HABITS, SAVING PROPENSITY, AND ECONOMIC GROWTH

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Abstract*: The purpose of this paper is to study economic growth with preference change on the basis of the Solow one-sector growth model, Zhang's alternative approach to household behavior, the Ramsey growth theory with time preference, and the traditional growth model with habit formation. The propensity to save is dependent on wealth and current income and the propensity to consumption is related to the habit stock. We simulate the model and demonstrate the motion of the economic dynamics with endogenous preference. We also examine effects of changes in some parameters on the motion of the economic system.*

Keywords: *habit stock, propensity to save, endogenous preference, economic growth*

Jel Classification Codes: O41

1. INTRODUCTION

Different people have different preferences. For instance, according to the empirical study by Lawrance (1991), nonwhite families without a college education have time preference rates that are higher than those of while. Becker and Mulligan (1997) showed that expenditures in health and education tend to make people more patient and increase savings (e.g., Fuchs, 1982; Shoda *et al*., 1990; Olsen, 1993; Kirby *et al*. 2002; and Chao *et al*., 2009). Preferences are changeable and many factors may attribute to these changes. In *The Theory of Moral Sentiments*, Adam Smith illustrates: "The man who lives within his income is naturally contented with his situation, which, by continual, though small accumulations, is growing better and better every day. He is enabled gradually to relax, both in the rigour of his parsimony and in the severity of his application; and he feels with double satisfaction this gradual increase of ease and enjoyment, from having felt before the hardship which attended the want of them." Fisher (1930: 72) emphasizes the influence of wealth and income on preference difference: "Poverty bears down heavily on all portions of a man's expected life. But it increases the want for immediate income even more than it increases the want for future income." Fisher (1930: 81) also points out connections between culture and preference: "In the case of primitive races, children, and other uninstructed groups in society, the future is seldom considered in its true proportions." He also mentions cultures and other factors such as self-control, habit, concerns for the lives of other people, and fashion. Many empirical studies also show preference changes in association with other changes in social and economic conditions. For instance, Horioka (1990) and Sheldon (1997, 1998) attributed Japan's high saving rates partly to the government's efforts in promoting the virtues of patience and thrift.

In the literature of economic growth and development, the Ramsey model has played the role of a core model in the development of theoretical dynamic model. As observed by Becker and Mulligan (1997: 729), "Time preference plays a fundamental role in theories of saving and investment, economic growth, interest rate determination and asset pricing, addiction, and many other issues that are getting increasing attention from economists. Yet, since Samuelson's [1937] discounted utility model, rates of time preference are almost invariably taken as "given" or exogenous, with little discussion of what determines their level." In fact, there are many studies on growth with preference change. A main approach is the approach of the so-called endogenous time preference. Strotz (1956) argued that discount functions are formed by teaching and social environment. The formal modeling in continuous time formation starts with Uzawa's seminal paper (Uzawa, 1968). Like Uzawa, Lucas and Stokey (1984) and Epstein (1987) relate change in time preference to consumptions. From their analysis, Becker and Mulligan (1997: 745) conclude: "persons who are richer because they have more assets would be more patient than persons with fewer assets. It is also implies that higher incomes due to greater earnings may have a different effect on the degree of patience than higher income due to greater assets, although the existence of a time cost does not necessarily allow us to rank the magnitude of the two effects." They also point out the possibility "to distinguish a "wealth causes patience" hypothesis from a "patience causes wealth" hypothesis." (Becker and Mulligan, 1997: 746). Becker and Barro (1988) assumes that a parent's generational discount rate is connected to their fertility. Many other studies on the implications of endogenous time preference for the macroeconomy have been conducted, for instance, Epstein and Hynes (1983), Obstfeld (1990), Shin and Epstein (1993), Palivos *et al.* (1997), Drugeon (1996, 2000), Stern (2006), Meng (2006), and Dioikitopoulos and Kalyvitis (2010). These studies have shown theoretically that it is important to take account of the endogeneity of time preference in explaining economic growth and development. The idea of analyzing change in impatience in this study is influenced by the literature of time preference. We introduce changes in impatience in an alternative utility proposed by Zhang (2005, 2009).

Another aspect in modeling preference change is related to the so-called habit formation or habit persistence model, which was introduced to formal economic analysis by Duesenberry (1949). The concept implies that individuals tend to get accustomed to a given "standard of living" which they like to keep. Becker (1992) explains the influence of habit on human behavior as follows: "the habit acquired as a child or young adult generally continue to influence behavior even when the environment changes radically. For instance, Indian adults who migrate to the United States often eat the same type of cuisine they had in India, and continue to wear the same type clothing." Habit formation is also applied to financial economics to explain the equity premium puzzle first identified in the seminal work of Mehra and Prescott (1985) (See also Sundaresan, 1989; Constantinides, 1990; and Campbell and Cochrane, 1999). Using the concept of habit, de la Croix (1996) explains oscillations in economic dynamics in a competitive economy. In the model, the aspirations of the new generation are so high at some point of an expansion that savings are depressed to maintain consumption standards, which leads to a contraction. The contraction ends when aspirations became lower. Boldrin *et al.* (2001) use the habit formation model to explain asset prices and business cycles with inflexibilities in some factor markets. There are also studies to explain the observed behavior at business-cycle frequency of a large number of macroeconomic variables (Christiano *et al.* 2005). In some models habit is treated external to the consumer (Pollak, 1970). The stock of habit depends on the history of aggregate past consumption rather than the consumer's own past consumption. Since the work of Abel (1990), 'catching up with the Joneses' is often used exchangeable with external habit formation. This assumption often simplifies the optimal problem because the evolution of habit is exogenous by the representative agent. Ravn *et al.* (2006) build a general equilibrium model of habit formation on a good-by-good basis. This type of habit formation is referred as 'deep habits'. In this model, consumers can form habits independently over narrowly defined categories of goods, such as housing, clothing, tourist resorts and cars. Huang (2012) builds a two-sector dynamic model with deep-habits of nondurable and housing goods. The housing deep-habit model allows agents to form their habits from individual housing goods and nondurable goods, with a higher level of the habit for housing goods than nondurable goods primarily because housing goods have higher transaction costs than nondurable goods. The model explains counter-cyclical markups of housing goods.

