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Résumé / Abstract

L'une des critiques habituelles adressées à la fonction d'utilité additive est qu'elle ne permet pas de distinguer l'aversion pour le risque de l'élasticité de substitution intertemporelle; plus exactement le paramètre de l'aversion pour le risque est à la fois l'inverse de l'élasticité de substitution intertemporelle. Cette critique est particulièrement pertinente lorsqu'il s'agit de rendre compte du taux d'intérêt sans risque et de la prime de risque. Mon intérêt dans ce travail est d'incorporer l'hypothèse de formation d'habitudes avec des préférences récursives dans un modèle du facteur d'escompte stochastique. L'idée générale est le fait que l'aversion de risque peut varier avec le temps. Avec une aversion de risque qui n'est pas constante, on peut expliquer la prévisibilité des excès-rendements des actifs risqués. Cette transformation est une bonne candidate capable de produire une aversion de risque temps-variée et qui peut apporter une meilleure performance aux études empiriques.

In the literature of financial economics, there has not been introduced yet a model which is capable of explaining at the same time high risk premium and low risk-free rate. Mehra and Prescott (1985) have found that it requires implausibly high levels of risk aversion on the part of the representative agent in order to reconcile these two puzzles. On the other hand, if the extremely risk averse agent hypothesis is taken to be true, then the classical consumption theory cannot explain empirically the risk-free interest rate puzzle unless a negative time preference rate is assumed. In this paper, we introduce habit formation into the consumption portfolio choice problem of infinitely lived representative agent with the Epstein-Zin preferences. We propose a better performing model than the one with the conventional additive and homogenous von Neuman Morgenstern intertemporal utility function in dealing with these two puzzles. It is well known that the specification of recursive preferences has the advantage of partially disentangling the intertemporal substitution and the risk aversion. On the other hand, a utility function with habit forming preferences implies temporal non-separability, since high past levels of consumption decrease the instantaneous utility level. This, in turn, modifies the optimality conditions and the expression of the risk premium.

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1. Introduction

In the literature of financial economics, there has not been yet introduced a generally accepted model which is capable of explaining the two famous puzzles: the equity premium puzzle and the risk-free rate puzzle.

The equity premium is the average difference between a return of risky asset and the one of the risk-free asset (the one whom nominal return is guaranteed). This puzzle has been put on evidence by Mehra et Prescott (1985) in an article with the standard model of neoclassical economy (rational anticipations, full equilibrium of the markets, etc.) They find that it requires implausibly high levels of risk aversion on the part of the representative agent in order to reconcile these two puzzles. That is, one need to suppose that the agents are ten times more risk averse in order to reproduce a risk premium close to the one that we observe in the American data. If, on the other hand, the extremely risk averse agent hypothesis is taken to be true, the classical consumption theory cannot explain empirically the risk-free rate puzzle, unless a negative rate of time preference is assumed. This result, called the risk-free rate puzzle, has been discovered by Weil (1989).

In this paper we introduce habit formation into the intertemporal consumption/portfolio choice problem with the Epstein-Zin preferences. We propose a better performing model than the one with the conventional additive and homogenous von Neuman-Morgenstern intertemporal utility function in dealing with these two asset puzzles. More precisely, the parameter of risk aversion is at the same time the inverse of the elasticity of intertemporal substitution. The intuition implies that the interest rate depends rather on the propensity of the agent to substitute current and future consumptions, whereas the risk premium depends on the attitude of the individual towards risk.

On the other hand, a utility function with habit forming preferences implies temporal non-separability, since high past levels of consumption decrease the instantaneous utility level. This, in turn, modifies the optimality conditions and the expression of the risk premium.

2. Recursive Preferences:

Recent empirical findings discover conflicting evidence first regarding the arbitrage between consumption and saving which implies a weak risk aversion, that is a very high elasticity of intertemporal substitution. Second, an arbitrage between risky and risk-free assets requires a stronger risk aversion. These results have been tackled by Weil (1989), and Epstein and Zin (1991) who use recursive utility functions proposed by Kreps and Porteus (1978). It is well known that the specification of recursive preferences has the advantage of partially disentangling the intertemporal substitution and the risk aversion. The recursive utility function distinguish risk aversion from the elasticity of intertemporal substitution by assigning to each behavior a preference parameter in order to resolve this dilemma. However, empirical application of this type of utility function using the American data does only resolve partially the equity premium puzzle.

