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Consumer behavior and the aspiration for conformity and consistency

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Abstract

The (socio-)psychological concepts of individual aspiration for conformity and consistency are integrated into the rational-choice framework. By using this integrative approach it is shown that after a shock the aspiration for conformity results in an equilibrium which deviates from the *homo oeconomicus*' behavior towards the consumption of the peer group, whereas the aspiration for consistency leads to the result that the equilibrium consumption is not reached at once. Combining these effects a new consumption path is derived. After a shock the individual consumption converges step-by-step to the new equilibrium consumption.

JEL classification: D01;D11;D91;Z13

Keywords: Consumer behavior; consistency; conformity; habit persistence; step-by-step adaptation

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1 Introduction

The importance of psychological and sociopsychological aspects is consistently increasing in economic theory.[1] The greater compatibility with psychological realism leads to a high improvement in describing economic behavior beyond the coverage of the standard economic model of the *homo oeconomicus* (Rabin 2002). Consequently, in recent contributions to consumer theory psychological and sociopsychological influences on individual purchase decisions have played an increasing role.

Abel (1990), Campbell and Cochrane (1999), Carrasco et al. (2005), Constantinides (1990) and Messinis (1999) analyze the influence of habit formation on individual purchase decisions which leads to the result that people tend to behave consistently over time. Thus, the individual purchase decisions depend on their own behavior in the past. If inconsistent behavior as intrapersonal dissonance constitutes a negative factor in the individual's utility function, that is, if - in economic jargon - it represents "costs", it is evident that by taking these psychological costs into account, the optimal behavior deviates from what is forecast by the model of the *homo oeconomicus*.

Bernheim (1994), Corneo and Jeanne (1997) and Nir (2004) focus on the tendency of individuals behavior to conform to that of their peer group.[2] Conformity means the concordance of attitudes and behavior of an individual with the norms, values and habits of the reference group (Hogg and Vaughan 2002). Non-conforming behavior will be punished by the reference group. The individual then has to carry the stigma of being regarded as eccentric, antisocial or criminal, which means interpersonal dissonance and therefore social costs to the individual.[3] As a consequence of taking these

[1]For an excellent overview of "Psychology and Economics" see (Rabin 1998). In the last decade a growing number of models which include psychological aspects are presented under the label Behavioral Economics (Rabin 2002).

[2]In contrast to this, in the contribution of Naik and Moore (1996) habit formation is directly influenced by the peer group behavior in the past.

[3]Conformity can, on the one hand, be fully internalized (internal adaptation). On the other hand, group-conforming behavior can also occur without accepting the group-specific attitudes (external adaptation) if, for example, group pressure is strong enough. The latter form describes the adaptation of behavior as a reaction to the group exerting a direct influence by giving rewards or imposing punishment. In contrast, internalization describes the adaptation of behavior because of indirect influence via the internalization of group-conforming norms and values. For sake of simplicity we only focus on the case of external adaptation here.

costs into account, individual behavior compared to the *homo oeconomicus* systematically converges towards group-conformity.

With this in mind, a model is developed here in which the individual is - in addition to the materialistic utility maximization of the *homo oeconomicus* - seeking for consistency and conformity. However, the analysis of habit formation and peer influence in a single model framework is not new . Alonso et al. (2004) analyze the efficiency of equilibria, when individual preferences depend on habit formation and consumption externalities. In contrast to them we analyze how the individual approaches the new equilibrium consumption after a shock and compare this to the behavior of the *homo oeconomicus*. While Bisin (2006) assume heterogeneous preferences which vary over time, in our model, the assumption of homogenous and constant preferences holds. We answer the questions: Which is the equilibrium consumption and how can the dynamics towards this new equilibrium be characterized in comparison with the consumption of the *homo oeconomicus*?

The paper proceeds as follows. In section 2 we develop a very simple model of a *homo oeconomicus* without the aspiration for consistency and conformity which serves as a benchmark in the following. In section 3 we set up a model which includes the aspiration for consistency and conformity. To get deeper insights into the mode of operation of our approach we first present a model which only includes the aspiration for conformity in section 3.1, then we present a model which only includes the aspiration for consistency in section 3.2 before presenting a model in section 3.3 which includes both mechanisms. In each version, the individual behavior after a shock is compared to the *homo oeconomicus*' behavior generated in section 2. Section 4 concludes.

