I love shopping.....but what am I going to buy? Social interaction and consumption choices

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Abstract

In the present work, we analyse the emergence of fashion cycles and complex phenomena in a discrete time dynamic model in which a population is divided in two groups, bandwagoners and snobs. Both groups react differently to the aggregate demand for goods in the previous period and, in particular, bandwagoners imitate the consumption styles prevailing in society, while snobs try to distinguish themselves from them. We consider a first specification of the model in which the structure of the population is fixed and we show how in case of polymorphic population it is possible to observe cyclical behaviours in collective consumption and the onset of chaotic regimes. We further propose an extension of the model in which we investigate the interdependence between the evolution of collective consumption choices and the evolution of the structure of the groups in a framework in which individuals may change structure of preferences and then switching between being of one type or another. In the extension, we analyse how both consumption cycles (and then fashion cycles) and the evolution of the groups may lead to the emergence of chaotic dynamics, as well as the coexistence of attractors.

The aim of this work is to study how the heterogeneity of consumers, defined by different structures of endogenous preferences on goods, may determine the formation of fashion cycles. In particular, we show how different degrees of heterogeneity induce different dynamics on the aggregate demand for a comsumption good and the possible emergence of complex phenomena. Moreover, in an extension of the basic model, we show how the possibility for individuals to change the structure of preferences induces the coevolution of consumption and social behaviours. In this case, coexistence of different styles may emerge.

1 Introduction

The study of consumption behaviour by economic agents is a phenomenon of relevant interest, both from a more strictly economic point of view and from a more social and psychological one. In the literature, however, it emerges that this phenomenon is extremely complex to analyse because of its *multidimensionality*. In fact, it is possible to notice how three main dimensions emerge in studies related to consumption behaviour: the historical dimension, i.e. the link between the choices of an individual in the present and the choices of the same individual made in the past (i.e. the experience of individuals); the social dimension, i.e. the relation between the preferences of an individual and the consumption choices of other agents; and finally a more psychological dimension, i.e. the choice on what type of agent be.

With regard to the effects of experience on individuals' consumption behaviour, the first studies date back to Pareto (see also Benhabib, 1979) and to some Keynesian theories of the consumption function that incorporate the effects of experience and the formation of habits on current levels of consumption (see Duesenberry et al., 1949; Modigliani, 1949). These theories has been subsequently taken up in Day (1971) and Benhabib and Day (1981) in order to study how preferences determined by individuals' experience affect the existence of a stable long run choice. In particular, Benhabib and Day (1981) showed how, when preferences are experience dependent, even rational choices in a stationary environment can lead to erratic behaviour, i.e. the existence of a sequence of choices that do not converge towards a long-term stationary value.

Although traditional microeconomic accounts of consumption choices tend to characterize consumers in terms of a certain utility function that needs to be optimized on the basis of price structure and feasible budget, the possibility that preferences in turn depend on the consumption choices of others has become increasingly widespread in the literature. A first reference to this phenomenon can be found in Veblen (1899), where the author studied the sudden changes in consumer behaviour and the tendency of consumers to imitate their richer peers in their purchasing choices. What emerges, therefore, is that the preferences of individuals in consumption choices are partly determined also by comparison with the consumption actions of a reference class (or group). Following this line, Simmel (1904) has argued how the emergence of imitative behaviour by the masses on the choices of a minority part of the population, the elite, may determine the emergence of fashion cycles, i.e. processes in which certain forms of behaviour (strictly social or consumer) experience temporary popularity before being replaced by different ones or by the rediscovery of those previously replaced. According to Simmel, (i) the elite try to distinguish themselves from the mass, adopting new styles, which the mass then imitates and (ii) the tendency to imitate expresses a primary need for social approval, while the tendency to stand out expresses the exact opposite, the fundamental need to affirm one's own personality. These theories has been later taken up in Leibenstein (1950), where interpersonal effects due to comparisons with reference groups and the consequent desire to imitate (bandwagon effect) or stand out (snob effect) enter into the formation of the market demand for a consumer good. The author defines this effect as the so-called *non-functional demand*. [1]

In the last thirty years, the literature has then focused on intertemporal mechanisms which, taking into account the social dimension of choices and the belonging of individuals to different social (and therefore consumer) groups, can allow to study the emergence of fashion dynamics in consumption. In this regard, Matsuyama (1992) has proposed a random matching game between conformists and non-conformists to characterize the social environments that give rise to certain customs and fashion cycles, identifying both scenarios in which (i) conformists establish social habit and non-conformists rebel against it, and scenarios in which (ii) non-conformists become fashion leaders, periodically change their actions, and conformists follow them with some delay. Subsequently, the model structure proposed by Benhabib and Day (1981) was reconsidered and extended in order to study the dynamics of consumption choices (and the emergence of fashion cycles) in contexts where the population is divided into groups (bandwagoners vs. snobs) and endogenous preferences are dependent both on individual experience and interaction with individuals in the other group. In particular, Naimzada and Tramontana (2009) show how different degrees of heterogeneity among agents may induce instability and the emergence of complex phenomena in the dynamics of the consumption of goods; similarly, Di Giovinazzo and Naimzada (2015) show the emergence of irregular phenomena related to the average consumption of a *conspicuous*[2] good in a context where the preferences of agents depend are differently influenced by the average (collective) consumption of that good expressed in the previous period.

Furthermore, some recent works have focused on a more *introspective* feature, i.e. the discrete choice of what type of consumer to be (bandwagoner or snob) and the possibility of being able to move, under certain conditions, between one type and another along time. In these works, developed in a context of pure exchange economy a là Chang and Stauber (2009), the focus becomes no longer the analysis of *real* cycles of consumption, but the study of cycles or irregularity in the evolution of the structure of the population over time. In particular, Naimzada and Pireddu (2018a) propose a discrete time evolutionary model in which using the exponential replicator mechanism introduced in Cabrales and Sobel (1992) and based on the comparison among the utility values realized by the two types, the authors show scenarios on the monomorphic or polymorphic structure of the population. Similarly, Naimzada and Pireddu (2018b) how the structure of the population evolves when the consumption choices of agents give rise to different degrees of attractiveness for the different preference structures. The works mentioned in the literature therefore present only some of the dimen-

[1] The term non-functional demand indicates that part of the market demand due to factors other than the intrinsic qualities of the good. For example, the effect generated by the purchase and consumption by others of the same good contributes to the formation of demand for those who have not yet purchased the good.

[2] The term refers to the definition of conspicuous consumption introduced in Veblen (1899) where conspicuous consumption means the act of buying many things, expensive, not necessary for one's life, made in such a way that the buyer has bought the goods.

sions into which the phenomenon of consumer behaviour may be broken down. Therefore, the aim of our work is to put together all the dimensions described, and discuss in a single model both the dynamics of collective choices related to the consumption of a bundle of goods, and the evolutionary dynamics of a population composed of two types of agents (bandwagoners and snobs) that may decide to modify the type of behaviour towards consumption. Unlike Di Giovinazzo and Naimzada (2015), it is assumed that individuals are bandwagoners or snobs with respect to the entire bundle of goods, and we notice that in the case of polymorphic population it is possible to observe cyclical fluctuations in collective consumption and the onset of irregular dynamic cycles. Recalling Naimzada and Pireddu (2018a), we also propose an extension of the model in which we study the coevolution of collective consumption choices and the population structure in a framework in which individuals may change inclination with respect to consumption and then switching between being of one type or another. This extension allows us to study how the willingness to change (determined by the parameter known in the literature as *intensity of choice*) ambiguously affects the dynamics discussed in the basic version of the model and therefore how the comparison that each agent makes, both with the agents of the opposite group (in the present) and with the consumption styles of both groups (in the past), may affect fashion cycles. The remainder of the paper is organized as follows: Section 2 describes the basic model, Section 3 provides relevant propositions and scenarios in which fashion cycles appear both in the case of monomorphic and polymorphic population, Section 4 presents an extension of the basic model where also the structure of the population evolves and Section 5 concludes.