As preferences are important for determining household saving, education, time distribution, family formation, and choice of goods and services, it is important to properly take account of the motion of preference in explaining economic growth. The purpose of this paper is to study economic growth with preference change on the basis of the Solow one-sector growth model, Zhang's approach to household behavior, the literature of time preference and the literature of habit formation. Section 2 introduces the basic model with wealth accumulation and preference dynamics. Section 3 examines dynamic properties of the model and simulates the model, identifying the existence of a unique equilibrium and checking the stability conditions. Section 4 studies effects of changes in some parameters on the system. Section 5 concludes the study.

2. THE BASIC MODEL

The economy has one production sector. Most aspects of the production sector are similar to the Solow one-sector growth model (see Solow, 1956; Burmeister and Dobell 1970; Barro and Sala-i-Martin, 1995). It is assumed that there are only one (durable) good. Households own capital of the economy and distribute their incomes to consume the commodity and to save. Exchanges take place in perfectly competitive markets. We assume a homogenous and fixed population. Labor market is perfectly competitive. We select commodity to serve as numeraire (whose price is normalized to 1), with all the other prices being measured relative to its price.

The production sector

We assume that production is to combine labor force, N, and physical capital, $K(t)$. The production function is specified as follows

$$F(t) = A K^{\alpha}(t) N^{\beta}, \quad A, \alpha, \beta > 0, \quad \alpha + \beta = 1, \tag{1}$$

where $F(t)$ is the output level of the production sector at time t, and A, α and β are parameters. Markets are competitive; thus labor and capital earn their marginal products. The rate of interest, $r(t)$, and wage rate, $w(t)$, are determined by markets. The marginal conditions are given by

$$r(t) + \delta_k = \frac{\alpha F(t)}{K(t)}, \quad w(t) = \frac{\beta F(t)}{N}, \tag{2}$$

where δ_k is the fixed depreciation rate of physical capital.

Consumer behaviors

Consumers choose how much to consume and how much to save. We apply an alternative approach to behavior of the household. We denote per capita wealth by $k(t)$, where $k(t) \equiv K(t)/N$. Per capita current income from the interest payment $r(t)k(t)$ and the wage payment $w(t)$ is given by

$$y(t) = r(t)k(t) + w(t).$$

We call $y(t)$ the current income in the sense that it comes from consumers' payment for efforts and consumers' current earnings from ownership of wealth. The total value of wealth that consumers can sell to purchase goods and to save is equal to $k(t)$. Here, we assume that selling and buying wealth can be conducted instantaneously without any transaction cost. The disposable income per head is given by

$$\hat{y}(t) = y(t) + k(t). \tag{3}$$

The disposable income is used for saving and consumption. At each point of time, a consumer would distribute the total available budget among saving, $s(t)$, and consumption of the commodity, $c(t)$. The budget constraint is given by

$$c(t) + s(t) = \hat{y}(t). \tag{4}$$

At each point of time, consumers decide $s(t)$ and $c(t)$. For simplicity of analysis, we specify the utility function as follows

$$U(t) = c^{\xi_0(t)}(t) s^{\lambda_0(t)}(t), \ \ \xi_0(t), \ \lambda_0(t) > 0,$$

where $\xi_0(t)$ is called the propensity to consume and $\lambda_0(t)$ the propensity to save. A detailed explanation of the approach and its applications to different problems of economic dynamics are provided in Zhang (2005, 2009).

For the representative consumer, wage rate $w(t)$ and rate of interest $r(t)$ are given in markets and wealth $k(t)$ is predetermined before decision. Maximizing $U(t)$ subject to budget constraint (4) yields

$$c(t) = \xi(t)\hat{y}(t), \ \ s(t) = \lambda(t)\hat{y}(t), \tag{5}$$

where

$$\xi(t) \equiv \rho(t)\xi_0(t), \ \ \lambda(t) \equiv \rho(t)\lambda_0(t), \ \ \rho(t) \equiv \frac{1}{\xi_0(t) + \lambda_0(t)}.$$

Wealth accumulation

According to the definition of $s(t)$, the change in the household's wealth is given by

$$\dot{k}(t) = s(t) - k(t). \tag{6}$$

This equation says that the change in wealth is equal to the saving minus dissaving.