3. Habit Formation

On the other hand, the utility function with habit forming preferences can the characteristics of weakening the temporal separability hypothesis of the utility function, which in turn reproduce the risk-free interest rate. The reason is that, the utility function with habits is such that for a given level of current consumption, high levels of past consumption decrease the instantaneous utility.

Habit formation has been used in several contexts in economics. The implications of habit formation were first discussed in Duesenberry's work (1949). His proposition was that families are willing to sacrifice saving in order to protect their living standards. In the event of a fall in income, consumption will not fall proportionately, producing a ratchet effect. This was reflected by including the individual's previous high income in the utility function. Thus, the ratchet effect creates an inertia in consumers' responses to current income changes in terms of consumers' memories of past peaks of real income. Duesenberry assumes that the decline of the effect of past habits is discontinuous over time rather than continuous as in the case of habit formation.

Whereas time separable preferences imply that current utility depends only on current consumption, time non-separable preferences with habit formation imply that past real consumption patterns and levels form consumer habits which persist long enough to slow down the effects of current income changes on current consumption. For a given level of current expenditures, past purchases contribute to a habit stock. Hence, it is an increase of current consumption over and above the habit stock which raises current utility.

Habit formation has two implications: First, it provides one explanation for the excess smoothness of aggregate consumption. Consumers with habit persistence will adjust slowly to shocks in permanent income. They prefer to have small changes rather than big jumps in consumption. Second, habit formation increases the disutility of large changes in consumption. In the presence of habit formation, an increase in current consumption increases the marginal utility of future consumption. There is thus, an adjacent complementarity in consumption. In such a case, following a negative shock to income, a consumption decrease will be delayed because of the persistence of high consumption schemes lingering from previous periods. An increase in current consumption in response to an increase in wealth or permanent income has two effects: it increases current utility, holding habit stock fixed; but (everything else equal) decreases utility at t+1. Since increasing consumption today generates a future externality, the rational consumer will respond to an increase in wealth or permanent income with a more moderate increase in consumption.

Ryder and Heal (1973) were the first to formally model habit formation. They studied its implications in a two-factor growth model. The specification of the utility function that they used was a continuous time model where the utility function depends also on a subsistence level of consumption. More recently, Becker and Murphy (1988) examined rational addiction in a model with habit formation using the same specification. Constantinides (1990) also used this specification and introduced habit formation in a rational expectations model to resolve the equity premium puzzle. By doing that, he was able to generate the necessary high variability in the marginal rate of substitution in consumption with relatively low variability in the consumption growth[1].

Several empirical papers in the consumption literature, however, have argued that habits may play an important role in determining consumption. Ferson and Constantinides (1991), Deaton and Paxson (1992), Dynan (1993), Carroll and Weil (1994), Heaton (1995), Fuhrer and Klein (1998) are among others. Ferson and Constantinides test the combined effects of durability and habit formation in consumption choices. They find that habit formation dominates durability in quarterly and annual data. Dynan finds that habit formation has a moderate influence on consumption and argues that habit formation only partly explains excess smoothness of aggregate consumption. Heaton examines the implications of various forms of intertemporal non-separability of total nondurable consumption on the behavior of asset prices. He finds evidence for the local substitution of consumption with habit formation occurring over longer periods of time. In a recent work, Fuhrer and Klein confirm the evidence of habit forming preferences for G-7 countries. Campbell and Cochrane (1999) develop a consumption-based model with a slow-moving external habit to the standard power utility function to capture the equity premium. On the other hand, Dunn and Singleton (1986)

[1]In his model, the presence of habit formation drives a wedge between the relative risk aversion of the representative agent and the intertemporal elasticity of substitution in consumption.

and Eichenbaum, Hansen and Singleton (1988), Muellbauer (1988), study the U.S. aggregate monthly consumption data and find no evidence of habit formation. Recently, in an intertemporal consumption-saving model with uncertainty and habit formation, Seckin (1999) mathematically derives the closed form of consumption.

4. The model:

Consider a program of an infinitely lived agent, who has habit forming behavior and recursivity in his consumption preferences. Then he chooses his consumption and portfolio allocation between risky and risk-free assets. It is known that when the utility function has a constant relative risk aversion, the agent's program can be resolved sequentially for the optimal allocation of wealth between different assets in terms of returns and risks.