2 The model

In this model, we consider a discrete-time economy populated by N agents, composed by two different groups, bandwagoners (type b) and snobs (type s) respectively, whose preferences are defined on two goods, x and y. The model proposes an interaction among individuals which causes an endogenous transformation of the parameters related to the preferences. For the bandwagoners, we assume that preferences for a good grows as the collective consumption, in the previous period, on the same good. For snobs, preferences on a good are negatively affected by mass consumption of the good, in the previous period. The preferences of an agent $i = \{b, s\}$ are defined by the following Cobb-Douglas function:

$$U_{i,t}(x_{i,t}, y_{i,t}, \alpha_{i,t}, \beta_{i,t}) = \alpha_{i,t} \ln x_{i,t} + \beta_{i,t} \ln y_{i,t}, \qquad 0 < \alpha_{i,t}, \beta_{i,t} < 1, \qquad (1)$$

where $U_{i,t}$ represents the utility of a generic agent i defined on the consumption of the two goods x and y at the time t, while $\alpha_{i,t}, \beta_{i,t}$ weigh the preferences of the agent on goods x and y, respectively. The agent's budget constraint is given by

$$px_{i,t} + qy_{i,t} = m_i, \tag{2}$$

where m_i is the income of the agent i, p is the price of x and q the price of y.[3] By normalizing to unity the mass of population, i.e. $N = 1$, we assume that (i) the population is composed by ω bandwagoners and $(1-\omega)$ snobs $(0 \leq \omega \leq 1)$ and (ii) within each group, agents are homogeneous in both income m_i and preferences $\alpha_{i,t}, \beta_{i,t}$. We further assume that the income of the agents of both types are homogeneous, i.e. $m_b = m_s = m$.
In order to solve the allocative problem for each agent, we consider the following first order conditions:

$$\begin{cases} \frac{\alpha_{i,t} y_{i,t}}{\beta_{i,t} x_{i,t}} = \frac{p}{q} \\ m - px_{i,t} - qy_{i,t} = 0 \end{cases} \qquad i = b, s \tag{3}$$

from which we obtain the demand functions of the two goods

$$x^*_{i,t} = \frac{\alpha_{i,t}\, m}{p(\alpha_{i,t} + \beta_{i,t})}; \qquad y^*_{i,t} = \frac{\beta_{i,t}\, m}{q(\alpha_{i,t} + \beta_{i,t})} \qquad i = b, s. \tag{4}$$

As stated above, preferences of agents depend on collective consumption in the previous period, i.e. on the own experience and on the visibility of the good. Therefore, we assume that the parameters $\alpha_{i,t}$ $\beta_{i,t}$ depend respectively on the average consumption in the previous period of x and y, that is $\alpha_{i,t} = f_i(\overline{x}_{t-1})$ while $\beta_{i,t} = g_i(\overline{y}_{t-1})$ where $\overline{x}_t$ and $\overline{y}_t$ are respectively

$$\overline{x}_t = \omega\, x_{b,t} + (1-\omega) x_{s,t}; \tag{5}$$

$$\overline{y}_t = \omega\, y_{b,t} + (1-\omega) y_{s,t}. \tag{6}$$

Introducing the dependence of the preferences with respect to the average consumption of previous period, we obtain the following equations:

$$\overline{x}_t = \omega \frac{f_b(\overline{x}_{t-1})\, m}{p[f_b(\overline{x}_{t-1}) + g_b(\overline{y}_{t-1})]} + (1-\omega) \frac{f_s(\overline{x}_{t-1})\, m}{p[f_s(\overline{x}_{t-1}) + g_s(\overline{y}_{t-1})]}; \tag{7}$$

$$\overline{y}_t = \omega \frac{g_b(\overline{y}_{t-1})\, m}{q[f_b(\overline{x}_{t-1}) + g_b(\overline{y}_{t-1})]} + (1-\omega) \frac{g_s(\overline{y}_{t-1})\, m}{q[f_s(\overline{x}_{t-1}) + g_s(\overline{y}_{t-1})]}. \tag{8}$$

Concerning the different attitudes to consumption of bandwagoners and snobs, the dependence of the preferential parameters α_i and β_i with respect the average past consumption of the population is defined as follows:

$$\alpha_{b,t+1} = f_b(\overline{x}_t) = 1 - e^{-\rho \overline{x}_t} \qquad \beta_{b,t+1} = g_b(\overline{y}_t) = 1 - e^{-\rho \overline{y}_t}; \tag{9}$$

$$\alpha_{s,t+1} = f_s(\overline{x}_t) = e^{-\sigma \overline{x}_t} \qquad \beta_{s,t+1} = g_s(\overline{y}_t) = e^{-\sigma \overline{y}_t}; \tag{10}$$

where $\rho, \sigma > 0$ represent the reactivity of bandwagoners and snobs agent, respectively, with respect to the average consumption of the goods x and y in

[3] For simplicity, the prices of two goods and the income are assumed to be constant.

the previous period.
By advancing the expressions in Equations (7) and (8) by one period and using the expressions in (9) and (10), we obtain the two-dimensional dynamic system

$$M : \begin{cases} \overline{x}_{t+1} = \omega \frac{(1-e^{-\rho \overline{x}_t})m}{p[2-e^{-\rho \overline{x}_t}-e^{-\rho \overline{y}_t}]} + (1-\omega)\frac{me^{-\sigma \overline{x}_t}}{p[e^{-\sigma \overline{x}_t}+e^{-\sigma \overline{y}_t}]} \\ \overline{y}_{t+1} = \omega \frac{(1-e^{-\rho \overline{y}_t})m}{q[2-e^{-\rho \overline{x}_t}-e^{-\rho \overline{y}_t}]} + (1-\omega)\frac{me^{-\sigma \overline{y}_t}}{q[e^{-\sigma \overline{x}_t}+e^{-\sigma \overline{y}_t}]}. \end{cases} \tag{11}$$

describing the dynamics of average consumption of x and y, performed by the population.
The homogeneity of incomes between the two groups makes it possible to use the budget constraint to reduce the dimension of the dynamic system. Specifically, by exploiting the relationship

$$\overline{y} = \frac{m}{q} - \frac{p}{q}\overline{x}; \tag{12}$$

we can rewrite the dynamic system M as a one-dimensional system in terms of the variable $\overline{x}_t$. Therefore, by introducing the unit time advancement operator $'$, we obtain the following map $H : [0, \frac{m}{p}] \to [0, \frac{m}{p}]$

$$H : \overline{x}^{'} = h(\overline{x}) = \omega \frac{(1-e^{-\rho\,\overline{x}})m}{p\left[2 - e^{-\rho\,\overline{x}} - e^{-\frac{\rho(m-p\,\overline{x})}{q}}\right]} + (1-\omega)\frac{me^{-\sigma\,\overline{x}}}{p\left[e^{-\sigma\,\overline{x}} + e^{-\frac{\sigma(m-p\overline{x})}{q}}\right]}. \tag{13}$$

3 Dynamic analysis

As we can notice from the specification in (13), the non-linearity of the map does not allow an in-depth analysis of the numerosity and stability of possible fixed points for the system. Nevertheless, the following proposition can be stated:

Proposition 1 *Let h be the function defined in (13). Then, there exists always at least one fixed point $\overline{x}^*$ for H.*

Proof. By calculating the value assumed by h at the extremes of the interval $[0, \frac{m}{p}]$, i.e. $h(0)$ and $h(\frac{m}{p})$, we have

$$h(0) = \frac{(1-\omega)m}{p\left(e^{-\frac{\sigma\,m}{q}} + 1\right)} \geq 0$$

$$h\left(\frac{m}{p}\right) = \frac{m\left(e^{-\frac{\sigma\,m}{p}} + \omega\right)}{p\left(e^{-\frac{\sigma\,m}{q}} + 1\right)} \leq \frac{m}{p}.$$

Then, the graph of h crosses at least one time the 45-degree line and the result follows. □

In what follows, we analyse both the case in which the population is composed only of bandwagoners or snobs, and the case in which both groups of subjects coexist.

