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Relational consumption and nonlinear dynamics in an overlapping generations model

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Abstract

In this paper, we show that incorporating the relational dimension into an otherwise standard OLG model and focusing on dynamic leisure externalities leads to dramatically different predictions. Here we show that when the old perceive private and relational consumption as substitutable goods, a series of interesting dynamic outcomes - such as local indeterminacy, non-linear phenomena (including chaotic dynamics) and even multiple equilibria with global indeterminacy - may arise. We also draw some welfare implications and relate them to the well-known 'happiness paradox' arising within contemporary affluent societies.

Keywords: overlapping generations framework; growth; leisure; relational goods; happiness paradox.

JEL Classification: D63, J22, O33, O41, Z13.

1 Introduction

The overlapping generations model, pioneered by Samuelson (1958) and Diamond (1965), is a well-known dynamic model of special theoretical interest as the economy goes on forever but agents were born at different dates and have finite lifetimes. In this paper, we show that introducing the relational dimension into an otherwise standard OLG model leads to dramatically different predictions, even though we keep on referring to a homogeneous population economy where competitive firms supply a private good through an extremely simple constant returns technology.

Philosophy and social psychology have long been emphasizing the importance of genuine interpersonal relations for human flourishing and individual

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well-being (see e.g. Nussbaum, 2001 and Carr, 2004). In economics, the idea that interpersonal relations are valuable mainly for non-instrumental, intrinsic reasons has been expressed and developed through the concept of 'relational good' (Gui, 1987; Uhlaner, 1989). Relational goods hold a key distinctive feature: they can be enjoyed only insofar as they are *shared with others*. Hence, they differ not only from standard private goods, which are typically enjoyed alone, but also from classic public goods, which can be enjoyed by any number (Uhlaner, 1989). While some goods are inherently relational (e.g. family and friendship), other goods - though non-relational in character - often possess a relevant relational component in the sense that the utility they confer to consumers is significantly higher insofar as they happen to be jointly consumed. Ample anecdotal evidence unambiguously confirms that this is actually the case: activities such as (some) sports, theatre, dancing, holidays, shopping and even watching TV (especially reality shows, soap operas, sports and political debates) are often performed together with friends or relatives. A further significant difference between standard (private and public) goods and relational goods is that whenever the latter are produced and consumed[1], the identity of the subjects involved in the relationship matters (Uhlaner, 1989). Relational goods positively affect people's happiness (or subjective well-being), i.e. they generate important positive hedonic consequences (see on this Bruni and Stanca, 2008, Becchetti et al., 2008 and Graham and Oswald, 2010), to the point that they have been identified as a potential solution to the well-known happiness paradox which characterizes affluent economies (see Easterlin, 1974). We can plausibly add that genuine relational goods are not only non-rival (like public goods), but often also *anti-rival*, in the sense that the utility conferred to the single agents by the consumption of this good *increases* as the number of relational consumers increases. Let us think for example of a party among friends or a dinner among former schoolmates where such a 'network-like effect' typically occurs[2].

As far as contemporary advanced societies are concerned, even though a growing literature in management and political science argues that relational goods can be produced and consumed to some degree also while people work (see on this Antoci et al., 2011), it is hardly deniable that the major channel that makes the provision of relational goods possible is people's *leisure*[3]. An important reason why this is the case is that relational goods are time-consuming and

[1] Another well-known distinctive trait of relational goods is that, unlike standard economic goods, the phases of production and consumption temporally and logically coincide.

[2] Though she used a different terminology, also this feature of relational goods had been illustrated by Uhlaner (1989), in her classical contribution on the issue (see on this also Becchetti et al., 2008). Gomes' (2006) dynamic model on social interactions incorporates a similar assumption. However, it is important to note that congestion effects of socially enjoyed leisure may occur (for example, when too many people use the same park), as there will be a threshold level over which an increase in average leisure time within a given society will *reduce* the utility that individuals get from consuming the relational good (see on this also Gomez Suarez, 2008 and Pintea, 2010).

[3] The examples of relational goods listed in the previous paragraph clearly confirm that this is typically the case, as they all refer to activities that people perform during their non-working time.

