	γ=1.5	1.3704	1.5994	42.557	1.4101	1.2262	1.0787	0.0418
	γ=2.5	1.5221	1.5994	55.805	1.1928	1.3274	1.0937	0.0491

Source: author's view

From the results of Table 3, which shows the fluctuations and correlation of the consumption variables with other variables, it is clear that as household risk aversion increases, time preference, which reflects the impatience of the current generation, increases consumption. This increase reduces future welfare by allocating resources to the detriment of the future and reducing the amount of savings. If the current generations worsen the welfare of the future, they will reduce their share of resources.

Table 3. Implied unconditional second moments

Risk Aversion	$\gamma = 0.5$	$\gamma = 1.5$	$\gamma = 2.5$
Volatilities			
$\mathbf{std(Y_t)}$	2.6	2.6	2.6
$\mathbf{std(CO_t)}$	2.1	2.2	2.5
$\mathbf{std(IN_t)}$	0.1	0.1	0.1
$\mathbf{std(HO_t)}$	1.0	1.0	1.0
$\mathbf{std(\frac{TB_t}{Y_t})}$	1.8	2.0	2.2
$\mathbf{std(\frac{CA_t}{Y_t})}$	1.7	1.8	1.8
Serial Correlations			
$\mathbf{corr(Y_t, Y_{t-1})}$	0.59	0.59	0.59
$\mathbf{corr(CO_t, CO_{t-1})}$	0.85	0.89	0.92
$\mathbf{corr(IN_t, IN_{t-1})}$	0.824	0.824	0.824
$\mathbf{corr(HO_t, HO_{t-1})}$	0.59	0.59	0.59
$\mathbf{corr(\frac{TB_t}{Y_t}, \frac{TB_{t-1}}{Y_{t-1}})}$	0.60	0.67	0.71
$\mathbf{corr(\frac{CA_t}{Y_t}, \frac{CA_{t-1}}{Y_{t-1}})}$	0.56	0.58	0.58
Correlations with Output			
$\mathbf{corr(CO_t, Y_t)}$	0.77	0.63	0.55
$\mathbf{corr(IN_t, Y_t)}$	0.77	0.77	0.77
$\mathbf{corr(HO_t, Y_t)}$	1.0	1.0	1.0
$\mathbf{corr(\frac{TB_t}{Y_t}, Y_t)}$	0.848	0.803	0.755
$\mathbf{corr(\frac{CA_t}{Y_t}, Y_t)}$	0.966	0.987	0.992

Source: author's view

Figure (1) shows the shock function of the response to the technology shock in the presence of changes in the household risk aversion parameter γ on the utility, consumption, and household debt variables. The results of this diagram show that the higher the value of this parameter and the risk aversion of the subjects, the more and similar the effect of the existing positive shock on the variables CO (consumption) and DB (debt). This effect has a different impact on the variable UTIL (utility) and the economy will experience a further decline in household utility. An important part of these large fluctuations in the economy is due to the increased risk aversion and changes in the consumption basket of the economy between periods.