3.1 Monomorphic population

In this section, we consider a population composed either exclusively of snob individuals ($\omega = 0$) or exclusively of imitators ($\omega = 1$). In these cases, an individual in the group compares the consumption levels experienced exclusively by members of such group in the past. Considering the case $\omega = 0$, the map H can be rewritten as

$$\widetilde{H} : \overline{x}^{'} = \widetilde{h}(\overline{x}) = \frac{me^{-\sigma\,\overline{x}}}{p\left[e^{-\sigma\,\overline{x}} + e^{-\frac{\sigma(m-p\overline{x})}{q}}\right]} \tag{14}$$

where $\widetilde{H} : [0, \frac{m}{p}] \to [0, \frac{m}{p}]$.

Proposition 2 *Let $\widetilde{h}$ be the function defined in (14). Then, there exists a unique stable fixed point $\overline{x}^*$ or a stable 2-cycle.*

Proof. Being a particular case of the general function h, $\widetilde{h}$ exhibits the same behaviour at the extremes of the interval $[0, \frac{m}{p}]$, as shown in in Proposition 1. In addition, $\widetilde{h}$ is monotically decreasing in $[0, \frac{m}{p}]$. Indeed,

$$\frac{d\widetilde{h}}{d\overline{x}} = -\frac{\sigma\, me^{-\sigma\,\overline{x}}\,(p+q)\,e^{-\frac{\sigma(m-p\overline{x})}{q}}}{p\,q\left[e^{-\sigma\,\overline{x}} + e^{-\frac{\sigma(m-p\overline{x})}{q}}\right]^2} < 0.$$

Therefore, the graph of h crosses the 45-degree line once in $[0, \frac{m}{p}]$ and, in addition, the monotic behaviour of the map guarantees that $\overline{x}^*$ is globally asymptotically stable or that the map converges to a stable 2-cycle. □

As Proposition 2 states, the collective consumption choices of a population composed only by snobs may converge either to (i) a stable equilibrium consumption $\overline{x}^*$, or (ii) to a consumption cycle of period 2, i.e. a cycle in which the consumption level alternately assumes the level $\overline{x}^1$ and $\overline{x}^2$. This result, in contrast to what is shown in Di Giovinazzo and Naimzada (2015), allows to observe cyclical phenomena even in the case of monomorphic population and to isolate the peculiar effect of the presence of snobs within society. We can notice how, in contexts of strong reactivity to past consumption, the *boredom* of the snobs towards mass choices ends up inducing them to change every period their choices on the consumption of x and y and therefore to determine a continuous switching in collective consumption $\overline{x}$. An explanation of such phenomenon is that, in case the consumption of x and y by snobs is not the same, an increase in σ shifts, via α and β, the steady state $\overline{x}^*$ (and simultaneously $\overline{y}^*$ in the opposite direction). This gives rise to a further change, in opposite directions, of the parameters α and β in the utility function. If σ is high enough and consumption is sufficiently polarized, given the prices, this phenomenon may destabilize the equilibrium. In this regard, Figure 1 shows how different values in σ may lead either to convergence or to the occurrence of cyclical behaviours.

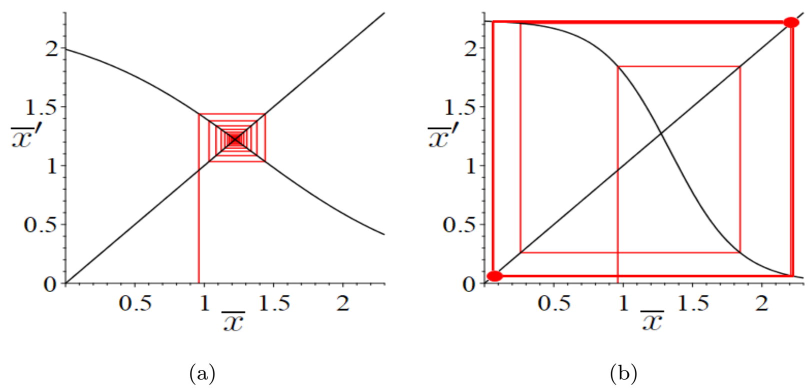


Figure 1: Parameter set: $m = 0.671, p = 0.3, q = 0.2, \overline{x}_0 = 0.96$. (a) Convergence to the stable $\overline{x}^* \simeq 1.22$ when $\sigma = 0.62$. (b) Convergence to the stable 2-cycle when $\sigma = 1.62$. (c) Bifurcation diagram with respect σ.

In addition, the particular role played by the reactivity of snobs can be explored in more detail. Indeed, if we further assume that the prices of the two goods are equal, we can explicitly determine the unique fixed point $\overline{x}^* = \frac{m}{2p}$. Therefore, we notice that (i) the expression of the fixed point is independent from the responsiveness of the snobs to consumption (σ), but (ii) σ affects the stability of the fixed point. In fact, at the steady state we have

$$\left.\frac{d\widetilde{h}}{d\,\overline{x}}\right|_{\overline{x}^*=\frac{m}{2p}} = -\frac{\sigma\, m}{2p}. \tag{15}$$

Then, for a sufficiently high value of σ the fixed point loses its stability.
If $p \neq q$, we can show how the parameter σ plays a role also in determining the value assumed by the steady state $\overline{x}^*$. To this end, it is worth considering the explicit dependence of $\widetilde{h}$ on σ and we refer with $\widetilde{h}(\overline{x};\sigma)$ the function defined in (14). Then, we provide the following result:

Proposition 3 *Let $\widetilde{h}$ be the function defined in (14) and $\overline{x}^*$ be a fixed point for $\widetilde{H}$, given the value σ^*, that is $\widetilde{h}(\overline{x}^*;\sigma^*) = \overline{x}^*$.*
(a) There exists a C^1 function $\hat{x} = \hat{x}(\sigma)$, defined in a neighborhood I_{σ^*} of σ^* such that $\hat{x}(\sigma^*) = \overline{x}^*$ and $\widetilde{h}(\hat{x}(\sigma);\sigma) = \hat{x}(\sigma)$ for all $\sigma \in I_{\sigma^*}$.
(b) Consequently, if $\overline{x}^* \leq \overline{y}^*$, then $\frac{d\,\hat{x}}{d\,\sigma}(\sigma^*) \geq 0$. Otherwise, $\frac{d\,\hat{x}}{d\,\sigma}(\sigma^*) < 0$.