Demand and supply balance

As output of the production sector is equal to the sum of the level of consumption, the depreciation of capital stock and the net savings, we have

$$C(t) + S(t) - K(t) + \delta_k K(t) = F(t), \tag{7}$$

where $C(t)$ is the total consumption, $C(t) = c(t)N$, and $S(t) - K(t) + \delta_k K(t)$ is the sum of the net saving and depreciation, $S(t) = s(t)N$.

The time preference and the propensity to hold wealth

In this study, we introduce preference change through making the propensity to own wealth and propensity to consume endogenous variables. The propensity to save measures patience of the household. In modeling motion of the propensity to save, we will base our approach on the traditional approach to preference change in economic theory. As reviewed in the introduction, the traditional way of preference change is to make the discounting utility rate endogenous. According to Chang *et al*. (2011), the representative household maximizes the following discounted lifetime utility with perfect foresight

$$\int_0^{\infty} u(c, m) e^{-\rho(t)} \, dt ,$$

subject to the budge constraint. Here, u is the utility function, c is consumption, and m is holdings of real money balances. In their study, the time preference $\rho(t)$ is endogenous determined (see also, Uzawa, 1968; Epstein, 1987; Obstfeld, 1990; and Shi and Epstein, 1993). The cumulated subjective discount rate is specified as follows

$$\rho(t) = \int_0^{t} \Delta(u(s)) d s ,$$

where $\Delta > 0$ is an instantaneous subjective discount rate at time s, which satisfies $\Delta' > 0$, $\Delta'' > 0$, and $\Delta - u\Delta' > 0$. We have

$$\dot{\rho}(t) = \Delta(u(t)).$$

The time preference change is a generalization of Uzawa's study on endogenous rate of time preference. According to Uzawa (1968), the rate of time preference is an increasing function of instantaneous utility, which itself depends positively on current consumption. An implication of this assumption is that rich people are more impatient. Some economists consider $\Delta' > 0$ improper (Blanchard and Fischer,1989; Das, 2003; and Hirose and Ikeda, 2008). Persson and Svensson (1985: 45) consider Uzawa's idea as "arbitrary and even counterintuitive" as it contradicts the evidence of savings as decreasing function of real wealth. Turnovsky (2000: 357) also cautions against using Uzawa's preference change: "… the requirement that the rate of time discount … must increase with the level of utility and therefore consumption, is not particularly appealing. It implies that, as agents become richer and increase their consumption levels, their preference for consumption over future consumption increases, whereas intuitively, one would expect the opposite to be more likely." To avoid this limitation, the rate of time preference is assumed to be an increasing function of real wealth (rather than current consumption), for instance, in studies by Dornbusch and Frenkel (1973), Orphanides and Solow (1990), Smithin (2004), and Kam and Mohsin (2006).

Although this study does not follow the Ramsey approach in modeling behavior of household, the ideas about time preference within the Ramsey framework are important for us to understand importance and issues related to formally modeling preference change. In Zhang's approach to household behavior, the preference for patience is directly measured by the propensity to save, $\lambda_0(t)$. The time preference is assumed to be influenced by real wealth or/and current consumption in the literature. In this study we consider that the propensity to save is influence by the current income and wealth. It should be noted that instead of the current consumption we use the current income. We use the current income to measure how the current economic condition affects the preference towards the future. We propose the dynamics of the propensity to save as follows

$$\lambda_0(t) = \bar{\lambda} + \lambda_y \, y(t) + \lambda_w \, k(t), \tag{8}$$

where $\bar{\lambda} > 0$, λ_y, and λ_w are parameters. When $\lambda_y = \lambda_w = 0$, the propensity to hold wealth is constant. If we follow Uzawa's idea, then it is reasonable to assume $\lambda_y > 0$ and $\lambda_w = 0$.

If we follow the assumption that the rate of time preference is positively related to wealth, for instance, accepted by Smithin (2004) and Kam and Mohsin (2006), then $\lambda_y = 0$ and $\lambda_w > 0$.

The habit formation and the propensity to consume

To formally illustrate the basic ideas in the habit formation approach, we consider a model by Corrado and Holly (2011). The infinitely lived representative consumer maximizes its expected utility

$$U = E_t \left\{ \sum_{j=1}^{\infty} \beta^j U_{t+j}(\cdot) \right\},$$

where $U_{t+j}(\cdot)$ is the instantaneous utility function, $\beta = 1/(1+\theta)$ measures the impatience to consume and θ is the subjective rate of time preference. The utility function is the standard constant relative risk aversion utility function with the coefficient of relative risk aversion α as follows

$$U_t = \frac{\left(C_t \hbar_t^{-v}\right)^{1-\alpha}}{1-\alpha},$$

where C_t is consumption at time t and $\hbar_t$ is the stock of habit. The parameter v indexes the importance of the habit stock. If $v = 0$, habit does not matter. If $v = 1$, consumption relative to the stock of habit is all that matters. The above form of the utility function is called multiplicative, in contrast to the subtractive formation $(C_t - \hbar_t)$. The implications of multiplicative form is referred to Carroll (2000); Amano and Laubach (2004), while those of the subtractive formation to Deaton and Muellbauer (1980). The habit formation is specified as follows

$$\hbar_t = \lambda F(\hbar_{t-1}) + (1-\lambda) F(C_{t-1}), \quad 0 < \lambda < 1,$$