their production requires a joint, coordinated socializing effort on the part of the people who are potentially involved. Therefore, while it is true that significant friendships may start in the workplace, it is mainly leisure that allow people to devote time to deepen their interpersonal relationships and maintain them over time. As Gomez Suarez (2008) points out, "The presence of spillovers associated to the leisure activity is plausible (..) since the satisfaction obtained from leisure usually depends on sharing activities with others" (p. 1497). In the last decades, a growing series of empirical studies have been documenting that non-instrumental social activities performed during individuals' non-working time - such as volunteering, attending social gatherings and staying with friends and family - often turn out to play a crucial role in the determination of time allocation decisions between labor and leisure (see e.g. Juster and Stafford, 1991). Alesina et al. (2006) claim that leisure externalities can be a significant factor for explaining the differences between working patterns in Europe and the US[4]. Notwithstanding this, economists so far have been paying scant attention to leisure externalities in general (Pintea, 2010) as well as, more specifically, to dynamic leisure externalities, so that relational goods have not been systematically integrated into existing growth models. As a consequence, the strand of literature on OLG growth models and relationality is surprisingly thin[5]. The problem is that, as Becchetti et al. (2008) correctly point out, "the neglect of relatedness as a fundamental aspect of human life may severely limit economic analysis and curtail the validity of its policy prescriptions. For instance, if economic growth is obtained at the expense of the quality of the relational environment, the final outcome can be negative for happiness and this may reduce the political consensus for growth oriented policies" (p. 344). Leisure can be devoted to several activities and focusing on the alternative, potential uses of free time is crucial in order to understand people's time allocation decisions between labor and leisure (Corneo, 2005). In Western countries, people spend a huge amount of time watching television (Bruni and Stanca, 2008; Corneo, 2005[6]). The major reason why this occurs is that TV viewing is not a time consuming activity, so that it comes as no surprise that Corneo (2005), in his cross-country analysis, finds a positive correlation between working hours and time spent by watching television.

As we will show in the next section, in the model presented in this paper we assume that people devote leisure to producing and consuming relational goods, that is performing socially enjoyed activities (e.g. personalized interactions with friends and neighbors or participation in the activities of clubs or community associations, religious bodies, political parties, unions and civic organizations) and explore the implications which can be drawn in dynamic terms

[4] Jenkins and Osberg's (2005) empirical analysis reveals that British spouses synchronize their working time in order to be able to spend their leisure time together (see also Hamermeesh, 2002 and Hunt, 1998 for similar effects on American and German spouses, respectively).

[5] For a dynamic model of social relationships in which relational goods are the results of individual joint efforts and past attitudes toward socializing, see Randon et al. (2008).

[6] In the sample of countries considered by Corneo in his empirical investigation, watching TV absorbs on average about as much time as working.

once we suppose that leisure has a social nature[7]. Our results indicate that in an otherwise standard OLG model, incorporating the relational dimension and focusing on dynamic leisure externalities makes the overall picture far richer and more complex, to the point that multiple equilibria may emerge. Here we show that when the old perceive private and relational consumption as substitutable goods, a series of interesting dynamic outcomes - such as local indeterminacy, non-linear phenomena (including chaotic dynamics) and even multiple equilibria with global indeterminacy - may arise. We also investigate the welfare implications of the main dynamic scenarios under study.

In our model, it is agents' expectations over the quality of the social environment for the old generation that play a crucial role in driving our local and global indeterminacy results. Specifically, we will show that as the importance of the quality of the social environment for the old increases, both local and global indeterminacy as well as non-linear phenomena may arise. Non-linear phenomena emerge as the presence of a variable such as the quality of the social environment for the old generation may determine choices which do not stabilize in the long run, so that even chaotic trajectories may emerge due to the presence of this relational variable, without introducing neither stochastic components nor exogenous shocks in the model. Further, as far as welfare analysis is concerned, we find that multiple equilibria which are both Pareto-rankable and simultaneously attractive may emerge. As a consequence, a coordination problem for the agents exists, as convergence to one of the equilibria will crucially depend on either initial conditions or agents' choices, which in turn will be affected by their expectations over the quality of the social environment for the old. In the latter case, global indeterminacy occurs, as even though initial conditions are the same, the equilibrium that will be actually reached will depend on individuals' expectation-driven choices. In particular, we find that, under certain conditions, an inverse relationship exists between utility and consumption. As we will see, such a scenario is in line with the well-known 'happiness paradox' affecting affluent societies in the last decades (Easterlin, 1974).

The remainder of the paper is as follows. Section 2 outlines the model. Section 3 illustrates our main results and draws some welfare implications, with special regard to the happiness paradox. Section 4 concludes.

2 The model

We consider a standard overlapping generations (OLG) economy with an infinite time horizon. Time is discrete: $t = 1, 2, 3, ..., \infty$. There exists a continuum of identical individuals who live for two periods and two generations of individuals (the *young* and the *old*) coexist in each period of time t. For

[7] In particular, as we will show in the next section, we suppose that when people are young they have to allocate their time between labor and leisure, and that leisure will be entirely devoted to socially enjoyed activities, i.e. provision and consumption of relational goods. Then, when they get old, they will cease working and allocate their time between private and relational consumption.