The comparison between the resulting behavior and the behavior forecast in the economic standard model of the *homo oeconomicus* allows deep insights into the mechanics of the model and offers a highly illustrative description of individual purchase decisions in an advanced model framework.

2 Consumption dynamics of a *homo oeconomicus*

Consider an agent who lives in a peer group for infinite periods $t = 0, 1, 2, ...$ In period t he gets an income y_t which he has to share among two consumer goods - an observable good and an unobservable good.[4] The consumption in period t is denoted by v_t and w_t for the observable and unobservable good. The agent can not save any income for future periods. The prices of the consumer goods v_t and w_t are denoted by $p_t^v > 0$ and $p_t^w > 0$. The model investigates a single shock which for simplicity takes place during period $t = 0$.[5] The shock is characterized by a permanent increase or decrease in prices p_t^v, p_t^w or in income y_t.

Definition 1 *By an equilibrium we denote a situation in which no shock takes place and the consumption of the consumer goods v^* and w^* satisfies $v_t = v_{t+1} \equiv v^*$, $w_t = w_{t+1} \equiv w^*$ and the budget constraint $p_t^v v^* + p_t^w w^* \leq y_t$ holds for all t. We denote equilibrium prices and income by p^v, p^w and y.*

First we derive the equilibrium consumption of a *homo oeconomicus* who maximizes the utility function

$$U_{\text{ho}}(v_t, w_t) \equiv v_t w_t \tag{1}$$

considering the budget constraint $y_t \geq p_t^v v_t + p_t^w w_t$ for all t. In equilibrium this is

$$U_{\text{ho}}(v_{\text{ho}}^*, w_{\text{ho}}^*) = v_{\text{ho}}^* w_{\text{ho}}^*. \tag{2}$$

So, in equilibrium consumption is given by

$$v_{\text{ho}}^* = \frac{y}{2p^v} \quad \text{and} \quad w_{\text{ho}}^* = \frac{y}{2p^w}. \tag{3}$$

For a *homo oeconomicus* the optimal consumption dynamics after the shock are to consume $v_t = v_{\text{ho}}^*$ and $w_t = w_{\text{ho}}^*$ for all $t > 0$. In every period t the derived equilibrium consumption v_{ho}^* and w_{ho}^* maximizes the utility given in equation (1). Figure 1 illustrates the adaptation of the consumer good v_t for the *homo oeconomicus* after a permanent increase in income.[6] In the figure t denotes the beginning of period t. The shock takes place during period $t = 0$. The agent adapts his consumption always at the beginning of a new

[4]The distinction between observable and unobservable goods follows Bernheim (1994).

[5]It is also possible to investigate additional shocks while the adaptation process goes on because we do not assume that v_0 and w_0 are equilibrium values given the initial prices p_0^v, p_0^w and the initial income y_0.

[6]The figure refers to the parameters $p^v = 1$, $p^w = 2$, $x = 45$,$y_0 = 90$, $y_t = 100$ $\forall t > 0$.

period. The analysis of the behavior of the *homo oeconomicus* is not new. It follows the set up in each standard microeconomic textbook (e.g. Gravelle and Rees (2004)) and just represents the reference case for the investigations of the next sections.

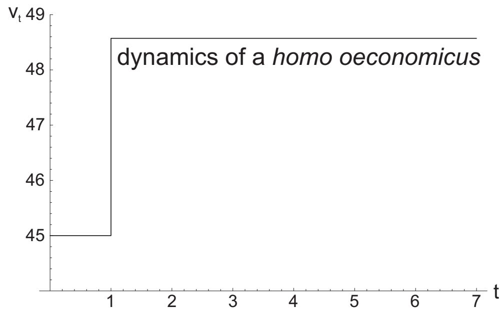

Figure 1: Adaptation of the *homo oeconomicus*

3 Consumption dynamics with aspiration for conformity and consistency

This section investigates the changes in the consumption dynamics if the agent takes aspiration for conformity and consistency into account. So, let the agent maximize

$$U_t \equiv v_t w_t \underbrace{-\beta(v_t - x)^2}_{I} \underbrace{-\gamma((v_t - v_{t-1})^2 + (w_t - w_{t-1})^2)}_{II} \ \forall t > 0, \tag{4}$$