where λ is the relative importance of consumption and F is a habit function. It should be noted that Fuhrer (2000) uses a linear (additive) form, and Kozicki and Tinsley (2002) uses a logarithmic (geometric) form. Another approach of habit formation is to take account of internal habits and external habits within the same framework (Carroll *et al.* 1997). We now consider a habit formation in continuous time (e.g., Alvarez-Cuadrado *et al.*, 2004; and Gómez, 2008)

$$\hbar(t) = \rho \int_{-\infty}^{t} e^{\hbar_0 (s-t)} C^{\phi}(s) \overline{C}^{1-\phi}(s)\, d s, \quad \rho > 0, \quad 0 \le \phi \le 1,$$

where $C(t)$ is the consumer's consumption and $\overline{C}(t)$ is the economy-wide average consumption. A larger value for $\hbar_0$ would involve lower weights given to more distant values of the levels of consumption. It measures the relative weights of consumption at different times. Differentiating the equation with respect to time yields

$$\dot{\hbar}(t) = \hbar_0 \left[C^{\phi}(s) \overline{C}^{1-\phi}(s) - \hbar(t) \right].$$

If $\phi = 0$, the habit formation corresponds to the model with external habits. If $\phi = 1$, the habit formation corresponds to the model with internal habits. If $0 < \phi < 1$, habits arise from both the consumer's and average past consumption.

In our model, the preference for consumption is measured by the propensity to consume. We also apply the concept of habit stock to analyze how the past consumption affects the current preference. Following the traditional way of modeling the habit formation, we assume the following habit formation

$$\dot{\hbar}(t) = \hbar_0 \left[c(t) - \hbar(t)\right]. \tag{9}$$

Equation (9) corresponds to the model with internal habits. If the current consumption is higher than the level of the habit stock, then the level of habit stock tends to rise, and vice versa. The propensity to consume is assumed to be a function of the habit stock in the following way

$$\xi_0(t) = \bar{\xi} + \xi_y\, y(t) + \xi_h \hbar(t), \tag{10}$$

where $\bar{\xi} > 0$, ξ_y and $\xi_h \geq 0$ are parameters. If $\xi_y = 0$ and $\xi_h = 0$, the propensity is constant. The term $\xi_y\, y(t)$ implies that the propensity to consume is affected by the current income. If $\xi_y > (<)\, 0$, then a rise in the current income raises (reduces) the propensity to consume. It is reasonable to assume $\xi_y \geq 0$. The term $\xi_h \hbar(t)$ implies that if the habit stock is increasing, the propensity to consume tends to rise, and vice versa.

We have thus built the dynamic model. We now examine dynamics of the model.

3. THE MOTION OF THE ECONOMIC SYSTEM

We now show that the dynamics can be expressed by two differential equations. From (2), we obtain

$$r + \delta_k = \frac{\alpha f(k)}{k}, \quad w = \beta f(k), \tag{11}$$

where $f \equiv A k^{\alpha}$ and $k \equiv K / N$. We omit time index. We see that r and w are functions of k. From their definitions, y, $\hat{y}$ and λ_0 are functions of k. From $c = \xi\, \hat{y}$ and (8)-(10), we have

$$c = \Omega(k\,,\, \hbar) \equiv \frac{\left(\bar{\xi} + \xi_y\, y + \xi_h \hbar\right)\hat{y}}{\bar{\xi} + \xi_y\, y + \xi_h \hbar + \lambda_0}. \tag{12}$$

Substituting (12) and $s = \hat{y} - c$ into (6) and (9) yields

$$\dot{k} = \hat{y} - \Omega(k\,,\, \hbar) - k\,,$$
$$\dot{\hbar} = \hbar_0 \left[\Omega(k\,,\, \hbar) - \hbar\right]. \tag{13}$$

From (13), we determine $k(t)$ and $\hbar(t)$. The rest variables are determined as functions of $k(t)$ and $\hbar(t)$ as follows: r and w by (11) $\rightarrow$ $K = k N$ $\rightarrow$ y and $\hat{y}$ by the definitions $\rightarrow$ ξ_0 by (10) $\rightarrow$ λ_0 by (8) $\rightarrow$ c by (12) $\rightarrow$ $s = \hat{y} - c$ $\rightarrow$ $F = f N$.

As the expressions are too complicated, we simulate the model to illustrate behavior of the system. In the remainder of this study, we specify the depreciation rates by $\delta_k = 0.03$. We specify the other parameters as follows

$$N = 10, \ A = 1.1, \ \alpha = 0.35, \ \bar{\lambda} = 0.5, \ \lambda_y = -0.01, \ \lambda_k = 0.04, \ \bar{\xi} = 0.07, \ \xi_y = 0.01, \ \xi_h = 0.02, \ \hbar_0 = 0.1. \tag{14}$$

The population is 10. The population size has no impact on the per-capita variables, even though it affects the aggregate variable levels. The total productivity is 1.1. We now specify the initial conditions to see how the gender-related variables change over time. To follow the motion of the system, we specify initial conditions: $k(0) = 27$ and $\hbar(0) = 1.7$. The simulation result is plotted in Figure 1. The population and human capital rise initially and then fall. The birth rate falls. The mortality rate falls initially and then rises. Most of the labor force is employed by the industrial sector. The motion of the rest variables is plotted in Figure 1. The per capita level of consumption rises over time. The stock of habit also rises over time. Initially the level of habit stock is lower than the consumption level. As the household consumes more, the level of habit stock is increased till the habit stock achieves the level of consumption level in the long term. The (relative) propensity to consume rises over time in association of the rise in the habit stock. As $\xi(t) + \lambda(t) = 1$ holds at any point of time, the propensity to save falls over time. The national wealth and output levels rise and then fall. It should be noted that the change patterns of the per capita wealth, national wealth and output level cannot be observed in the Solow model (Zhang, 2005). In the Solow model, these variables change monotonically over time.