the sake of analytical simplicity, we assume that individuals work when they are young and consume the private good produced by the economy when they are old and retire[8]. The private good is produced by a continuum of perfectly competitive firms. In each period t, the representative young individual has to allocate his time endowment that (for analytical convenience) is fixed to 2, between labor L_t (where $2 \geq L_t \geq 0$), remunerated, by the representative firm, at the wage rate W_t, and leisure, identified with socially enjoyed activities, $2 - L_t$. The remuneration $L_t \cdot W_t$ is saved and entirely invested in productive capital K_{t+1} (i.e. $K_{t+1} = L_t \cdot W_t$) that the individual will rent to the representative firm at time $t+1$ at the interest factor R_{t+1}. The resulting amount, $W_t \cdot L_t \cdot R_{t+1}$, allows him to buy and consume the quantity $C_{t+1} = W_t \cdot L_t \cdot R_{t+1}$ of the private good produced by the firm ($W_t \cdot L_t$ and $W_t \cdot L_t \cdot R_{t+1}$ are expressed in unities of the consumption good). Individuals leave no bequests and the population of each generation remains constant. Therefore, in each period t, the young have to make a time allocation decision between working and enjoying social activities.

Such time allocation decisions play a crucial role in the determination of long-term consequences, as we also assume that when individuals get old, they both consume the private good and have access to a public (i.e. non-rival and non-excludable) good provided by a social environment whose quality, S_{t+1}, critically depends on their time allocation decisions made at time t[9]. Specifically, we suppose that $S_{t+1} = G(2 - \overline{L}_t)$, where G is an increasing function and $\overline{L}_t$ is the average time spent in labor activities in the economy. Therefore, S_{t+1} positively depends on $(2 - \overline{L}_t)$, that is the average leisure in the economy. The intuition behind this assumption is simple: we assume that when people get old, their relational opportunities will critically depend on how much time their generation as a whole devoted to (the provision of a public good such as) socially enjoyed leisure when they were young. In other words, in line with Coleman (1990) as well as with Randon et al.'s (2008) dynamic analysis, we suppose that it is past attitudes towards socializing that affect the quality of the social environment today. As we will see in the next section, this dynamic leisure externalities assumption leads to dramatically different long-run outcomes, compared to a scenario where current time allocation decisions do not affect future relational opportunities.

However, though in fact the quality of the social environment for the old critically depends on young agents' time allocation decisions, we also suppose that the young are unable to coordinate with one another and perceive their own individual choices as producing a negligible effect on S_{t+1}. As a consequence, S_{t+1} is taken as exogenously given by them. For example, if I am young and I have to decide whether to work more (and earn more for tomorrow) or spend

[8] This assumption is adopted in several OLG models (see e.g. John and Pecchenino, 1994; Zhang, 1999; Duranton, 2001; Antoci and Sodini, 2009). It simplifies our analysis by abstracting from the consumption-saving decisions.

[9] As far as old people are concerned, Becchetti et al.'s (2008) empirical analysis shows that consuming relational goods has a greater impact on subjective well-being for this category of people.

more time with my friends and/or family, in making this choice today I do not consider the impact this will produce on the quality of my social environment in the future. Hence, the presence or lack of a social environment rich of participation opportunities for the old, that is the level of S_{t+1}, is not to be viewed as the result of a rational investment, but rather as the *by-product* of time allocation decisions made by the agents when they were young[10]. This assumption is in line with a well-known idea in the sociological literature, where it is common to view the creation of interpersonal relationships as a *non-intentional*, external effect of agents' behavior (see, e.g., Coleman, 1990). In line with other OLG models (see, e.g., Antoci and Sodini, 2009), we also suppose that the representative individual, at time t, is able to perfectly foresee the value of S_{t+1} (*perfect foresight*), so that young agents' time allocation decisions will take this information into account[11]. Hence, on the whole, we suppose that even though perfect foresight over the value of S_{t+1} holds, each young agent considers the quality of his future social environment as exogenously given, as the effects of a single individual's time allocation decisions on S_{t+1} are viewed as negligible.

2.0.1 Utility functions

We assume that, unlike the private consumption good, agents consume relational goods both when they are young and when they are old. When agents are young (i.e. at time t), the relational good is given by:

$$R_t = (2 - L_t)^{\beta}(2 - \overline{L}_t)^{1-\beta}$$

where $\beta \in (0,1)$ and $2 - \overline{L}_t$ is average leisure in the economy at time t. As far as the representative agent's utility function is concerned, let us start by considering a very simple specification *à la* Duranton (2001), such as:

$$U(2-L_t, C_{t+1}, 2-\overline{L}_t, S_{t+1}) = \frac{\left[(2-L_t)^{\beta}(2-\overline{L}_t)^{1-\beta}\right]^{1-x}}{1-x} + \frac{B}{1+\theta} \cdot \frac{(S_{t+1}^{\varepsilon} C_{t+1})^{1-\sigma}}{1-\sigma}$$

where $\frac{1}{1+\theta}$ is the discount factor, B is a positive scale parameter that will be used to apply the "normalized steady state" technique; ε, x and σ are positive parameters, with σ, $x \neq 1$.