But, first, let us suppose that habit formation hypothesis has not yet included in the model of recursive preferences. The representative agent maximizes his expected lifetime recursive utility function. In order to take into account the attitude of the agent vis à vis the intertemporal substitution, one can write that the instantaneous utility depends on the current consumption and on the certainty equivalent at time t of the future instantaneous utility at time $t+1$, (noted as $\widehat{U}_{t+1}$), with an elasticity of substitution between current consumption and the certainty equivalent of the future utility which is assumed to be constant and equal to $\frac{1}{\rho}$:

$$U_t = \left[c_t^{1-\rho} + \beta \left(\widehat{U}_{t+1}^{1-\gamma} \right)^{\frac{(1-\rho)}{(1-\gamma)}} \right]^{\frac{1}{(1-\rho)}} \tag{4.1}$$

The certainty equivalent at time t of the instantaneous utility at time $t+1$ depends on the attitude of the agent vis à vis the risk that we can write with a simple functional form of CRRA (constant relative risk aversion):

$$V(\widetilde{U}_{t+1}) = \widetilde{U}_{t+1}^{1-\gamma} \Rightarrow \widehat{U}_{t+1} = \left[E\left(\widetilde{U}_{t+1}^{1-\gamma} \right) \right]^{\frac{1}{1-\gamma}} \tag{4.2}$$

where $\widetilde{U}_{t+1}$ is the stochastic future instantaneous utility. The recursive utility function is the following:

$$U_t = \left[c_t^{1-\rho} + \beta \left[E\left(\widetilde{U}_{t+1}^{1-\gamma} \right) \right]^{\frac{(1-\rho)}{(1-\gamma)}} \right]^{\frac{1}{(1-\rho)}} \tag{4.3}$$

If the coefficient relative risk aversion γ is equal to the inverse of the elasticity of intertemporal substitution ρ, we obtain a special case of preferences. Hence, the instantaneous utility function is written as:

$$U_t = \frac{c_t^{1-\gamma}}{1-\gamma} \tag{4.4}$$

In this case with no habit formation, the problem is defined as:

$$\begin{aligned} MaxU_0 &= E_0 \sum_{t=0}^{\infty} \beta^t \left[c_t^{1-\rho} + \beta \left[E_t \left(\widetilde{U}_{t+1}^{1-\gamma} \right)^{\frac{(1-\rho)}{(1-\gamma)}} \right] \right]^{\frac{1}{(1-\rho)}} && (4.5) \\ \text{with } 0 &< \alpha < 1 \\ \text{subject to } &: \\ W_{t+1} &= (1 + R_{m,t})(W_t - c_t) && (4.6) \\ & \text{and} && (4.7) \\ (1 + R_{m,t}) &= \sum_i a_{i,t}(1 + R_{i,t}) \end{aligned}$$

$R_{m,t}$ being the market rate of return, and $R_{i,t}$ is the return of asset i and $a_{i,t}$ the share of the asset i in the wealth of the representative agent and $\sum_i a_i = 1$.

In the case only with two assets, one risky asset (stock), and one risk-free asset (government bond), we can write the two first order conditions as:

$$E \left[U_{t+1}^{\rho-\gamma} (c_{t+1}/c_t)^{-\rho} (R_{t+1}^s - R_{t+1}^b) \right] = 0 \tag{4.8}$$

$$\beta E \left[(E_t U_{t+1}^{1-\gamma})^{\frac{(\gamma-\rho)}{(1-\gamma)}} U_{t+1}^{\rho-\gamma} (c_{t+1}/c_t)^{-\rho} R_{t+1}^b \right] = 1 \tag{4.9}$$

The equation (4.8) implies the equality between the marginal rate of substitution between time t and time $t+1$ and the market return of the asset portfolio.

The equation (4.9) expresses the arbitrage condition between assets with risks. It gives the risk premium at the equilibrium $(R^s_{t+1} - R^b_{t+1})$ given the risk aversion of the agent.