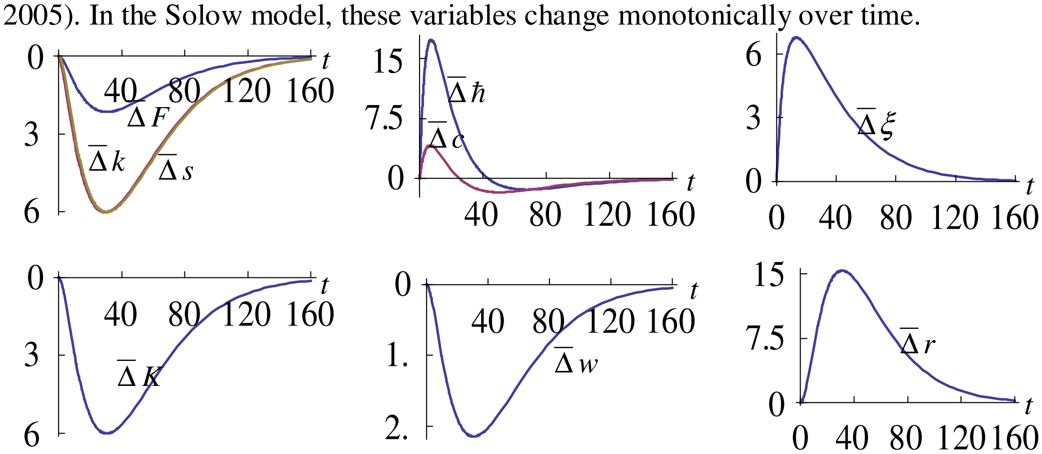

Figure 1. The Motion of the Economic System

From Figure 1, we observe that the system approaches an equilibrium point. Our simulation demonstrates that the dynamic system has a unique equilibrium point. We list the equilibrium values of the variables as follows

$$k = 30, \ \hbar = c = 2.72, \ K = 300, \ F = 36.17, \ \xi_0 = 0.152, \ \lambda_0 = 1{,}673, \ w = 2.35, \ r = 0.012.$$

We calculate the two eigenvalues as follows: $-0.04 + 0.01i$ and $-0.04 - 0.01i$. As the real parts of the two eigenvalues are negative, the unique equilibrium is locally stable. Hence, the system always approaches its equilibrium if it is not far from the equilibrium.

4. COMPARATIVE DYNAMIC ANALYSIS IN SOME PARAMETERS BY SIMULATION

This section studies impact of changes on dynamic processes of the system. We examine effects of changes in $\hbar_0$, ξ_h, and λ_k.

The past consumption weighs less in affecting the current consumption

First, we study the case that the weight of the past consumption is changed as follows: $\hbar_0 : 0.1 \Rightarrow 0.3$. The simulation results are plotted in Figure 2. In the plots, a variable $\bar{\Delta} x(t)$ stands for the change rate of the variable, $x(t)$, in percentage due to changes in the parameter value. We will use the symbol $\bar{\Delta}$ with the same meaning when we analyze other parameters. In order to examine how each variable is affected over time, we should follow the motion of the entire system as each variable is related to the others in the dynamic system. When $\hbar_0$ is increased, the consumer weighs less the past influence on the decision of consumption. First, we note that the system is not affected in the long term. The reason is that a change in $\hbar_0$ only affects how fast the current consumption adapts to the habit stock. If the economic system operates long and the other parameters are not affected, the current consumption is equal to the habit stock in the long term. The transitional processes from the initial conditions to the equilibrium point are affected by the shift in $\hbar_0$. As the past consumption weighs less in affecting the current consumption, the habit stock accumulates faster, which also stimulates the current consumption through affecting the propensity to save. As the consumption is increased, the wealth and total capital stocks are reduced. The reduction in the capital stocks raises the rate of interest and reduces the wage rate. As the household has less for consumption, the consumption level will fall after it is increased for a while. As the consumption level falls, the habit stock also begins to fall. The pattern of the change is similar for the other variables.