A key difference between the young and the old is that when agents are old they consume both the private good and the relational good. Let us further observe that both $S_{t+1}$and R_t depend on $2 - \overline{L}_t$. The latter variable directly affects R_t as young agents' utility from (socially enjoyed) leisure depends on how much time other young agents devote to leisure. As far as S_{t+1} is concerned, we pointed out above that the time that young agents devote to leisure affects the quality of the future social environment, in the sense that it plays a crucial role in determining old agents' relational opportunities.

[10] For other dynamic models sharing this behavioral assumption, see e.g. Antoci et al. (2008) and Antoci et al. (2010).

[11] As we will show, this assumption plays a decisive role in the determination of the global indeterminacy outcomes that we obtain.

The parameter ε plays a crucial role here as it captures the importance that individuals associate to the relational dimension[12], whereas the parameter σ denotes the inverse of the intertemporal elasticity of substitution in consumption. Let us note that if $\sigma \in (0,1)$, then C_{t+1} and S_{t+1} are complements, while if $\sigma > 1$ they are substitutes, in that:

$$\frac{\partial^2 U(R_t, C_{t+1}, S_{t+1})}{\partial C_{t+1} \partial S_{t+1}} \lesseqgtr 0$$

for $\sigma \gtreqless 1$. As we will show, assuming *complementarity* vs. *substitutability* between the two goods crucially affects our results. Some studies suggest that it is plausible to view the two goods as complements: for example, when the consumption good is a technology such as high-speed internet, then this will allow individuals to more easily keep contacts with physically distant friends and relatives (e.g. sons and grandchildren living in different cities or countries, in the case of old people). However, other contributions rely on the reasonable assumption that since consuming relational goods is a time-intensive activity, as it calls for personal socializing efforts and requires similar efforts on the part of one's friends and/or relatives, people may opt for time-saving private goods instead. As a consequence, many forms of private consumption will end up crowding-out socially enjoyed leisure[13]. For example, devoting time to watching TV alone may significantly reduce the time that people spend with family and friends (for empirical evidence on this, see again Corneo, 2005 and Bruni and Stanca, 2008). Moreover, it is worth observing that the same two goods such as access to a virtual social network (e.g. Facebook, MySpace or Twitter) and a genuine relational good (e.g. going out with friends on Saturday night) may be either complements or substitutes: insofar as one uses the virtual social network to make real-life contacts more frequent and pleasant (e.g. when two friends are temporarily physically distant), the two goods are complements; by contrast, if the time spent chatting online crowds out the time devoted to true relational goods, the two goods become substitutes. So far, available evidence is mixed: while some recent studies document the prevalence of the former effect (Hampton and Wellman, 2003; Ellison et al., 2007), others find that the latter effect occurs (Burke et al., 2009; Gershuny, 2003)[14].

Analogously, let us also note that if $x < 1$, then L_t and L_t are complements, whereas if $x > 1$, then L_t and L_t are substitutes in that:

$$\frac{\partial^2 U(R_t, C_{t+1}, S_{t+1})}{\partial L_t \partial \overline{L}_t} \lesseqgtr 0 \text{ for } x \gtreqless 1$$

In this case, it is plausible to view L_t and $\overline{L}_t$ as complements, as when a

[12] If $\varepsilon = 0$, we obtain the specification suggested by Duranton (2001), where relationality plays no role.

[13] See again Putnam (2000), on this. For dynamic analyses on the evolution of social participation and social capital where a process of substitution between relational and (market provided) private goods plays a potentially important role, see Antoci et al. (2007), Bartolini and Bonatti (2008) and Antoci et al. (2009; 2011).

[14] See on this Antoci et al. (2011).

young agent's leisure and the average leisure in the economy at time t increase, also my utility increases, due to the relational nature of the good to be consumed. Hence, we will stick to this assumption and suppose that $x < 1$.

The utility function is concave in $2 - L_t$ and C_{t+1}; it is not assumed to be jointly concave in $2 - L_t$, C_{t+1} and S_{t+1} in that in the decentralized competitive market economy which we focus on, the variable S_{t+1} is not a choice variable for each economic agent.

2.1 The productive sector

As we anticipated in the introductory section, we purposely rely on an extremely simple production technology. We assume constant returns to scale. Our representative firm is characterized by the following standard Cobb-Douglas production function:

$$Y = A \cdot F(K_t, L_t) = A \cdot L_t^{1-\alpha} \cdot K_t^{\alpha} = A \cdot L_t \cdot k_t^{\alpha}$$

where $k_t := K_t/L_t$ and A is a positive parameter representing (exogenous) technological progress.