where the punishment parameters $\beta > 0$ and $\gamma > 0$ are chosen so that $\frac{\partial U_t}{\partial v_t} > 0$, $\frac{\partial U_t}{\partial w_t} > 0$, $\frac{\partial^2 U_t}{\partial v_t^2} < 0$ and $\frac{\partial^2 U_t}{\partial w_t^2} < 0$ holds. Parameter β weights the deviation from the peer group's average consumption of the observable good x, i.e. the non-conformity, and parameter γ weights the deviation from the consumption of the preceding period $t-1$, i.e. the non-consistency. Term I reduces the materialistic utility by β times the quadratic difference between the individual consumption of good v_t in period t and the average peer group consumption of the observable good x in the same period t.[7]

[7]Note, we assume that the average peer group consumption of the observable good x is constant over time. The quadratic function prevents positive and negative adaptations

Term II reduces the materialistic utility by γ times the sum of the quadratic differences between last period's and current consumption of the two goods. As seen, we assume that the argument in the agent's utility function is an additive combination of present and past values of individual consumption and the current average consumption of the peer group. Alonso et al. (2004) and Nir (2004) choose a similar approach. The budget constraint is again $y_t \geq p^v v_t + p^w w_t$ for all t. In each period t the agent decides about his optimal consumption. First, in the beginning of period 1 the agent calculates the optimal consumption v_1 and w_1 given the initial consumption v_0 and w_0. Then in the beginning of period 2, he takes this new consumption to calculate the optimal consumption in period $t = 2$ and so on. This is why we call this behavior step-by-step adaptation in the following.

3.1 Step-by-step adaptation with aspiration for conformity

First we only focus on the aspiration for conformity. Therefore, the agent maximizes

$$U_{\text{conf}}(v_t, w_t) \equiv v_t w_t - \beta(v_t - x)^2. \tag{5}$$

In equilibrium this is

$$U_{\text{conf}}(v^*_{\text{conf}}, w^*_{\text{conf}}) = v^*_{\text{conf}} w^*_{\text{conf}} - \beta(v^*_{\text{conf}} - x)^2, \tag{6}$$

where $v^*_{\text{conf}}, w^*_{\text{conf}}$ have to be non-negative. So, the equilibrium consumption is given by[8]

$$v^*_{\text{conf}} = \begin{cases} \frac{y}{p^v} & \text{if } \frac{1}{2(p^v+\beta p^w)}y + \frac{\beta p^w x}{p^v+\beta p^w} > \frac{y}{p^v} \\ \frac{1}{2(p^v+\beta p^w)}y + \frac{\beta p^w x}{p^v+\beta p^w} & \text{otherwise} \end{cases} \tag{7}$$

and

$$w^*_{\text{conf}} = \begin{cases} 0 & \text{if } \frac{1}{2p^w}\left(\frac{p^v+2\beta p^w}{p^v+\beta p^w}\right)y - \frac{\beta p^v x}{p^v+\beta p^w} < 0 \\ \frac{1}{2p^w}\left(\frac{p^v+2\beta p^w}{p^v+\beta p^w}\right)y - \frac{\beta p^v x}{p^v+\beta p^w} & \text{otherwise .} \end{cases} \tag{8}$$

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from canceling each other out. The formulation of the "costs" of non-conformity is similar to the formulation of Nir (2004).

[8] There exist two cases because the maximization via Lagrange can result in a negative w^* and a v^* which is higher than the given income. In this case the agent consumes nothing of the unobservable good and as much as possible of the observable good.

The case where $\frac{1}{2(p^v+\beta p^w)} y + \frac{\beta p^w x}{p^v+\beta p^w} > \frac{y}{p^v}$ holds we call the boundary solution.

The higher the punishment parameter β, the smaller is the difference between the agent's consumption of the observable good v^*_{conf} and the peer group's consumption of this good x.[9] According to the intuition, if there is no difference in the consumption, then a change in β does not have any influence.

Lemma 1 describes the adaptation of the consumption with aspiration for conformity in comparison to the dynamics of the *homo oeconomicus*.