Since it is difficult to predict the growth rate of future consumption with the current available information, following Kocherlakota (1996), we assume that the growth rate of future consumption is statically independent of any available current information. Under this restriction, it is possible to show that the utility in time $t+1$ is a multiple, constant in time, of future consumption. Hence, one can re-write (4.8) and (4.9) as:

$$E\left[(c_{t+1}/c_t)^{-\gamma}(R^s_{t+1} - R^b_{t+1})\right] = 0 \tag{4.10}$$

$$\beta\left[\left[(E(c_{t+1}/c_t)^{1-\gamma})\right]^{\frac{(\gamma-\rho)}{(1-\gamma)}} E(c_{t+1}/c_t)^{-\gamma} R^b_{t+1}\right] = 1 \tag{4.11}$$

Now, let us incorporate habit formation into this model of recursive preferences. Let $\widehat{c}_t$, the net consumption, that is we take into account the effect of previous period's consumption level on the current consumption choice of the individual. The net consumption is equal to:

$$\widehat{c}_t = c_t - \alpha c_{t-1} \text{ and } 0 < \alpha < 1 \tag{4.12}$$

The parameter α signifies the strength of habits on consumption. To simplify this model, past values older than one period is not taken into consideration. Hence, the instantaneous utility can be written as:[2]:

$$U_t = \left[\left[\widehat{c}_t^{1-\rho} + \beta \left[E\left(\widetilde{U}_{t+1}^{1-\gamma} \right) \right]^{\frac{(1-\rho)}{(1-\gamma)}} \right]^{\frac{1}{(1-\rho)}} \right] \tag{4.13}$$

The certainty equivalent at time t of the instantaneous utility (of the net consumption) at time $t+1$ depends on the attitude of the agent vis à vis the risk that we retrace with a simple functional form of

$$V(\widetilde{U}_{t+1}) = \widetilde{U}_{t+1}^{1-\gamma} \Rightarrow \hat{U}_{t+1} = \left[E\left(\widetilde{U}_{t+1}^{1-\gamma} \right) \right]^{\frac{1}{1-\gamma}} \tag{4.14}$$

where $\widetilde{U}_{t+1}$ is the stochastic future instantaneous utility. Until now, all the terms are written in terms of net consumption, but not yet in terms of current consump-

[2]Here, the instantaneous utility function is in terms of net consumption, $\widehat{c}_t$.

tion. The recursive utility function is the following:

$$U_t = \left[\widehat{c}_t^{1-\rho} + \beta \left[E \left(\widetilde{U}_{t+1}^{1-\gamma} \right) \right]^{\frac{(1-\rho)}{(1-\gamma)}} \right]^{\frac{1}{(1-\rho)}} \tag{4.15}$$

Hence, if we write the instantaneous utility function in term of current consumption, this one will be equal to U_t,

$$U_t = \left[(c_t - \alpha c_{t-1})^{1-\rho} + \beta \left[EU(c_{t+1} - \alpha c_t)^{1-\gamma} \right]^{\frac{(1-\rho)}{(1-\gamma)}} \right]^{\frac{1}{(1-\rho)}} \tag{4.16}$$

Then now, we can establish the model with recursive preferences and habit formation using current and past consumption levels. The problem of the agent then is defined as the following:

$$MaxU_0 = E_0 \left[\sum_{t=0}^{\infty} \beta^t \left[(c_t - \alpha c_{t-1})^{1-\rho} + \beta \left[EU(c_{t+1} - \alpha c_t)^{1-\gamma} \right]^{\frac{(1-\rho)}{(1-\gamma)}} \right]^{\frac{1}{(1-\rho)}} \right] \tag{4.17}$$

with $0 < \alpha < 1$

subject to :

$$W_{t+1} = (1 + R_{m,t})(W_t - c_t) \tag{4.18}$$

and

$$(1+R_{m,t}) = \sum_i a_{i,t}(1+R_{i,t}) \tag{4.19}$$

Here, one has to take into account the impact of past consumption levels on current consumption/portfolio choices.

The current marginal utility of the individual is equal to:

$$MU_t = \left\{ \begin{array}{c} [(c_t-\alpha c_{t-1})^{-\rho} - \alpha\beta E(c_{t+1}-\alpha c_t)^{-\rho}] \\ -\alpha\beta(1-\rho)\left[EU(c_{t+1}-\alpha c_t)^{-\rho} - \alpha\beta EU(c_{t+2}-\alpha c_{t+1})^{-\rho}\right] \end{array} \right\}$$
$$\times \left[(c_t-\alpha c_{t-1})^{1-\rho} + \beta\left[EU(c_{t+1}-\alpha c_t)^{1-\gamma}\right]^{\frac{(1-\rho)}{(1-\gamma)}} \right]^{\frac{-\rho}{(1-\rho)}} \tag{4.20}$$

The optimal consumption/saving portfolio of the individual must satisfy the two first order conditions which will make him indifferent between buying or selling stocks or government bonds. Hence,

$$\beta E\left[(MU_{t+1}/MU_t)(R^s_{t+1}-R^b_{t+1})\right] = 0 \tag{4.21}$$
$$\beta E\left[(MU_{t+1}/MU_t)R^b_{t+1}\right] = 1$$

where MU_t is defined as above.