Proof. Let us consider the function

$$Z(\overline{x};\sigma) = \overline{x} - \widetilde{h}(\overline{x};\sigma). \tag{16}$$

Since $Z(\overline{x}^*;\sigma^*) = 0$, the result (a) follows by the Implicit Function Theorem. Therefore, we have

$$\frac{d\,\hat{x}}{d\,\sigma}(\sigma^*) = -\frac{\frac{\partial\,Z}{\partial\,\sigma}(\overline{x}^*;\sigma^*)}{\frac{\partial\,Z}{\partial\,\overline{x}}(\overline{x}^*;\sigma^*)} \tag{17}$$

where

$$\frac{\partial\,Z}{\partial\,\overline{x}}(\overline{x}^*;\sigma^*) = 1 - \frac{\partial\,\widetilde{h}}{\partial\,\overline{x}}(\overline{x}^*;\sigma^*) > 0 \tag{18}$$

for every $\overline{x}$, being $\frac{\partial\,\widetilde{h}}{\partial\,\overline{x}} < 0$ for every $\overline{x}$ as proved in Proposition 2; instead,

$$\frac{\partial\,Z}{\partial\,\sigma}(\overline{x}^*;\sigma^*) = \frac{m}{p}\frac{e^{-\sigma^*[\overline{x}^* + \frac{m}{q} - \frac{p}{q}\overline{x}^*]}}{(e^{-\sigma^*[\frac{m}{q} - \frac{p}{q}\overline{x}^*]} + e^{-\sigma^*\overline{x}^*})^2}\left[\overline{x}^* - \frac{m}{q} + \frac{p}{q}\overline{x}^*\right] \leq 0 \tag{19}$$

if and only if $\overline{x}^* \leq \frac{m}{q} - \frac{p}{q}\overline{x}^*$. Being $\overline{y}^* = \frac{m}{q} - \frac{p}{q}\overline{x}^*$, the result in (b) is straightforward. □

Therefore, σ plays a twofold role. Indeed, first it affects the value of the steady state and finally it may induce the onset of a flip bifurcation and the convergence to a stable 2-cycle. The bifurcation diagram in Figure 2 highlights the different roles played by σ in the cases $p = q$ and $p \neq q$, respectively. Specifically, (i) the diagram in blue shows how the value of the fixed point remains constant until the system is destabilized via flip bifurcation and a 2-cycle occurs; differently, (ii) the diagram in red shows how, starting from a parametric configuration for which $\overline{x}^* < \overline{y}^*$, first the value of the stable fixed point increases as σ increases and finally how a sufficiently high value of the responsiveness of snobs may induce the onset of a 2-cycle.

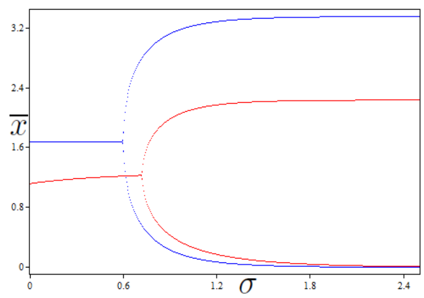


Figure 2: (a) Parameter set: $m = 0.671, \overline{x}_0 = 0.96$. Two bifurcation diagrams with respect to σ showing different behaviours when (i) $p = q = 0.2$ (blue diagram) and (ii) $p = 0.3, q = 0.2$ (red diagram).

In the case of a monomorphic population composed only by bandwagoners, i.e. when $\omega = 1$, the general map H reads as

$$\tilde{\tilde{\tilde{H}}} : \overline{x}' = \tilde{\tilde{\tilde{h}}}(\overline{x}) = \frac{(1 - e^{-\rho\,\overline{x}})m}{p\left[2 - e^{-\rho\,\overline{x}} - e^{-\frac{\rho(m - p\,\overline{x})}{q}}\right]} \tag{20}$$

where $\tilde{\tilde{\tilde{H}}} : [0, \frac{m}{p}] \to [0, \frac{m}{p}]$.

First, we show that the map $\tilde{\tilde{\tilde{H}}}$ is monotonically increasing. Indeed, we have that

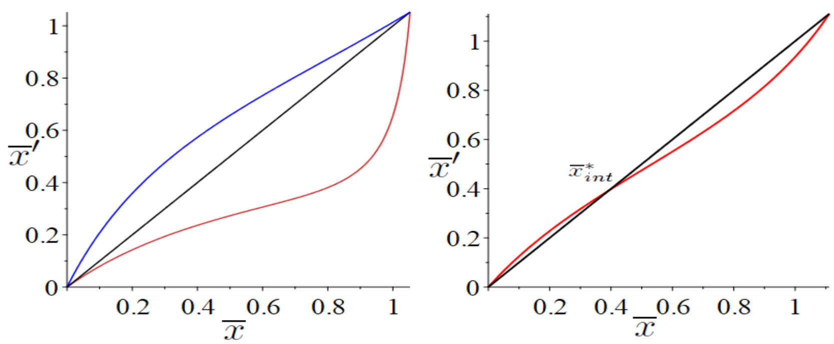
$$\tilde{\tilde{\tilde{h}}}'(\overline{x}) = -\rho\left(\frac{me^{\frac{\rho\,m}{q}}}{qzp}\right)\left(\frac{p(z-1)z^{\frac{p}{q}} - qz(e^{\rho\frac{m-p}{q}} - 1)z^{-\frac{p}{q}}}{(z^{-\frac{p}{q}} + e^{\frac{\rho\,m}{q}}(z-2))^2}\right)e^{-\rho\,\overline{x}} \geq 0 \tag{21}$$

where $z = e^{-\rho\,\overline{x}}$ and $\frac{m-p}{q} \geq 0$. This result implies that the dynamics are monotone and then oscillations cannot occur. With regard to the number of fixed points and their stability, the following proposition applies:

Proposition 4 *Let $\tilde{\tilde{\tilde{H}}}$ be the map defined in (20). Then, 0 and $\frac{m}{p}$ are always fixed points for $\tilde{\tilde{\tilde{H}}}$. Assume that $q > \rho\,m$.*
(a) If $p < \frac{\rho\,m}{1-e^{-\frac{\rho\,m}{q}}}$ (resp. $p > \frac{\rho\,m}{1-e^{-\frac{\rho\,m}{q}}}$), then 0 in unstable (resp. locally asymptotically stable).
(b) If $p < -\frac{\rho\,m}{\ln\left(1-\frac{\rho\,m}{q}\right)}$ (resp. $p > -\frac{\rho\,m}{\ln\left(1-\frac{\rho\,m}{q}\right)}$), then $\frac{m}{p}$ is locally asymptotically stable (resp. unstable).
(c) Fixed points 0 and $\frac{m}{p}$ cannot be both locally attractive. If $-\frac{\rho\,m}{\ln\left(1-\frac{\rho\,m}{q}\right)} < p < \frac{\rho\,m}{1-e^{-\frac{\rho\,m}{q}}}$, then 0 and $\frac{m}{p}$ are unstable and there exists at least an interior locally asymptotically stable fixed point x^*_{int}.

Proof. In order to prove the result, it is sufficient to evaluate the derivative of the map at the extremes of its domain, 0 and $\frac{m}{p}$ and compare it with the slope of the 45-degree line. From the continuity of the function $\tilde{\tilde{h}}$ follows the result on the existence of the interior fixed point. □

The scenarios described in Proposition 4 are shown in Figure 3. In particular, in Panel (a) of Figure 3 we observe the cases in which 0 (orange curve) or $\frac{m}{p}$ (blue curve) is locally asymptotically stable. Panel (b) in Figure 3 shows instead the case in which an interior locally asymptotically stable fixed point exists. The economic interpretation of such results is rather simple. If the price of a good is sufficiently low, the imitative behaviour of bendwagoners tends to create a scenario where all agents coordinate in the consumption of only one good. If, on the other hand, prices do not significantly differentiate between them, then a scenario where agents consume both goods arises.
The results provided also allow to observe that bandwagoners play a stabilizing role within the society. In fact, in a population composed only of imitators, there is no possibility of oscillations in the dynamics, in contrast to what is shown in the case of a population composed only of snobs.