The economy is assumed to be perfectly competitive. Therefore, in each period t, the representative firm maximizes the profit function:

$$A \cdot F(K_t, L_t) - W_t \cdot L_t - R_t \cdot K_t \tag{1}$$

taking the wage rate W_t and the interest factor R_t as exogenously given. As usual, this assumption gives rise to the following first-order conditions:

$$W_t = A \cdot (1 - \alpha) \cdot k_t^{\alpha} \tag{2}$$
$$R_t = A \cdot \alpha \cdot k_t^{\alpha - 1} \tag{3}$$

2.2 The agent's optimization problem

The representative agent maximizes his objective function:

$$\max U(R_t, C_{t+1}, S_{t+1})$$

subject to:

$$C_{t+1} = R_{t+1} \cdot W_t \cdot L_t \tag{4}$$
$$L_t \in [0, 2] \tag{5}$$

In our perfectly competitive economy, W_t and R_{t+1} are considered as exogenously given. Furthermore, as we anticipated above, we assume that the representative individual, at time t, is able to perfectly foresee the value of

S_{t+1} (perfect foresight). However, S_{t+1} is considered as exogenously determined in that the representative individual considers as negligible the impact of his choices on its value.

Under these assumptions, the first order condition for an interior solution of the representative individual's choice problem is:

$$-\frac{\beta\left((2-L_t)^{\beta}(2-\overline{L}_t)^{1-\beta}\right)^{1-x}}{2-L_t}+B\frac{[R_{t+1}\cdot W_t\cdot S_{t+1}^{\varepsilon}]^{1-\sigma}}{(1+\theta)L_t^{\sigma}}=0 \tag{6}$$

By substituting (1) and (2) in (6) we obtain:

$$-\frac{\beta\left((2-L_t)^{\beta}(2-\overline{L}_t)^{1-\beta}\right)^{1-x}}{2-L_t}+B\frac{[\alpha\cdot(1-\alpha)\cdot A^2\cdot k_t^{\alpha}\cdot k_{t+1}^{\alpha-1}\cdot S_{t+1}^{\varepsilon}]^{1-\sigma}}{L_t^{\sigma}}=0 \tag{7}$$

2.3 Equilibrium dynamics

We assume that the stock S at time $t+1$ positively and linearly depends on the average level of (socially enjoyed) leisure at time t, that is:

$$S_{t+1}=2-\overline{L}_t \tag{8}$$

We assume that each economic agent considers $\overline{L}_t$ as exogenously determined. However, since we also suppose that economic agents are identical (homogeneous population), ex-post $\overline{L}_t=L_t$ holds. The choices of the representative individual are not optimal and S_{t+1} is a positive externality. However, the orbits followed by the economy are Nash equilibria, in that no single individual has interest to modify his choices if also the others avoid to revise theirs.

By plugging (8) in (7) and taking into account that, by (2), it holds:

$$K_{t+1}=L_{t+1}\cdot k_{t+1}=L_t\cdot W_t=L_t\cdot A\cdot(1-\alpha)\cdot k_t^{\alpha} \tag{9}$$

The dynamic system representing the dynamics of the economy is:

$$-\frac{1+\theta}{(2-L_t)^{x}}\beta+B\frac{[\alpha\cdot(1-\alpha)\cdot A^2\cdot k_t^{\alpha}\cdot k_{t+1}^{\alpha-1}\cdot(2-L_t)^{\varepsilon}]^{1-\sigma}}{L_t^{\sigma}}=0 \tag{10}$$

$$k_{t+1}\cdot L_{t+1}=A\cdot(1-\alpha)\cdot k_t^{\alpha}\cdot L_t \tag{11}$$

3 Results

In this section, we outline the major results of our dynamic analysis and draw some welfare implications, with special regard to the *happiness paradox*.

3.1 Geometrical methods

The system (10)-(11) defines k_{t+1} and L_{t+1} as functions of k_t and L_t. In this section, we study the stability of the fixed points of such a discrete dynamic system. Since our model contains a large number of parameters, for clarity reasons we use the geometrical-graphical method developed by Grandmont et al. (1998), which allows us to characterize the stability properties of the fixed points of our dynamic system. We impose some conditions on parameters under which a fixed point (k^*, L^*) with $k^* = L^* = 1$ exists. This allows us to analyze the effects on stability due to changes in parameters' values being sure that the fixed point does not disappear.

Requiring that $k^* = L^* = 1$ (by (10)-(11)), we obtain the following conditions on parameters' values:

$$A = A^* := \frac{1}{1-\alpha},\ B = B^* := \beta(\theta+1)\left(\frac{\alpha}{1-\alpha}\right)^{\sigma-1} \tag{12}$$