LEMMA **1** *The utility of the homo oeconomicus as well as the utility of an agent with aspiration for conformity in $t+1, t+2, ...$ is not influenced by the consumption decision in t. So, in both cases the agent's optimal strategy is to choose the equilibrium consumption for all $t > 0$. If the average peer group consumption of the observable good x is higher than the equilibrium consumption of the homo oeconomicus v^*_{ho}, then the equilibrium consumption including aspiration for conformity v^*_{conf} is higher than the equilibrium consumption of the homo oeconomicus v^*_{ho} as well. Formally,*

$$x > v^*_{\text{ho}} \Leftrightarrow v^*_{\text{conf}} > v^*_{\text{ho}}. \tag{9}$$

Analogously the statement holds for "<" and "=". A analogous comparison of the equilibrium consumption of the unobservable good leads to

$$v^*_{\text{ho}} < x \Leftrightarrow w^*_{\text{conf}} < w^*_{\text{ho}}. \tag{10}$$

The statement also holds for ">" and "=".

The proof of the lemma follows directly by replacing v^*_{conf} and v^*_{ho} with the derived values given in the equations (7) and (3). The results for the unobservable good then are determined by the budget constraint.

Figure 2 illustrates the dynamics of an income increase in the model with aspiration for conformity for the consumer good v_t.[10]

[9] It is $\frac{\partial v^*_{\text{conf}}}{\partial \beta} = \frac{p^w(2p^v x - y)}{2(p^v+\beta p^w)^2} > 0 \Leftrightarrow x > \frac{y}{2p^v} = v^*_{\text{ho}}$.

[10] The figure refers to the parameters $y_0 = 90$, $\forall t:\ y_t = 100$, $p^v = 1$, $p^w = 2$, $x = 45$ and $\beta = 0.2$. Therefore we get $v^*_{\text{conf}} = 48.5714$ and $w^*_{\text{conf}} = 25.7143$

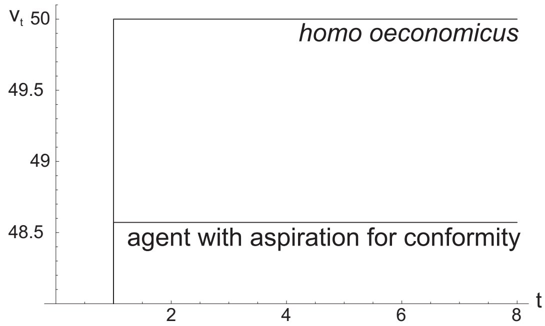

Figure 2: Step-by-step adaptation with aspiration for conformity

3.2 Step-by-step adaptation with aspiration for consistency

Now we focus on an agent with aspiration for consistency (but without aspiration for conformity). The agent maximizes

$$U_{\text{cons}}(v_t, w_t, v_{t-1}, w_{t-1}) \equiv v_t w_t - \gamma((v_t - v_{t-1})^2 + (w_t - w_{t-1})^2) \tag{11}$$

considering the budget constraint. In equilibrium this is

$$U_{\text{cons}}(v^*_{\text{cons}}, w^*_{\text{cons}}) = v^*_{\text{cons}} w^*_{\text{cons}}. \tag{12}$$

Therefore the equilibrium consumption in the model considering aspiration for consistency is given by

$$v^*_{\text{cons}} = \frac{y}{2p^v} \quad \textit{and} \quad w^*_{\text{cons}} = \frac{y}{2p^w}. \tag{13}$$

Note, this equilibrium consumption equals the equilibrium consumption of the *homo oeconomicus*, i.e. equation (13) equals equation (3). So, Lemma 1 also describes the comparison of the equilibrium consumption between the model which only includes aspiration for consistency and the model which only includes aspiration for conformity.

The agent does not select the equilibrium consumption directly in the period after the shock, because a deviation from the previous consumption yields a utility loss. The optimal consumption path is given by Proposition 1.