(a) (b)

Figure 3: Parameter set: $\rho = 6.3, m = 1, p = 0.95$. (a) 0 is locally asymptotically stable for $q = 0.1$ (curve depicted in orange), while $\frac{m}{p}$ is locally asymptotically stable for $q = 1.91$ (curve depicted in blue). (b) Existence of a locally asymptotically stable interior fixed point $\overline{x}^*$ for $q = 0.75$.

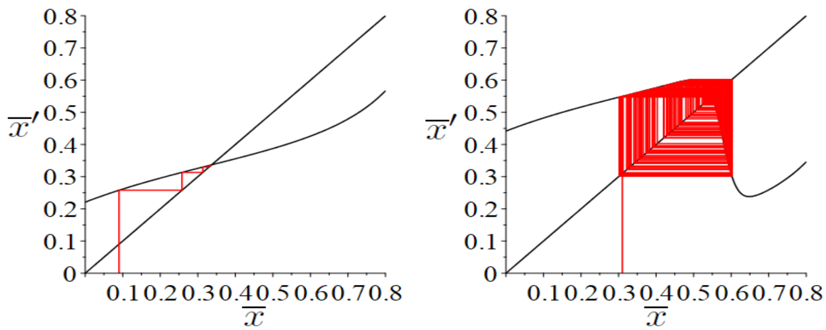
The assumption of monomorphic population (only snobs or only bandwagoners) clearly represents a simplification of the model compared with the polymorphic version (which will be discussed in the following section) and allows both (i) to deal more easily from a mathematical point of view with the dynamic system and thus to provide some analytical results on the existence of fixed points and the role of parameters in affecting the stability, and (ii) to isolate the different roles played respectively by agents who are snobs or bandwagoners on the bundle of goods considered.

3.2 Polymorphic population

In this section, we consider the case in which the two groups which compose the population coexist. Therefore, we assume that the share of the population composed of bandwagoners ω belongs to the interval $(0, 1)$ and the map assumes the general specification defined in (13).
As in the two extreme cases discussed in the previous section, the high nonlinearity of the map cannot allow an in-depth analytical study of the numerosity and stability of possible fixed points for the system. For this reason, the analysis is conducted through numerical exercises. Specifically, we propose a numerical analysis of the effects generated on collective choices by both bandwagoners and snobs reactivity to the collective consumption in the previous period.
The following figures show how the dynamics of collective consumption of x are driven essentially by two factors: (A) the values associated to the reactivity (with respect to collective consumption in the previous period) of the two groups of individuals and (B) the composition of the population, i.e. the ratio between the number of bandwagoners and snobs in the population.
Concerning factor (A), we show how individuals' reactions to past consumption may affect the dynamics of the demand of x, and thus the emergence of fashion cycles. Consider the case in which $\sigma = 0$. In this case, the population is therefore composed of bandwagoners with a positive reactivity ρ and snob agents without *memory* of the previous collective consumption. We can see how the map, for $\sigma = 0$, reads as

$$\overline{x}' = \omega \,\tilde{\tilde{h}}(\overline{x}) + (1 - \omega)\frac{m}{2p}. \tag{22}$$

Being $\tilde{\tilde{h}}$ an increasing monotone map, we deduce that when $\sigma = 0$ the market does not experience fashion cycles (see Panel (a) in Figure 4). As σ becomes higher than zero, we can notice how a destabilization of the system and therefore the onset of fashion cycles may appear. In addition, for very high values of the reactivity of snob agents, it is possible to observe the emergence of irregular (i.e. chaotic) fluctuations in the aggregate demand for the good x (see Panel (b) in Figure 4).



(a) (b)

Figure 4: Parameter set: $\rho = 0.98, m = 1, p = 1.2, q = 0.53, \omega = 0.47$. (a) Convergence to a stable interior stationary state when $\sigma = 0$. (b) Erratic fluctuations in the level of $\overline{x}$ and emergence of a chaotic regime when $\sigma = 16.5$.

The bifurcation diagram in figure 5 shows in detail how the system, given a positive value of ρ, is gradually destabilized as σ increases. In particular, we notice that for very low values of σ, the fixed point is stable. As σ reaches the value 5.21, the stable fixed point undergoes a flip bifurcation that generates a stable 2-cycle. As σ further increases, a sequence of period doubling bifurcations occur leading to the emergence of chaos for $\sigma \simeq 14,67$.

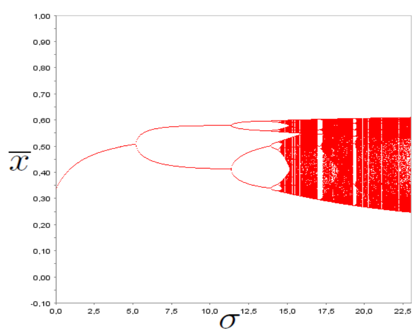
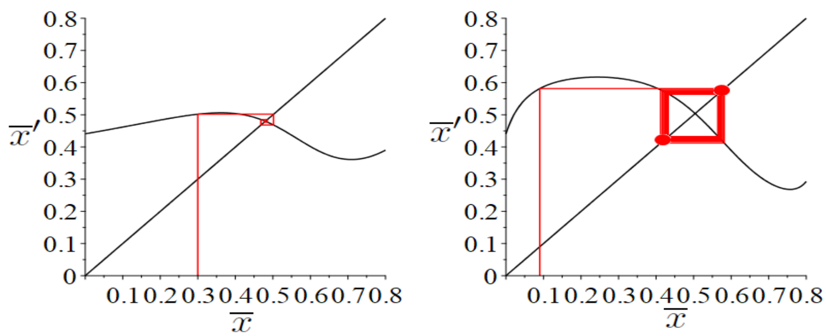


Figure 5: (a) Parameter set: $\rho = 0.98, m = 1, p = 1.2, q = 0.53, \omega = 0.47$. Bifurcation diagram with respect to σ showing how, as σ becomes strongly large, chaotic dynamics appear.

Consider now the case in which $\rho = 0$. In this case, the population is therefore composed of snobs with a positive reactivity σ and bandwagoner agents without *memory* of the previous collective consumption. Now, the map reads as

$$\overline{x}' = (1 - \omega)\, \widetilde{h}(\overline{x}). \tag{23}$$

In this case, it can be noticed that the interaction between a group of agents reactive to past consumption and others without memory generates a stability scenario (see Panel (a) in Figure 6). When ρ increases, the interaction between bandwagoners and snobs with a positive reactivity (on the previous period collective consumption) generates destabilization and in this case the onset of fashion cycles (see Panel (b) in Figure 6).



(a) (b)

Figure 6: Parameter set: $\sigma = 3.5, m = 1, p = 1.2, q = 0.53, \omega = 0.47$. (a) Convergence to a stable interior stationary state when $\rho = 0$. (b) Stable 2-cycle for $\rho = 9.28$.

The bifurcation diagram in Figure 7 summarises the manner in which a variation in the reactivity to consumption of bandwagoners ρ, given a constant value of the reactivity of snobs σ, affects the dynamics of collective consumption and favors the emergence of a fashion cycle. Specifically, in the numerical exercise we propose, at $\rho \simeq 1.78$ the steady state undergoes a flip bifurcation generating a stable 2-cycle.