Using the law of repeated iterations, we obtain:

$$\beta E\left[(MU_{t+1}/MU_t)(R^s_{t+1} - R^b_{t+1})\right] = 0 \tag{4.22}$$

$$\beta E\left[(MU_{t+1}/MU_t)R^b_{t+1}\right] = 1 \tag{4.23}$$

Hence, we can write the equation (4.22) as,

$$\beta[\frac{E\{[(c_t-\alpha c_{t-1})^{-\rho}-\alpha\beta E(c_{t+1}-\alpha c_t)^{-\rho}]-\alpha\beta(1-\rho)[EU(c_{t+1}-\alpha c_t)^{-\rho} -\alpha\beta EU(c_{t+2}-\alpha c_{t+1})^{-\rho}]\}}{E\{[(c_{t+1}-\alpha c_t)^{-\rho}-\alpha\beta E(c_{t+2}-\alpha c_{t+1})^{-\rho}]-\alpha\beta(1-\rho)[EU(c_{t+2}-\alpha c_{t+1})^{-\rho} -\alpha\beta EU(c_{t+3}-\alpha c_{t+2})^{-\rho}]\}}]$$
$$\times\beta E\frac{[(c_t-\alpha c_{t-1})^{1-\rho}+\beta[EU(c_{t+1}-\alpha c_t)^{1-\gamma}]^{\frac{(1-\rho)}{(1-\gamma)}}]^{\frac{-\rho}{(1-\rho)}}}{\left[[(c_{t+1}-\alpha c_t)^{1-\rho}+\beta[EU(c_{t+2}-\alpha c_{t+1})^{1-\gamma}]^{\frac{(1-\rho)}{(1-\gamma)}}]\right]^{\frac{-\rho}{(1-\rho)}}}[R^s_{t+1}-R^b_{t+1}]=0 \tag{4.24}$$

We can similarly write the equation (4.23) in the following way:

$$\beta\left[\frac{E\{[(c_t-\alpha c_{t-1})^{-\rho}-\alpha\beta E(c_{t+1}-\alpha c_t)^{-\rho}]-\alpha\beta(1-\rho)[EU(c_{t+1}-\alpha c_t)^{-\rho} -\alpha\beta EU(c_{t+2}-\alpha c_{t+1})^{-\rho}]\}}{E\{[(c_{t+1}-\alpha c_t)^{-\rho}-\alpha\beta E(c_{t+2}-\alpha c_{t+1})^{-\rho}]-\alpha\beta(1-\rho)[EU(c_{t+2}-\alpha c_{t+1})^{-\rho} -\alpha\beta EU(c_{t+3}-\alpha c_{t+2})^{-\rho}]\}}\right]$$

$$\times\beta E\frac{[(c_t-\alpha c_{t-1})^{1-\rho}+\beta[EU(c_{t+1}-\alpha c_t)^{1-\gamma}]^{\frac{(1-\rho)}{(1-\gamma)}}]^{\frac{-\rho}{(1-\rho)}}}{\left[[(c_{t+1}-\alpha c_t)^{1-\rho}+\beta[EU(c_{t+2}-\alpha c_{t+1})^{1-\gamma}]^{\frac{(1-\rho)}{(1-\gamma)}}]\right]^{\frac{-\rho}{(1-\rho)}}}E(R^b_{t+1})=0 \tag{4.25}$$

In the hybrid model of habit formation and recursive preferences, the Euler equations are written as shown above. We observe that not only current and past consumption levels, but also future consumption levels up to time $t+3$ enter into the equations and will jointly affect the optimal consumption and portfolio choice of the individual.

5. Conclusion

This work is essentially theoretical. It proposes another way of model the consumption/portfolio choice of the individual in order to reconcile the empirical reality with theoretical design. The idea is to put up together two promising assumptions in resolving the equity premium and the risk-free rate puzzles. Although the result is far being simple, it makes us think on the interdependence of preferences and the difficult process of decision making of an individual who cares the timing of uncertainty and the level of his living standards. The model's presented here is far closer to the reality.

The next step is to test this model and assess its success in terms of explaining these two famous puzzles.

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