Proposition 1 *Given the parameters p^v, p^w, y and γ which refer to the periods after the shock and the initial consumption v_0 and w_0, the optimal consumption for all $t > 0$ is given as follows*

$$v_t = c_{\text{cons}} a_{\text{cons}}^t + b_{\text{cons}} \Big(\frac{1 - a_{\text{cons}}^t}{1 - a_{\text{cons}}} \Big) \quad \text{and} \quad w_t = \frac{y - p^v v_t}{p^w} \quad \forall t > 0, \tag{14}$$

where

$$a_{\text{cons}} \equiv \frac{((p^v)^2 + (p^w)^2)\gamma}{p^v p^w + ((p^v)^2 + (p^w)^2)\gamma}, \quad b_{\text{cons}} \equiv \frac{p^w y}{2(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma)} \tag{15}$$

and

$$c_{\text{cons}} \equiv \frac{p^v y + p^w (p^w v_0 - p^v w_0)}{(p^v)^2 + (p^w)^2}. \tag{16}$$

The proof can be found in the Appendix. Starting below the equilibrium consumption in $t = 0$ it is possible both that the consumption in $t = 1$ lies below the equilibrium consumption (see figure 3 part a)) or that the consumption in $t = 1$ lies above the equilibrium consumption (see figure 3 part b)).[11] From $t = 1$ the consumption path is a strict, monotone function which converges to the new equilibrium consumption.[12] Analogously, the statement holds if the consumption in $t = 0$ starts above the equilibrium consumption.

Figure 3 illustrates two examples of the dynamics with aspiration for consistency in the case of a permanent income increase.[13]

[11] Assume that v_0 and w_0 is the equilibrium consumption before the shock. With v_0 smaller than the equilibrium consumption v^*, a permanent increase in the income implies a v_1 higher than the equilibrium consumption if and only if $(p^v)^2 - (p^w)^2 > 0$ holds. This results directly from a comparison between v_1 (see equation (23)) and $v^* = \frac{y}{2p^v}$. Analogously it results that a change of the price p^v can not imply the case illustrated in figure 3 because v_1 is higher than the equilibrium consumption if and only if $p \equiv p_t > p_0$, $\forall t > 0$ holds. But in this case the old equilibrium consumption v_0 has to lie above the new equilibrium consumption v^*. A change of the price p^w has no influence because v_0 then is already the equilibrium consumption.

[12] By equation (24) it is $v_t - v_{t-1} = \frac{p^w (y - 2p^v v_{t-1})}{2(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma)}$ for all $t > 1$. Considering $y = 2p^v v^*_{\text{cons}}$ (see equ. (13)) we obtain $v_t - v_{t-1} > 0 \Leftrightarrow v^*_{\text{cons}} - v_{t-1} > 0$ for all $t > 1$.

[13] Part a) of the figure refers to the parameters $p^v = 1$, $p^w = 2$, $\gamma = 0.2$, $v_0 = 45$, $w_0 = 22.5$ and $y_t = 100$ $\forall t > 0$. Part b) of the figure refers to the parameters $p^v = 2$, $p^w = 1$, $\gamma = 0.2$, $v_0 = 22.5$, $w_0 = 50$ and $y_t = 200$ $\forall t > 0$.

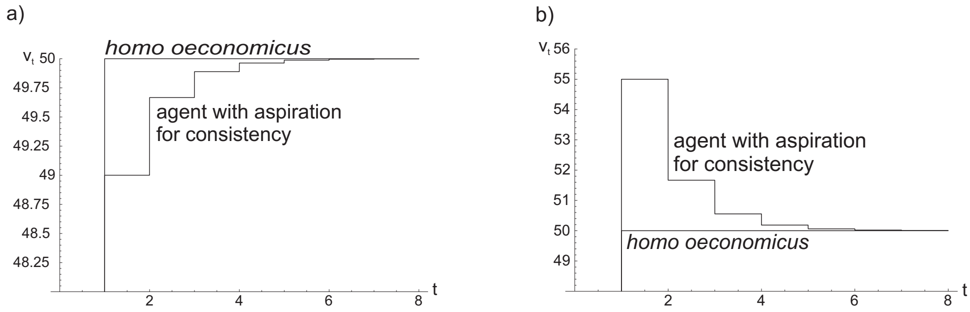

Figure 3: Step-by-step adaptation with aspiration for consistency

Lemma **2** *Leaving all other parameters p^v, p^w and y constant, a higher value of the punishment parameter γ results in a flatter adaptation function for all $t > 1$. If the adaptation starts with $v_1 < v^*$ and we compare the adaptation functions which result from γ and $\hat{\gamma} > \gamma$, the adaptation considering γ lies above the adaptation function considering $\hat{\gamma}$ for all periods $t > 1$. Analogously, with $v_1 > v^*$ the adaptation function considering γ lies below the adaptation function considering $\hat{\gamma}$ for all periods $t > 1$.*

Intuitively, it is clear that a higher punishment causes the agent to adapt more smoothly. A formal proof of Lemma 2 can be found in the Appendix.