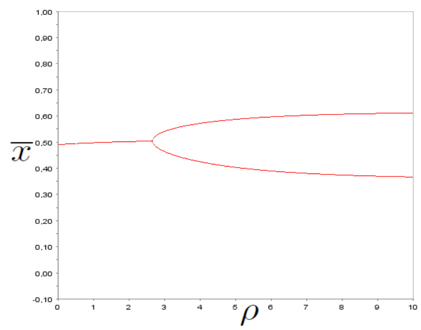


Figure 7: (a) Parameter set: $\sigma = 3.5, m = 1, p = 1.2, q = 0.53, \omega = 0.47$. Bifurcation diagram with respect to ρ showing how, for a sufficiently high value of ρ, the system converges to a 2-cycle.

Therefore, the numerical exercises described above allow the following evidence to be shown: (i) the matching between a group whose preferences depend on the memory of past collective consumption and another composed of agents whose preferences are independent of memory is never able to produce the onset of complex dynamics, i.e. it only generates dynamics converging to a stable steady state or to a stable 2-cycle; (ii) when both bandwagoners and snobs have a positive reactivity of their preferences with respect to past collective consumption, then the system can be destabilized by an increase in or the bandwagoners reactivy or the snobs reactivity to past consumption (Figures 5 and 7); (iii) only snobs with an enough strong counter-adaptive reactivity to past consumption are able to generate, in a context where even bandwagoners are reactive to past consumption, irregular cycles of the aggregate demand of x.
With regard to factor (B), the graph in Figure 8 shows that, in the case of a strong reactive push by the group of snobs (the most prone to non-linear dynamics among those proposed), the population structure has a twofold effect. A shift from a population with a strong predominance of snobs to a more heterogeneous one generates a destabilizing effect on the system (from a stable 2-cycle to a chaotic regime); a further increase in the share of bandwagoners stabilizes the dynamics of $\overline{x}$ (a globally asymptotically stable equilibrium emerges).

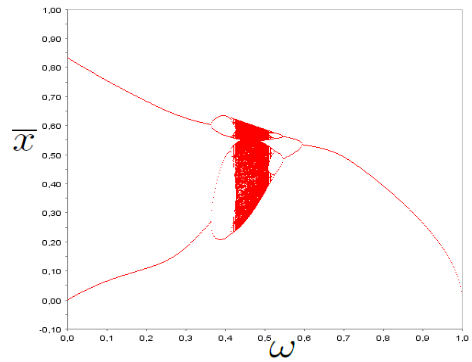


Figure 8: (a) Parameter set: $\rho = 0.98, \sigma = 16.5, m = 1, p = 1.2, q = 0.53$. Bifurcation diagram with respect to ω showing the onset and final closure of the chaotic regime as ω varies from 0 to 1.

4 An extension: evolutionary dynamics of ω

The results shown in the previous paragraph arise from a study carried out in a context in which the structure of the population, and therefore the consumption behaviour of the two types (bandwagoners and snobs) can not change.[4] At this stage is reasonable to examine how the dynamics of the system may change in a framework in which individuals can move from one group to another through an endogenous mechanism. To this end, we propose a second version of the model in which ω (i.e. the fraction of bandwagoners in the population) is not constant but varies over time. Therefore, we consider a new two dimensional map in which both the collective consumption of x and the population composition evolve.

As far as the evolutionary mechanism of the bandwagoners is concerned, we assume that the agents know their own individual degree of satisfaction and they are correctly informed about the realisation of the utilities of the members of the other group, so that they can compare the two values. Specifically, we consider a discrete exponential replicator mechanism and then the fraction of bandwagoners ω_t is described by the following discrete choice function:

$$\omega_{t+1} = \frac{\omega_t \, e^{\mu \, U_{b,t}(\alpha_{b,t}, \beta_{b,t}, x^*_{b,t}, y^*_{b,t})}}{\omega_t \, e^{\mu \, U_{b,t}(\alpha_{b,t}, \beta_{b,t}, x^*_{b,t}, y^*_{b,t})} + (1 - \omega_t) \, e^{\mu \, U_{s,t}(\alpha_{s,t}, \beta_{s,t}, x^*_s, y^*_s)}} =$$

$$= \frac{\omega_t}{\omega_t + (1 - \omega_t) \, e^{-\mu \, (U_{b,t}(\alpha_{b,t}, \beta_{b,t}, x^*_{b,t}, y^*_{b,t}) - U_{s,t}(\alpha_{s,t}, \beta_{s,t}, x^*_{s,t}, y^*_{s,t}))}} \qquad (24)$$

where $U_{b,t}(\alpha_{b,t}, \beta_{b,t}, x^*_{b,t}, y^*_{b,t})$ and $U_{s,t}(\alpha_{s,t}, \beta_{s,t}, x^*_{s,t}, y^*_{s,t})$ have the following expressions, respectively

[4] In this regard, see Antoci et al. (2018).

$$U_{b,t}(\alpha_{b,t},\beta_{b,t},x^*_{b,t},y^*_{b,t}) = (1-e^{-\rho\,\overline{x}_t})\ln\frac{(1-e^{-\rho\,\overline{x}_t})\,m}{p\left[2-e^{-\rho\,\overline{x}_t}-e^{-\frac{\rho(m-p\,\overline{x}_t)}{q}}\right]}+$$

$$+\left[1-e^{-\frac{\rho(m-p\,\overline{x}_t)}{q}}\right]\ln\frac{m\left(1-e^{-\frac{\rho(m-p\,\overline{x}_t)}{q}}\right)}{q\left[2-e^{-\rho\,\overline{x}_t}-e^{-\frac{\rho(m-p\,\overline{x}_t)}{q}}\right]},$$

$$U_{s,t}(\alpha_{b,t},\beta_{b,t},x^*_{s,t},y^*_{s,t}) = e^{-\sigma\,\overline{x}_t}\ln\frac{me^{-\sigma\,\overline{x}_t}}{p\left[e^{-\sigma\,\overline{x}_t}+e^{-\frac{\sigma(m-p\overline{x}_t)}{q}}\right]}+$$

$$+e^{-\frac{\sigma(m-p\overline{x}_t)}{q}}\ln\frac{\left(e^{-\frac{\sigma(m-p\,\overline{x}_t)}{q}}\right)m}{q\left[e^{-\sigma\,\overline{x}_t}+e^{-\frac{\sigma(m-p\overline{x}_t)}{q}}\right]}$$

The new two-dimensional dynamic system is then described by the map

$$V:\begin{cases}\overline{x}^{'} = \omega\,\dfrac{(1-e^{-\rho\,\overline{x}})\,m}{p\left[2-e^{-\rho\,\overline{x}}-e^{-\frac{\rho(m-p\,\overline{x})}{q}}\right]}+(1-\omega)\dfrac{me^{-\sigma\,\overline{x}}}{p\left[e^{-\sigma\,\overline{x}}+e^{-\frac{\sigma(m-p\overline{x})}{q}}\right]}\\ \omega^{'} = \dfrac{\omega}{\omega+(1-\omega)\,e^{-\mu\,(U_b(\alpha_b,\beta_b,x^*_b,y^*_b)-U_s(\alpha_s,\beta_s,x^*_s,y^*_s))}}\end{cases}\tag{25}$$