Using conditions (12), the dynamic system (10)-(11) can be explicitly written as:

$$k_{t+1} = V(k_t, L_t) := \left[\frac{(2-L_t)^{x+\varepsilon(1-\sigma)} k_t^{\alpha(1-\sigma)}}{L_t^\sigma}\right]^{\frac{1}{(1-\alpha)(1-\sigma)}} \tag{13}$$

$$L_{t+1} = Q(k_t, L_t) := L_t \cdot k_t^\alpha \cdot \left[\frac{L_t^\sigma}{(2-L_t)^{x+\varepsilon(1-\sigma)} k_t^{\alpha(1-\sigma)}}\right]^{\frac{1}{(1-\alpha)(1-\sigma)}} \tag{14}$$

where (k_t, L_t) belongs to the set:

$$D = \left\{(k_t, L_t) \in R^2 : k_t > 0,\ 0 < L_t < 2\right\}$$

Notice that $k = 1$ always holds at the fixed points of system (13)-(14) (see (9)), while the fixed point values of L are given by the solutions of the equation:

$$g(L) := \left[\frac{(2-L_t)^{x+\varepsilon(1-\sigma)}}{L_t^\sigma}\right]^{\frac{1}{(1-\alpha)(1-\sigma)}} = 1 \tag{15}$$

Obviously, $L = 1$ is a solution of such equation. The following proposition can be easily checked.

Proposition 1 *When $\sigma < 1$, the normalized fixed point (k^*, L^*), with $k^* = L^* = 1$, is the unique fixed point of system (13)-(14). If $\sigma > 1$, two configurations may occur: the normalized fixed is the unique fixed point of system (13)-(14) if and only if $\varepsilon < \frac{\sigma-x}{\sigma-1}$. Otherwise there exists another fixed point $(1, L^{**})$ with $L^{**} < 1$ (respectively, $L^{**} > 1$) if $\varepsilon(1-\sigma)+x+\sigma < 0$ (respectively, $\varepsilon(1-\sigma)+x+\sigma > 0$).*

Proof. With straightforward computation we find that:

$$sign\,[g'(L)] = sign\left[\frac{-L\,[x-\sigma+\varepsilon(1-\sigma)]-2\sigma}{1-\sigma}\right]$$

The expression in parentheses on the *r.h.s.* is linear, thus g' may change sign at most one time. If $\sigma < 1$, then $\lim_{L\to 0} g(L) = 0$, and $\lim_{L\to 2} g(L) = +\infty$. It follows that the graph of g cuts the horizontal line 1 at a unique point with abscissa $L = 1$. If $\sigma > 1$, then $\lim_{L\to 0} g(L) = 0$, while $\lim_{L\to 2} g(L)$ depends on the sign of $x-\sigma+\varepsilon(1-\sigma)$.Specifically, $\lim_{L\to 2} g(L) = +\infty \Longleftrightarrow x-\sigma+\varepsilon(1-\sigma) > 0$, while $\lim_{L\to 2} g(L) = 0 \Longleftrightarrow x-\sigma+\varepsilon(1-\sigma) < 0$. In the former case, g is a strictly increasing function, while, in the latter g is a unimodal function and the related graph cuts the horizontal line 1 even at another point. Evaluating the sign of $g'(1)$ we complete the proof. ∎

3.2 Stability of the normalized fixed point and local indeterminacy

As specified above, the variables K_t and L_t in (13,14) play different roles: productive capital K_t is a state variable, so its initial value K_0 is given while the variable L_t is a *jumping* variable in that it measures the representative individual's labor input, chosen taking into account of the average labour input in the economy. Consequently, individuals have to choose the initial value L_0 (and consequently the initial value of $k_t = K_t/L_t$). If the normalized fixed point is a saddle and K_0 is near enough to 1, then there exists a unique initial value of L_t, L_0, such that the orbit passing through (k_0, L_0) approaches the saddle point. When the fixed point is a sink, given the initial value K_0, then there exists a continuum of initial values L_0 such that the orbit passing through (k_0, L_0) approaches it. Consequently, the orbit the economy will follow is 'indeterminate', in that it depends on the choice of the initial value L_0.

The Jacobian matrix of (13)-(14), evaluated at the normalized fixed point, is:

$$J = \begin{pmatrix} \frac{\alpha}{1-\alpha} & \frac{-x-\varepsilon-\sigma+\sigma\varepsilon}{(1-\sigma)(1-\alpha)} \\ \frac{-\alpha^2}{(1-\alpha)} & \frac{-\alpha+1+x+\sigma\alpha+\varepsilon-\varepsilon\sigma}{(1-\sigma)(1-\alpha)} \end{pmatrix}$$

with:

$$Tr(J) = \frac{1+x}{(1-\alpha)(1-\sigma)} + \frac{\varepsilon}{(1-\alpha)} \tag{16}$$

$$Det(J) = \frac{\alpha(1+x)}{(1-\alpha)(1-\sigma)} + \frac{\alpha\varepsilon}{(1-\alpha)} \tag{17}$$