3.3 Step-by-step adaptation with aspiration for conformity and consistency

We already know that the aspiration for conformity has an important influence on the equilibrium consumption and that the aspiration for consistency prevents the agent from reaching the new equilibrium in just one step.

The utility function which has to be maximized is given in equation (4). In equilibrium the agent maximizes

$$U(v^*, w^*) = v^* w^* - \beta(v^* - x)^2 \tag{17}$$

for $v^*, w^* > 0$, considering the budget constraint. This is equation (6).

Inside an equilibrium the aspiration for consistency does not matter, i.e. does not influence utility, whereas the conformity bias is still present. Therefore the equilibrium consumption of an agent with an aspiration for conformity and consistency equals the equilibrium consumption of an agent with an aspiration for conformity. The equilibrium consumption is given in equations (7) and (8). Again, the higher the punishment parameter β the smaller the difference between the agent's and the peer group's consumption of the observable good. Now we describe the adaptation process.

PROPOSITION **2** *Given the parameters p^v, p^w, y, x, β and γ which refer to the periods after the shock and the initial consumption v_0 and w_0, the optimal consumption is given for all $t > 0$ which satisfy $v_t \leq \frac{y}{p^v}$ by*

$$v_t = ca^t + b\Big(\frac{1-a^t}{1-a}\Big) \quad \textit{and} \quad w_t = \frac{y - p^v v_t}{p^w} \tag{18}$$

where

$$a \equiv \frac{((p^v)^2 + (p^w)^2)\gamma}{p^v p^w + ((p^v)^2 + (p^w)^2)\gamma + \beta(p^w)^2}, \tag{19}$$

$$b \equiv \frac{(p^w)(y + 2\beta p^w x)}{2(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma + \beta(p^w)^2)}, \tag{20}$$

and

$$c \equiv \frac{p^v y + p^w(p^w v_0 - p^v w_0)}{((p^v)^2 + (p^w)^2)}. \tag{21}$$

For all $t \geq t'$ where $t' = min\{t : v_t > \frac{y}{p^v}\}$ the optimal consumption is $v_t = \frac{y}{p^v}$ and $w_t = 0$. This is the case of the boundary solution.

The proof can be found in the Appendix.

The step-by-step adaptation of the consumption with both aspiration for consistency and conformity is illustrated in Figure 4. The figure also includes the reference case of the *homo oeconomicus* and the average peer group consumption of the observable good.[14]

Again, a higher value of the punishment parameter γ results in a flatter adaptation function.[15]

As one can see, the individual aspiration for conformity results in an equilibrium path which alters the *homo oeconomicus*' behavior in the direction of the peer group's. The individual aspiration for consistency leads to the result that the actor does not select the equilibrium consumption directly after the shock.

[14] The figure refers to the parameters $p^v = 1$, $p^w = 2$, $\beta = \gamma = 0.2$, $y_0 = 90$, $y_t = 100$ $\forall t > 0$ and $x = 45$.

[15] The proof of Lemma 2 considers also the situation in which the utility function of the agent includes aspiration for consistency as well as aspiration for conformity.