where we use again $'$ as the time advancement operator. The positive parameter μ represents the intensity of choice, i.e. the speed of adjustment of the evolutionary mechanism. According to Naimzada and Pireddu (2018a), it describes the ability of individuals to analyse and compare the benefits made to decide the type of behaviour to be adopted in the next period, i.e. their willingness to change and move towards the preferences that guaranteed the highest utility level in the previous period. In particular, we can notice that for $\mu \to 0$ the individuals continue to choose the preferences they chose in the previous period, i.e. $\omega^{'} = \omega$; when $\mu > 0$, the function in (24) is an increasing monotone function of $U_{b,t}(\alpha_{b,t},\beta_{b,t},x^*_{b,t},y^*_{b,t}) - U_{s,t}(\alpha_{s,t},\beta_{s,t},x^*_{s,t},y^*_{s,t})$; as $\mu \to +\infty$, the individuals move in one shot toward the preferences that guaranteed the highest utility level in the previous period. Specifically, (i) if $U_{b,t}(\alpha_{b,t},\beta_{b,t},x^*_{b,t},y^*_{b,t}) < U_{s,t}(\alpha_{s,t},\beta_{s,t},x^*_{s,t},y^*_{s,t})$, then $\omega^{'} \to 0$ as $\mu \to +\infty$, (ii) if $U_{b,t}(\alpha_{b,t},\beta_{b,t},x^*_{b,t},y^*_{b,t}) > U_{s,t}(\alpha_{s,t},\beta_{s,t},x^*_{s,t},y^*_{s,t})$, then $\omega^{'} \to 1$ as $\mu \to +\infty$. Considering the map V allows us to study and determine the dynamics of both collective consumption and population structure, and unlike Naimzada and Pireddu (2018b) (where the aggregate demand for goods is constant and therefore not affected by fashion cycles), this makes possible the analysis of *real* consumption cycles which evolve depending on the evolution of the structure of the groups. Due to its strong nonlinearity, also in this section it is not possible to discuss, from an analytical point of view, the existence and stability of fixed

points. Therefore, we provide a numerical analysis of some relevant results that allow relating the results found in the unidimensional model with this extended version.
We notice that the possibility to switch from a type to another does not have a clear role in affecting the dynamics of the model. Specifically, it may both destabilize configurations of the model in which the interaction between fixed groups produces convergence at a stationary state; or stabilize specifications in which the interaction between fixed groups produces irregular dynamics of the collective consumption of x. Consider the following parameter set: $\rho = 5.3, \sigma = 9.13, m = 1, p = 6.5, q = 0.53$. If we assume $\mu = 0$, the dynamics of the model depend on the map H. Figure 9 allows to observe that in this case the trajectories of the aggregate demand of x converge to a stationary value.

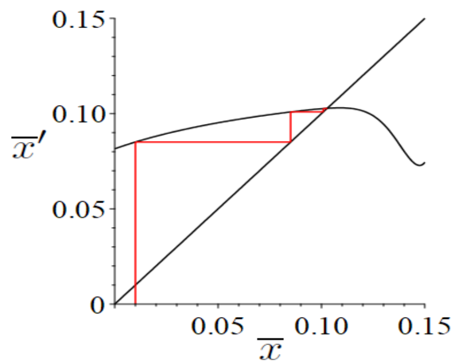
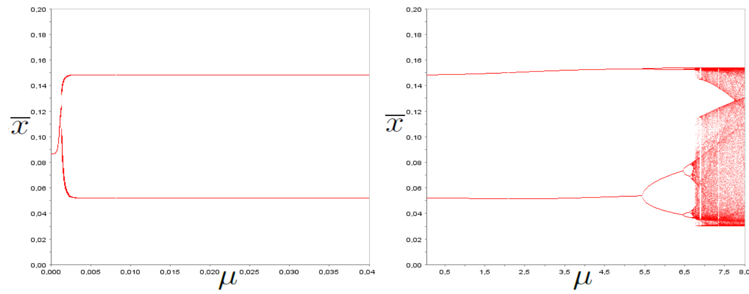


Figure 9: (a) Convergence of $\overline{x}$ to a steady state when $\mu = 0$ and ω is assumed as constant.

As μ increases, i.e. as the willingness to switch for individuals of both groups increases, we can notice a destabilization of the system and the onset (for sufficiently high values of μ) of chaotic regimes concerning the collective consumption of x. Specifically, Panel (a) in Figure 10 shows as a small increase of μ may destabilize the system towards a stable 2-cycle. Panel (b) in Figure 10 highlights how further increases in the value of μ may generate a sequence of period doubling bifurcation and then, for $\mu > 6.72$, the occurrence of chaotic dynamics.



(a) (b)

Figure 10: (a) Bifurcation diagram with respect to μ when, for very low values of μ a destabilization of the steady state occurs. (b) The same bifurcation diagram highlighs, for sufficiently high values of μ, the appearance of a chaotic regime.

In the same manner, as the willingness to switch increases, we can observe the emergence of irregular dynamics in the structure of the population (see Figure 11).

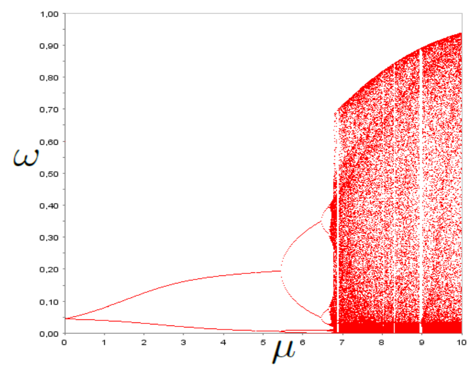
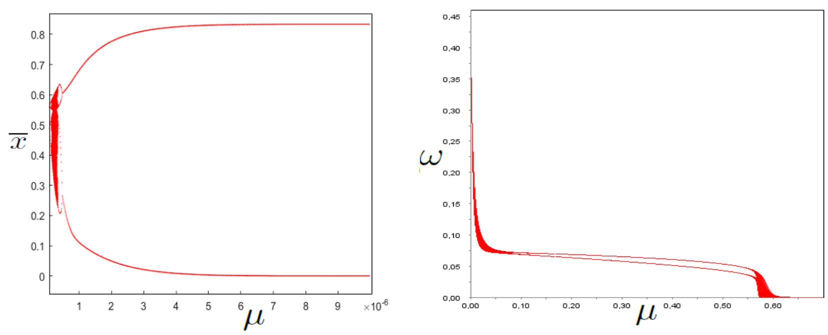


Figure 11: (a) Parameter set: $\rho = 5.3, \sigma = 9.13, m = 1, p = 6.5, q = 0.53$. Bifurcation diagram with respect to μ describing the emergence of a chaotic regime in the population structure, when μ approaches high values.

As mentioned above, we can show scenarios in which the possibility of changing the structure of preferences has a stabilizing role on the system. Consider the following parameter set: $\rho = 0.98, \sigma = 16.5, m = 1, p = 1.2, q = 0.53$. If we assume $\mu = 0$, the dynamics of the model are chaotic in x (see Panel (b) in Figure 4). In this case, we can notice how a small increase in the willingness of the agents in reviewing their preferences structure (μ), induces the convergence of the system towards a regular attractor (fashion cycles continue to persist, albeit with a regular frequency). Panels (a) and (b) in Figure 12 show the bifurcation diagrams of $\overline{x}$ and ω with respect μ which highlight this stabilizing phenomenon. In particular, Panel (a) shows how as μ increases (even if within very low values) may induce the motion of the system from a chaotic regime to a stable 2-cycle. Panel (b) shows how the increase in μ affects the dynamics of the population structure and its final convergence to a stable 2-cycle (in the graph, the poles of the cycle are very close together and close to the lower bound of the interval).