Let us note that, ceteris paribus, varying the parameter ε, the point (see equations (17)-(16)):

$$(P_1, P_2) := \left(\frac{1+x}{(1-\alpha)(1-\sigma)} + \frac{\varepsilon}{(1-\alpha)}, \frac{\alpha(1+x)}{(1-\alpha)(1-\sigma)} + \frac{\alpha\varepsilon}{(1-\alpha)} \right)$$

describes in the plane $(Tr(J), Det(J))$ a half-line T_1 with slope α $(0 < \alpha < 1)$ (see Figures 1.a and 1.b) starting from the point (obtained posing $\varepsilon = 0$ in (17)-(16):

$$(\overline{P}_1, \overline{P}_2) := \left(\frac{1+x}{(1-\alpha)(1-\sigma)}, \frac{\alpha(1+x)}{(1-\alpha)(1-\sigma)} \right) \tag{18}$$

If $\sigma > 1$, then $(\overline{P}_1, \overline{P}_2) \to (-\infty, -\infty)$ for $\alpha \to 1$ and $(P_1, P_2) \to (+\infty, +\infty)$ for $\varepsilon \to +\infty$

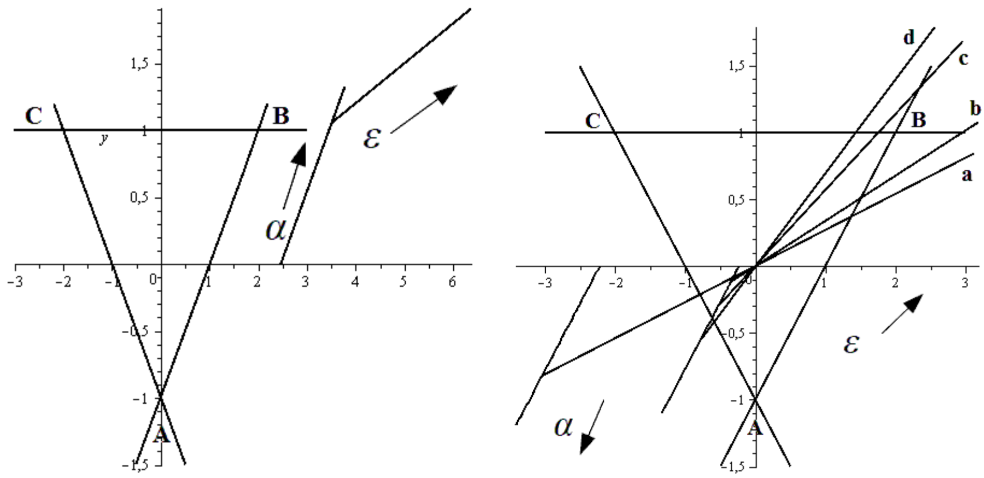

Figure1: *a) Case $\sigma \in (0,1)$: The private consumption C and the relational consumption S are complements: the steady state in unique and there exists a unique path converging to the stationary equilibrium; b) case $\sigma > 1$: C and S are substitutes. Varying ε, ceteris paribus, the normalized fixed point may be (locally) indeterminate or determined. Furthermore it may undergo a supercritical flip bifurcation (when the half-line P cuts the segment AC) as well as a supercritical Neimark Sacker bifurcation (when the half-line P cuts the segment BC). A stability change occurs when the half-line P cuts the segment AB.*

Then the following results generically hold[15]:

Proposition 2 *Let* $\varepsilon_{trans} := \frac{\sigma+x}{\sigma-1}$, $\varepsilon_{flip} := \frac{2+x(1+\alpha)-\sigma(1-\alpha)}{(1+\alpha)(\sigma-1)}$, $\varepsilon_{n.s.} := \frac{\alpha(2+x)+\sigma(1-\alpha)-1}{(\sigma-1)\alpha}$. *If $\sigma \in (0,1)$, then the unique fixed point is a saddle-point, thus there exists a*

[15] Some regularity conditions on derivatives of the map have to be fulfilled in order to avoid degenerate bifurcations.

unique path converging to it.
Let $\sigma > 1$, the following cases are possible:

1. If $\max\left(0, \frac{(\sigma - x - 2)}{x+\sigma}\right) < \alpha < \frac{1}{2}$, then the normalized fixed point (k^*, L^*) is initially (for $\varepsilon = 0$) a saddle. When ε increases, it becomes a sink via a supercritical flip bifurcation occurring for $\varepsilon = \varepsilon_{flip}$; a further increase in ε leads to transcritical bifurcation for $\varepsilon = \varepsilon_{trans}$ according to which it becomes a saddle-point and an other attractive fixed point arises (see the half-line a in Figure 1.b).

2. If $\alpha < \min(\frac{1}{2}, \frac{(-2-x+\sigma)}{x+\sigma})$, then the normalized fixed point (k^*, L^*) is initially (for $\varepsilon = 0$) a sink; when ε increases, it undergoes a supercritical flip bifurcation for $\varepsilon = \varepsilon_{flip}$ according to which it becomes a saddle-point and another attractive fixed point arises (see the half-line b in Figure 1.b).