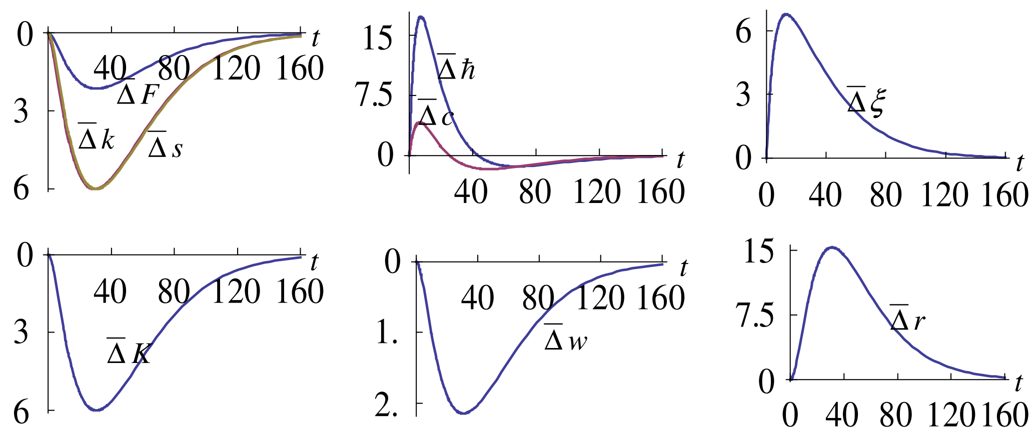

Figure 2. The Past Consumption Weighs Less

The impact of habit stock on the propensity to consume becomes stronger

We now examine what will happen to the dynamic system if $\xi_h : 0.02 \Rightarrow 0.022$. As this parameter value is increased, the (relative) propensity to save tends to rise. As more disposable income is spent on consumption, the level of consumption tends to rise initially. As the income is increased, the habit stock is also increased. The rise in the consumption reduces the wealth. As less saving is made, the capital stock falls. The fall in the capital stock raises the rate of interest and reduces the wage rate. As a net result of the rises in the propensity to save and the falls in the wage income, the consumption level is reduced in the long term. The strengthened impact of the habit stock on the propensity to save has negative effects on the living conditions and economic performances in the long term.

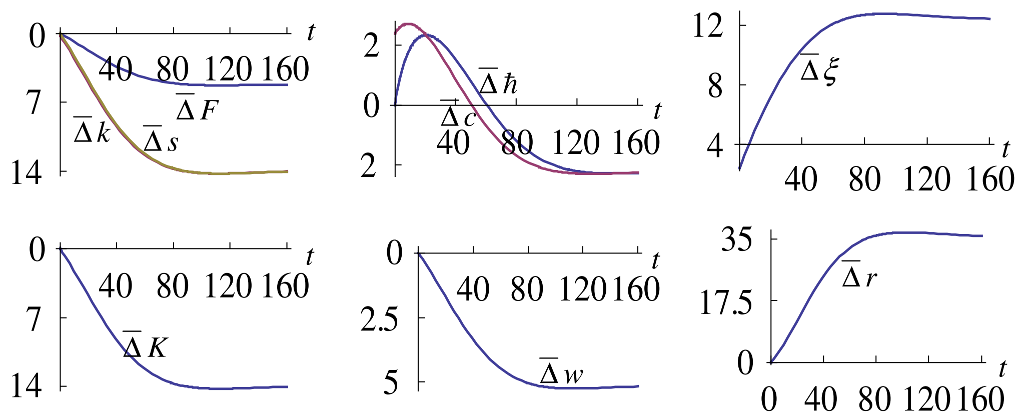

Figure 3. The Impact of Habit Stock on the Propensity to Consume Becomes Stronger

The impact of wealth on the propensity to save becomes stronger

We now examine the impact of the following change: $\lambda_k : 0.04 \Rightarrow 0.042$. As the impact of wealth on the propensity to save becomes stronger, the propensity to save is increased. As more disposal income is devoted to saving, consumption is reduced initially. In association with the initial fall in consumption, the habit stock is also reduced. As the economy accumulates more wealth, the wage rate is increased and the rate of interest is reduced. The disposable income is increased. The long-run net result of the fall in the propensity to consume and the rise in the disposable income is that the consumption level and habit stock are increased.