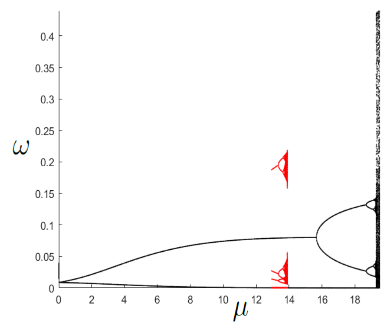


(a) (b)

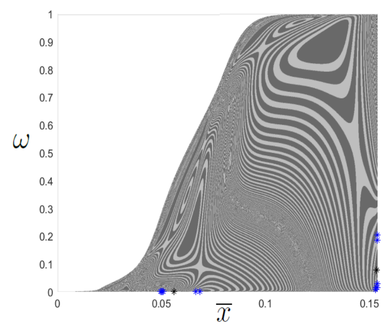
Figure 12: (a) Bifurcation diagram of $\overline{x}$ with respect to μ, showing the convergence to a 2-cycle. (b) Bifurcation diagram of ω with respect to μ, showing the convergence to a monomorphic structure of the population ($\omega \simeq 0$).

The twofold and ambiguous role of the intensity of choice parameter μ described in the previous paragraph can be justified by the high nonlinearity and complexity of the two dimensional model. In this context, in fact, agents make multidimensional comparisons, i.e. they compare themselves with agents with different preference structure in the present (and on the basis of this comparison they may decide to switch to the other preferences structure) and also with collective consumption styles (i.e. of both groups) in the past, participating the latter in the formation of individual endogenous preferences. This means that the introduction of the willingness to switch may overturn the dynamics generated by a fixed structure of the population either by destabilizing them when they are converging or by stabilizing them when they are irregular.
From a mathematical point of view, it is interesting to notice that in the two-dimensional model, using an appropriate parameter set, it is possible to observe phenomena of multistability. In this regard, by considering the parameter set $\sigma = 5.3, m = 1, p = 6.5, q = 0.53, \rho = 9.13$, a fixed point with ω really closed to 1 always exists for any positive value of μ. Nonetheless, starting from initial conditions with ω sufficiently low, we observe the existence of other attractors. Specifically, Panel (a) in Figure 13 shows how the coexistence of two attractors in addition to the one with ω closed to 1, emerges in the interval $(12.919, 13.986)$ between a 2-cycle (depicted in black) and another attractor (depicted in red). The latter arises as a 5-cycle through a saddle-node bifurcation and, as μ increases, it turns into a chaotic attractor. Moreover, the diagram allows noticing,

for values of μ larger than 19.2, the explosion in the dimension of the attractor induced by an enlargement in the absorbing area. Panel (b) in Figure 13 shows the basins of attraction for the different attractors of the system. In detail, the two different shades of grey identify the two basins of attraction for the attractors highlighted in the bifurcation diagram, the white area instead describes the basin of the stationary state in which the population is almost entirely composed of bandwagoners.



(a)



(b)

Figure 13: (a) Bifurcation diagram with respect to μ, performed with two different initial conditions with ω sufficiently low (another attractor with ω closed to 1, not shown in the graph, exists). (b) Basins of attraction (in light grey, dark grey and white, respectively) in the plane $(\overline{x}, \omega)$ when three attractors coexist ($\mu = 13.578$).

In economic terms, this result means that starting from different initial conditions concerning both the aggregate demand of x and the structure of the groups, higher and higher rationality of the agents in comparing utilities may lead to the occurrence of different fashion cycles of consumption and social cycles for the population.

5 Conclusions

In this article, we have analysed the emergence of fashion cycles and complex phenomena in a discrete time dynamic model in which (i) unlike Di Giovinazzo and Naimzada (2015), individuals are bandwagoner or snob on the entire bundle of goods considered and (ii) have different structure of endogenous preferences depending on the aggregate demand of the goods in the previous period. We have shown how in the case of polymorphic population, both the reactivity (to the past collective consumption) of bandwagoners and the reactivity (to the past collective consumption) of snobs may destabilize, albeit in different forms, the dynamics of the aggregate demand for a conspicuous good. In particular, we have provided numerical exercises highlighting the occurrence of fashion cycles and the onset of chaotic regimes. We have also proposed an extension of the model in which we have investigated the interdependence between the evolution of collective consumption choices and the dynamics of the population structure in a framework in which individuals may change structure of preferences and then switching between being of one type or another. Unlike Naimzada and Pireddu (2018a), in such extension we analyse both *real* consumption cycles (and then fashion cycles) and the evolution of the structure of the groups. In particular, we have illustrated scenarios related to the ambiguous role played by the *willingness to switch* parameter, allowing both destabilizing and stabilizing collective consumption dynamics. In addition, we have proposed a numerical example displaying a peculiar dynamic scenario in which different attractors coexist.

Data Availability Statement

The data that supports the findings of this study are available within the article [and its supplementary material].

References

A. Antoci, N. Bellanca, G. Galdi, and M. Sodini. Narrative dynamics in social groups: A discrete choice model. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, 28(5):055915, 2018.

J. Benhabib. Pareto vs. wicksell on adjustment costs in consumption: A reformulation. *Economics Letters*, 2(2):121–124, 1979.

J. Benhabib and R. H. Day. Rational choice and erratic behaviour. *The Review of Economic Studies*, 48(3):459–471, 1981.

T. M. Brown. Habit persistence and lags in consumer behaviour. *Econometrica: Journal of the Econometric Society*, pages 355–371, 1952.

A. Cabrales and J. Sobel. On the limit points of discrete selection dynamics. *Journal of Economic Theory*, 57(2):407–419, 1992.

J. Chang and R. Stauber. Evolution of preferences in an exchange economy. *Economics Letters*, 103(3):131–134, 2009.

G. Corneo and O. Jeanne. Conspicuous consumption, snobbism and conformism. *Journal of public economics*, 66(1):55–71, 1997.

R. H. Day. Rational choice and economic behavior. *Theory and decision*, 1(3): 229–251, 1971.

V. Di Giovinazzo and A. Naimzada. . . . do as the romans do. a model of conformity with the endogenous formation of preferences. *The Journal of Socio-Economics*, 41(5):654–658, 2012.

V. Di Giovinazzo and A. Naimzada. A model of fashion: Endogenous preferences in social interaction. *Economic Modelling*, 47:12–17, 2015.

J. S. Duesenberry et al. Income, saving, and the theory of consumer behavior. 1949.

L. R. Iannaccone. Bandwagons and the threat of chaos: interpersonal effects revisited. *Journal of Economic Behavior & Organization*, 11(3):431–442, 1989.

E. Karni and D. Schmeidler. Fixed preferences and changing tastes. *The American Economic Review*, 80(2):262–267, 1990.

H. Leibenstein. Bandwagon, snob, and veblen effects in the theory of consumers' demand. *The quarterly journal of economics*, 64(2):183–207, 1950.

K. Matsuyama. *Custom versus fashion: Path-dependence and limit cycles in a random matching game*. Working Paper No. E-92-11, Stanford University, 1992.

F. Modigliani. Fluctuations in the income-saving ratio: a problem in economic forecasting. *Studies in Income and Wealth*, 11, 1949.

A. Naimzada and M. Pireddu. Complex dynamics in an evolutionary general equilibrium model. *Discrete Dynamics in Nature and Society*, 2018, 2018a.

A. K. Naimzada and M. Pireddu. Fashion cycle dynamics in a model with endogenous discrete evolution of heterogeneous preferences. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, 28(5):055907, 2018b.

A. K. Naimzada and F. Tramontana. Interdependent preferences. In *Networks, Topology and Dynamics*, pages 127–142. Springer, 2009.

T. Scitovsky. The joyless economy: An inquiry into human satisfaction and dissatisfaction, 1976.

G. Simmel. Fashion. *International Quarterly*, 10(1):136, 1904.

T. Veblen. The theory of the leisure. *Class (New York: The New American Library, 1953)*, 1899.