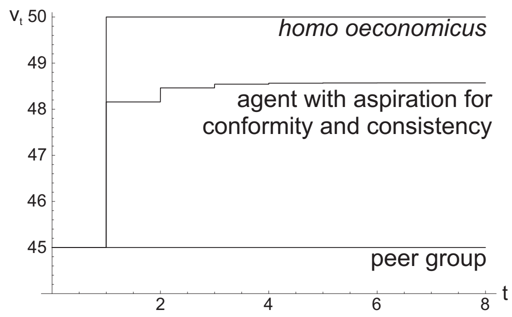

Figure 4: Step-by-step adaptation with aspiration for conformity and consistency

4 Concluding remarks

Because of the broad discussion about the validity of the standard model of human behavior *homo oeconomicus*, we focus on the influence of the social environment and of habit persistence on consumer purchase decisions. With this in mind, the individual aspirations for conformity and consistency are integrated into the rational-choice framework. Under strict compliance with the rational-choice paradigm a model is developed here in which the individual's utility depends - in addition to the materialistic utility of the consumption - on his preceding consumption and the average consumption of the peer group. By using this integrative approach it is shown that after a shock the individual aspiration for conformity results in an equilibrium which deviates from the *homo oeconomicus*' behavior in the direction of the average consumption of the peer group, whereas the individual aspiration for consistency leads to the result that the agent does not get to the equilibrium consumption at once. Combining these effects a consumption path is described where, after a exogenous shock, the individual approaches the new equilibrium consumption step-by-step. Nevertheless, this new equilibrium consumption might differ from those of the peer group. As one can see, if non-conforming behavior is heavily punished, the individual tends more to the behavior of the peer group. Otherwise, if inconsistent behavior leads to heavy cognitive dissonance - the costs of inconsistent behavior - the consumption path runs more smoothly.

Empirical evidence for the importance of conformity in consumption (Beraden et al. 1994) and for the tendency to behave consistently in consumption over time (Abel 1990; Carrasco et al. 2005) has already been found.

With regard to future research the model could be developed into a more sophisticated model of the interaction between the individual and the peer group. While focus here is only on the influence of the peer group on the individual purchase decision, it might be useful to investigate the opposite direction of influence too.

Finally, with the integration of aspiration for conformity and consistency in the rational-choice framework we have presented a simple model here which we have applied to consumer decisions as an example. It might be useful to apply this model to numerous other fields in the economic and political context. This might yield a better explanation of observable empirical phenomena which could only be seen as the emergence of human irrationality from an orthodox economic perspective.

Appendix

Proof of Proposition 1
The Lagrangian function is given by

$$L_{\text{cons}} = v_t w_t - \gamma((v_t - v_{t-1})^2 + (w_t - w_{t-1})^2) - \lambda(y - p^v v_t - p^w w_t), \quad (22)$$

where λ is the Lagrangian multiplier. Using the first-order conditions of this function we obtain the optimal consumption of the observable good as follows

$$v_t = \frac{(p^w + 2\gamma p^v)y + 2\gamma(p^w)^2 v_{t-1} - 2\gamma p^v p^w w_{t-1}}{2(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma)} \quad \forall t \geq 1. \quad (23)$$

For $t > 1$ we set $w_{t-1} = \frac{y - p^v v_{t-1}}{p^w}$.[16] This results in

$$v_t = \underbrace{\frac{((p^v)^2 + (p^w)^2)\gamma}{p_v p_w + ((p^v)^2 + (p^w)^2)\gamma}}_{=a_{\text{cons}}} v_{t-1} + \underbrace{\frac{p^w y}{2(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma)}}_{=b_{\text{cons}}} \quad \forall t > 1. (24)$$

Equation (24) represents a linear, inhomogeneous, first-order difference equation which can be solved by

$$v_t = c_{\text{cons}} a^t_{\text{cons}} + b_{\text{cons}} \left(\frac{1 - a^t_{\text{cons}}}{1 - a_{\text{cons}}} \right) \forall t > 1, \quad (25)$$

[16]Note, $w_0 = \frac{y - p^v v_0}{p^w}$ generally does not hold because the parameters y, p^v and p^w refer to the periods after the shock.

if $a \neq 1$ (Shone 2002). This holds because of $p^v, p^w, \gamma > 0$. To derive the constant c_{cons} we assume $t = 2$, set equation (24) equal to (25) and solve for c_{cons}. Considering the optimal v_1 this results in $c_{\text{cons}} = \frac{p^v y + p^w (p^w v_0 - p^v w_0)}{(p^v)^2 + (p^w)^2}$. For $t = 1$ equation (23) equals equation (25). So, the solution of the difference equation also holds for $t = 1$. $\square$