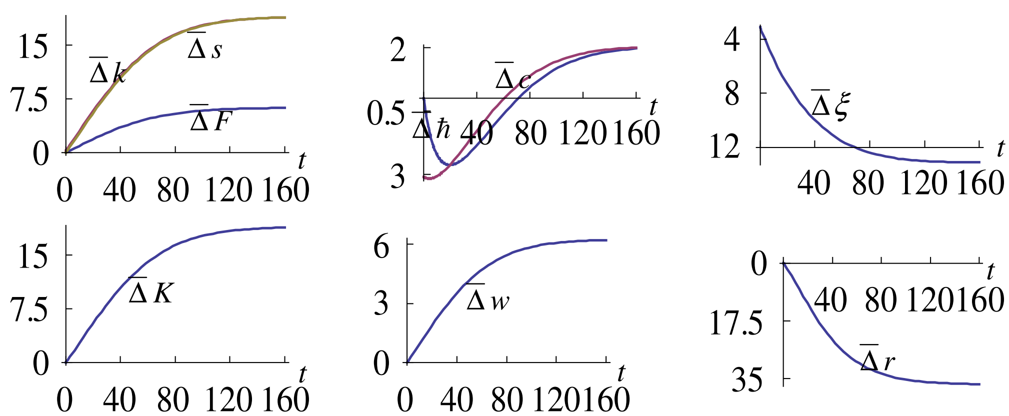

Figure 4. The Impact of Wealth on the Propensity to Save Becomes Stronger

5. CONCLUDING REMARKS

This paper studied economic growth with preference change on the basis of the Solow one-sector growth model, Zhang's alternative approach to household behavior, the Ramsey growth theory with time preference, and the traditional growth model with habit formation. The propensity to save is dependent on wealth and current income and the propensity to consumption is related to the habit stock. We simulate the model and demonstrate the motion of the economic dynamics with endogenous preference. We also examine effects of changes in some parameters on the motion of the economic system. For instance, when the consumer weighs less the past influence on the decision of consumption, the system is not affected in the long term. Nevertheless, the transitional processes from the initial conditions to the equilibrium point are affected by the shift in the parameter. The habit stock accumulates faster, which also stimulates the current consumption through affecting the propensity to save. As the consumption is increased, the wealth and total capital stocks are reduced. The reduction in the capital stocks raises the rate of interest and reduces the wage rate. As the household has less for consumption, the consumption level will fall after it is increased for a while. As the consumption level falls, the habit stock also begins to fall. The pattern of the change is similar for the other variables.

REFERENCES

1. Abel, A. (1990) Asset Prices under Habit Formation and Catching up with the Joneses. American Economic Review 80, 38-42.
2. Alvarez-Cuadrado, F., Monteriro, G., and Turnovsky, S.J. (2004) Habit Formation, Catching-Up with the Joneses, and Economic Growth. Journal of Economic Growth 9, 47-80.
3. Amato, J.D. and Laubach, T. (2004) Implication of Habit Formation for Optimal Monetary Policy. Journal of Monetay Economics 51, 305-25.
4. Barro, R.J. and X. Sala-i-Martin (1995) Economic Growth. New York: McGraw-Hill, Inc.
5. Becker, G. (1992) Habits, Addictions and Traditions. Kyklos 45, 327-45.
6. Becker, G.S. and Barro, R.J. (1988) A Reformation of the Economic Theory of Fertility. Quarterly Journal of Economics 103, 139-71.
7. Becker, G.S. and Mulligan, C.B. (1997) The Endogenous Determination of Time Preference. The Quarterly Journal of Economics 112, 729-58.
8. Blanchard, O.J. and Fischer, S. (1989) Lectures on Macroeconomics. Cambridge, MA: MIT Press.
9. Boldrin, M., Christiano, L., and Fisher, J. (2001) Habit Persistence, Asset Returns, and the Business Cycle. American Economic Review 91, 149-66.
10. Burmeister, E. and Dobell, A.R. (1970) Mathematical Theories of Economic Growth. London: Collier Macmillan Publishers.
11. Campbell, J. and Cochrane, J. (1999) By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior. Journal of Political Economy 107, 205-51.
12. Carroll, C.D. (2000) Solving Consumption Models with Multiplicative Habits. Economics Letters 68, 67-77.
13. Carroll, C.D., Overland, J., and Weil, D.N. (1997) Consumption Utility in a Growth Model. Journal of Economic Growth 2, 339-67.
14. Chang, W.Y., Tsai, H.F., and Chang, J.J. (2011) Endogenous Time Preference, Interest-Rate Rules, and Indeterminacy. The Japanese Economic Review 62, 348-64.
15. Chao, L.W., Szrek, H., Pereira, N.S., and Paul, M. (2009) Time Preference and Its Relationship with Age, Health, and Survival Probability. Judgment and Decision Making 4, 1-19.
16. Christiano, L., Eichenbaum, M., and Evans, C. (2005) Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. Journal of Political Economy 113, 1-45.
17. Constantinides, G. (1990) Habir Formation: A Resolution of the Equity Premium Puzzle. Journal of Political Economy 98, 519-43.
18. Corrado, L. and Holly, S. (2011) Multiplicative Habit Formation and Consumption: A Note. Economics Letters 113, 116-19.