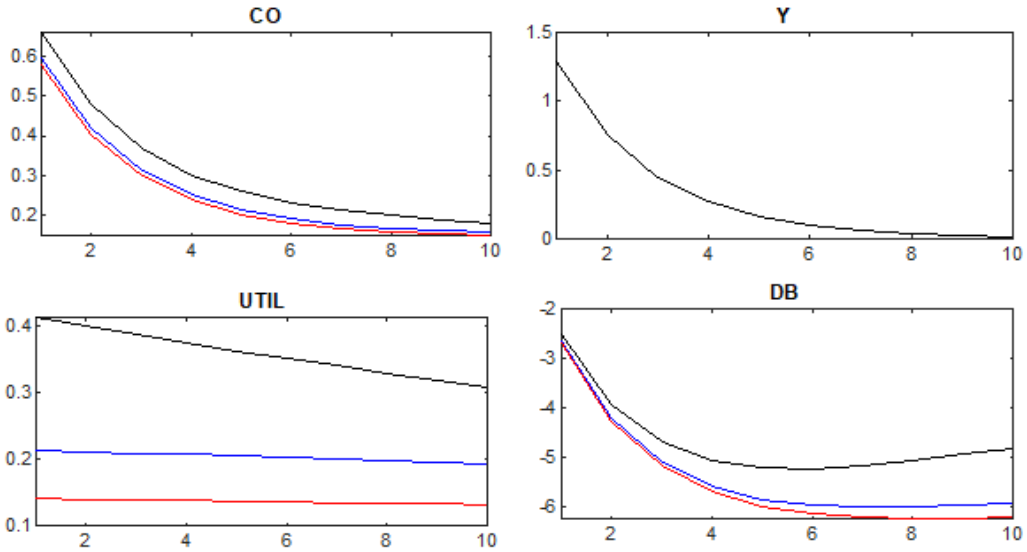

Figure 1. Impulse Response to A Unit Technology Shock in Model. Note. Black Line: γ=0.5 , Blue Line: γ=1.5 and Red Line: γ=2.5.

Source: author's view

Figure (2) shows the shock function of the response to the technology shock in the presence of changes in the household risk aversion parameter γ on the trade balance, current account balance, and household discount factor variables. The results of this graph show that the higher the value of this parameter and the risk aversion of the subjects, the more and similar the effect on the variables TB (trade balance) and CA (current account balance) due to the existing positive shock. This effect has a different impact on the variable BETA (endogenous discount factor), which is due to changes in household intermediate consumption in the economy.

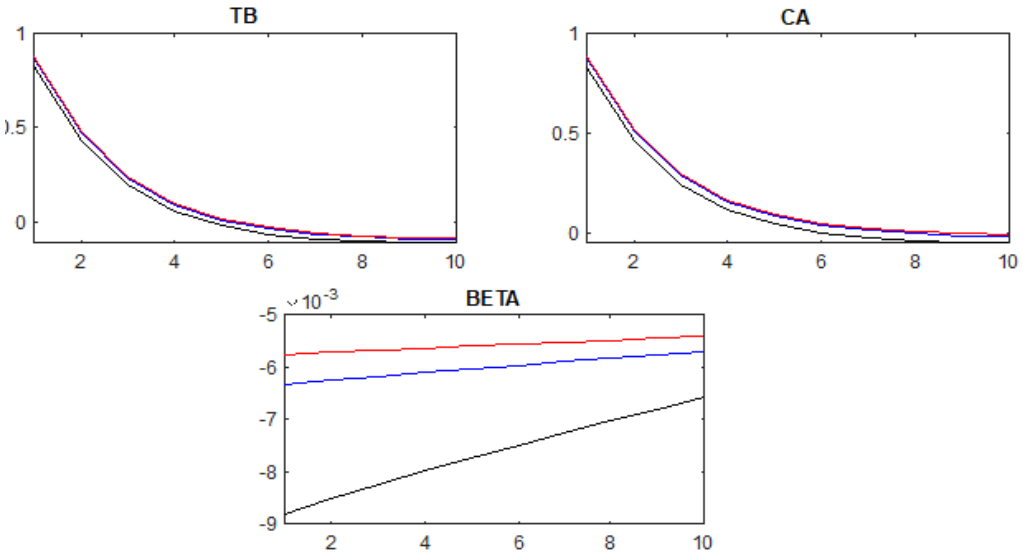

Figure 2. Impulse Response to A Unit Technology Shock in Model. Note. Black Line: γ=0.5, Blue Line: γ=1.5 and Red Line: γ=2.5.
Source: author's view

Conclusions

People's risk preferences affect investment, consumption, savings, and the purchase of insurance. Given the role that risk preferences play in the decision-making process, it is necessary and important to consider changes in the risk situation in the economy as a whole. As people view risk and the degree of risk aversion, the household tends to transfer consumption between different time periods and finds that as risk aversion increases, the individual prefers current consumption to future consumption. The results show that for a risk averse individual, the increase in risk leads to variations in the consumption, debt, utility and discount factor variables. All this depends on the degree of risk aversion of the household and consequently on the determination of the household portfolio between periods. Thus, the fluctuations and correlations of the variables in this model clearly show that as household risk aversion increases, time preference, which indicates the impatience of the current generation, will change the variables in favor of the current generation. Also, the effect of technology shock when the household risk aversion parameter changes on the model variables shows that the higher the household risk aversion, the greater the effect on the model variables.

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