Proof of Lemma 2
a) Consider an agent with aspiration for consistency but without aspiration for conformity. By equation (24) it is $v_t = a_{\text{cons}} v_{t-1} + b_{\text{cons}}$ for all $t > 1$. If we replace a_{cons} and b_{cons} by the given values in Proposition 1 and differentiate this term with respect to γ we get

$$\frac{\partial v_t}{\partial \gamma} = \frac{p^w((p^v)^2 + (p^w)^2)(-y + 2p^v v_{t-1})}{2(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma)^2} \quad \forall t > 1 \tag{26}$$

and therefore

$$\frac{\partial v_t}{\partial \gamma} > 0 \;\Leftrightarrow\; 2p^v v_{t-1} - y > 0 \quad \forall t > 1. \tag{27}$$

Considering the equilibrium consumption v^*_{cons} (see equation (13)) this equation can be rewritten as

$$\frac{\partial v_t}{\partial \gamma} > 0 \;\Leftrightarrow\; v_{t-1} - v^*_{\text{cons}} > 0 \quad \forall t > 1. \tag{28}$$

b) Now consider an agent with aspiration for conformity and consistency. Again, it is $v_t = a v_{t-1} + b$ for all $t > 1$. The parameters a and b are given in Proposition 2. So,

$$\frac{\partial v_t}{\partial \gamma} = \frac{p^w((p^v)^2 + (p^w)^2)(-y - 2p^w x\beta + 2(p^v + \beta p^w)v_{t-1})}{2(p^v p^w + (p^v)^2\gamma + (p^w)^2(\beta + \gamma))^2} \quad \forall t > 1 \tag{29}$$

results. Therefore,

$$\frac{\partial v_t}{\partial \gamma} > 0 \Leftrightarrow -y - 2p^w x\beta + 2(p^v + \beta p^w)v_{t-1} \quad \forall t > 1. \tag{30}$$

Considering the equilibrium consumption v^* (see equation (7)) we can rewrite the last equation to

$$\frac{\partial v_t}{\partial \gamma} > 0 \;\Leftrightarrow\; v_{t-1} - v^* > 0 \quad \forall t > 1. \tag{31}$$

Note, the boundary solution of the equilibrium does not influence this investigation of the adaptation process, because it just represents a possible freeze of the process, i.e. there is a t' with $v_t = \frac{y}{p^v}$ for all $t \geq t'$. The higher the punishment parameter γ the flatter the adaptation process and therefore the later the time t' of a possible freeze. $\square$

Proof of Proposition 2
The Lagrangian function is given by

$$\begin{aligned} L &= v_t w_t - \beta(v_t - x)^2 - \gamma((v_t - v_{t-1})^2 + (w_t - w_{t-1})^2) \\ &\quad -\lambda(y - p^v v_t - p^w w_t), \end{aligned} \tag{32}$$

where λ is the Lagrangian multiplier. Using the first-order conditions of this function we obtain the optimal consumption of the observable good as follows

$$v_t = \frac{p^w y + 2\gamma p^v y + 2\beta(p^w)^2 x + 2\gamma(p^w)^2 v_{t-1} - 2\gamma p^v p^w w_{t-1}}{2(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma + \beta(p^w)^2} \quad \forall t > 0 \tag{33}$$

For $t > 1$ we set again $w_{t-1} = \frac{y - p^v v_{t-1}}{p^w}$. So, it is

$$\begin{aligned} v_t = \quad & \underbrace{\frac{((p^v)^2 + (p^w)^2)\gamma}{(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma + \beta(p^w)^2)}}_{=a} v_{t-1} \\ & + \underbrace{\frac{p^w(y + 2\beta p^w x)}{2(p^v p^w + ((p^v)^2 + (p^w)^2)\gamma + \beta(p^w)^2)}}_{=b}. \end{aligned} \tag{34}$$

This is a linear, inhomogeneous, first-order difference equation. Its solution is

$$v_t = ca^t + b\Big(\frac{1 - a^t}{1 - a}\Big) \quad \forall t > 1, \tag{35}$$

if $a \neq 1$ (Shone 2002). This condition holds, because of $p^v, p^w, \gamma > 0$. To derive the constant c we assume $t = 2$, set equation (33) equal to (35) and solve for c. Considering the optimal v_1 this results in $c_{\text{cons}} = \frac{p^v y + p^w(p^w v_0 - p^v w_0)}{(p^v)^2 + (p^w)^2}$. For $t = 1$ equation (35) equals equation (33). So, the solution of the difference equation also holds for $t = 1$ $\square$

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