19. Das, M. (2003) Optimal Growth with Decreasing Maginal Impatience. Journal of Economic Dynamics and Control 27, 1881-98.
20. De la Croix, D. (1996) The Dynamics of Bequeathed Tastes. Economics Letters 51, 89-96.
21. Deaton, A. and Muellbauer, J. (1980) Economics and Consumer Behavior. Cambridge: Cambridge University Press.
22. Dioikitopoulos, E.V. and Kalyvitis, S. (2010) Endogenous Time Preference and Public Policy: Growth and Fiscal Implications. Macroeconomic Dynamics 14, 243-57.
23. Duesenberry, J. (1949) Income, Saving, and the Theory of Consumer Behavior. Cambridge, MA.: Harvard University Press.
24. Dornbusch, R. and Frenkel, J. (1973) Inflation and Growth: Alternative Approaches. Journal of Money, Credit and Banking 50, 141-56.
25. Drugeon, J.P. (1996) Impatience and Long-run Growth. Journal of Economic Dynamics and Control 20, 281-313.
26. Drugeon, J.P. (2000) On the Roles of Impatience in Homothetic Growth Paths. Economic Theory 15, 139-61.
27. Epstein, L.G. (1987) A Simple Dynaic General Equilibrium Model. Journal of Economic Theory 41, 68-95.
28. Epstein, L.G. and Hynes, J.A. (1983) The Rate of Time Preference and Dynamic Economic Analysis. Journal of Political Economy 91, 611-35.
29. Fisher, I. (1930) The Theory of Interest. New York: Macmillan.
30. Fuhrer, J. (2000) Habit Formation in Consumption and Its Implications for Monetary Policy Models. American Economic Review 90, 367-90.
31. Fuchs, V.R. (1982) Time Preference and Health: An Exploratory Study, in Economic Aspects of Health, edited by Fuchs, V.R. Chicago: University of Chicago Press.
32. Gómez M.A. (2008) Convergence Speed in the AK Endogenous Growth Model with Habit Formation. Economics Letter 100, 16-21.
33. Hirose, K.I. and Ikeda, S. (2008) On Decreasing Marginal Impatience. Japanese Economic Review 59, 259-74.
34. Horioka, C. (1990) Why Is Japan's Households Saving So High? A Literature Survey. Journal of the Japanese and International Economics 4, 49-92.
35. Huang, M.M. (2012) Housing Deep-Habit Model: Mutual Implications of Macroeconomics and Asset Pricing. Economics Letters (forthcoming).
36. Kam, E. and Mohsin, M. (2006) Monetary Policy and Endogenous Time Preference. Journal of Economic Studies 33, 52-67.
37. Kirby, K.N., Godoy, R., Reyes-Garcia, V., Byron, B., Apaza, L., Leonard, W., Perez, B., Vadez, V., and Wilkie, D. (2002) Correlates of Delay-Discount Rates: Evidence from Tsimane Amerindians of the Bolivia Rain Forest. Journal of Economic Psychology 23, 291-316.
38. Kozicki, C. and Tinsley, P. (2002) Dynamic Specifications in Optimizing Trend-Deviation Macro Models. Journal of Economic Dynamics Control 26, 1586-611.
39. Lawrance, E.C. (1991) Poverty and the Rate of Time Preference: Evidence from Panel Data. Journal of Political Economy 99, 54-77.
40. Lucas, R.E. Jr. and Stokey, N.L. (1984) Optimal Growth with Many Consumers. Journal of Economic Theory 32, 139-71.
41. Mehra, R. and Prescott, E. (1985) The Equity Premium: A Puzzle. Journal of Monetary Economics 15, 145-61.
42. Meng, Q. (2006) Impatience and Equilibrium Indeterminacy. Journal of Economic Dynamics and Control 30, 2671-92.

43. Obstfeld, M. (1990) Intertemporal Dependence, Impatience, and Dynamics. Journal of Monetary Economics 26, 45-75.
44. Olsen, J.A. (1993) Time Preference for Health Gains: An Empirical Investigation. Health Economics 2, 257-65.
45. Orphanides, A. and Solow, R. (1990) Money, Inflation and Growth, in Handbook of Monetary Economics, edited by Friedman, B. and Hahn, F. North-Holland: Amsterdam.
46. Palivos, T., Wang, P., and Zhang, J. (1997) On the Existence of Balanced Equilibrium. International Economic Review 38, 205-24.
47. Persson, T. and Svensson, L. (1985) Current Account Dynamics and the Terms of Trade: Harberger-Laursen-Metzler Two Generations Later. Journal of Political Economy 93, 43-65.
48. Pollak, R. (1970) Habit Formation and Dynamic Demand Functions. Journal of Political Economy 78, 745-63.
49. Ravn, M., Schmitt-Grohe, S., and Uribe, M. (2006) Deep Habits. Review of Economic Studies 73, 195-218.
50. Sheldon, G. (1997) Molding Japanese Minds: The State in Everyday Life. Princeton NJ: Princeton University Press.
51. Sheldon, G. (1998) Fashioning a Culture of Diligence and Thrift: Savings and Frugality Campaigns in Japan, 1990-1931, Honolulu: University of Hawaii Press.
52. Shi, S. and Epstein, L.G. (1993) Habits and Time Preference. International Economic Review 34, 61-84.
53. Shin, S. and Epstein, L.G. (1993) Habits and Time Preference International Economic Review 34, 61-84.
54. Shoda, Y., Mischel, W., and Peake, P.K. (1990) Predicting Adolescent Cognitive and Self-Regulatory Competencies from Preschool Delays of Gratification: Identifying Diagnostic Conditions. Developmental Psychology 26, 978-86.
55. Smithin, J. (2004) Controversies in Monetary Economies. Cheltenham: Edward Elgar.
56. Solow, R. (1956) A Contribution to the Theory of Growth. Quarterly Journal of Economics 70, 65-94.
57. Stern, M.L. (2006) Endogeneous Time Preference and Optimal Growth. Economic Theory 29, 49-70.
58. Strotz, R. (1956) Myopia and Inconsistency in Dynamic Utility Maximization. Review of Economic Studies 23, 165-80.
59. Sundaresan, S.M. (1989) Intertemporally Dependent Preferences and the Volatility of Consumption and Wealth. Review of Financial Studies 2, 73-89.
60. Uzawa, H. (1968) Time Preference, the Consumption Function, and Optimum Asset Holdings, in Value, Capital and Growth: Papers in Honor of Sir John Hicks, edited by Wolfe, J.N. Chicago: Aldine, 485-504.
61. Zhang, W.B. (2005) Economic Growth Theory. Hampshire: Ashgate.
62. Zhang, W.B. (2009) Monetary Growth Theory: Money, Interest, Prices, Capital, Knowledge, and Economic Structure over Time and Space. London: Routledge.