3. If $\frac{1}{2} < \alpha < \frac{(-2-x+\sigma)}{x+\sigma}$, then the normalized fixed point is initially a sink; when ε increases, it undergoes a supercritical Neimark Sacker bifurcation for $\varepsilon = \varepsilon_{n.s}$ according to which it becomes a source and an attracting invariant curve (a closed curve mapped onto itself) appears (see the half-line b in Figure 1.b). For greater values of ε it becomes a saddle.

4. If $\alpha > \max(\frac{1}{2}, \frac{(-2-x+\sigma)}{x+\sigma})$ (see Figure 1.b), then the normalized fixed point (L^*, k^*) is initially (for $\varepsilon = 0$) a saddle. When ε increases, it becomes a sink via a supercritical flip bifurcation for $\varepsilon = \varepsilon_{flip}$; if ε increase further, it undergoes to a supercritical Neimark Sacker bifurcation for $\varepsilon = \varepsilon_{n.s.}$ according to which the normalized fixed point becomes a source and an attracting invariant curve (a closed curve mapped onto itself) appears (see the half-line b in Figure 1.b). For larger values of ε it becomes a saddle.

Proof. In order to obtain the bifurcation values, it is sufficient to find the values of the parameter ε such that the point (P_1, P_2) belongs to sides of the triangle. Then, we characterize the various cases in the Proposition by considering the position of the point $(\overline{P}_1, \overline{P}_2)$ and the slope of the half-line T_1. The nature of the bifurcation (subcritical or supercritical) is obtained by simulations. ■

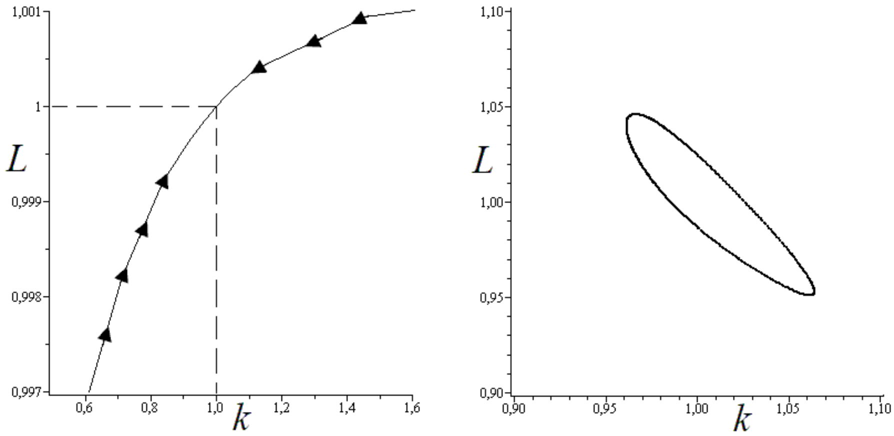

Figure 2: *a) Parameter values:* $\alpha = 0.14$, $\varepsilon = 1.4$, $\sigma = 0.5$, $x := 0.99$*; the normalized fixed point is a saddle: a unique trajectory converges to it. b) Parameter values:* $\alpha = 0.7$, $\varepsilon = 5.405$, $\sigma = 1.4$, $x := 0.99$*; the normalized fixed point is a source and a closed invariant curve surrounds it: the long-run dynamics are quasiperiodic.*

The study of the bifurcation diagram corroborates the usual result in OLG models with endogenous labour-supply (see, among others, De Vilder 1996, Antoci et al. 2009) that starting from the flip bifurcation, other flip bifurcations occur according to which cycles of periods $4, 8, ..., 2^n$ arise until the rise of a strange attractor (*period-doubling route to chaos*). This result may be obtained around the normalized steady state as well as in the neighborhood of the other one.

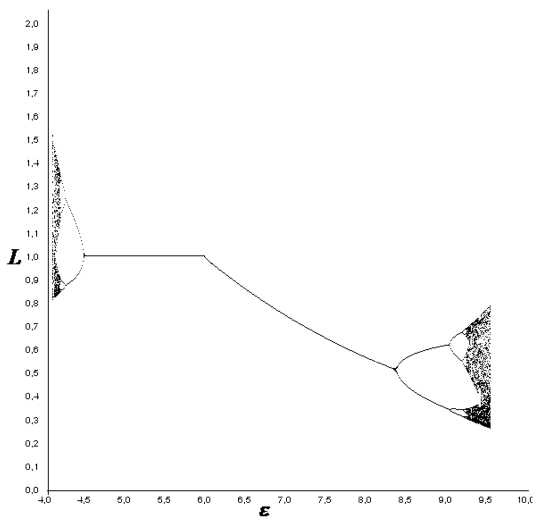

Figure 3: *Parameter values:* $\alpha = 0.35$ $\sigma = 1.4$*,* $x := 0.99$*; Varying* ε we can observe two sequences of flip bifurcations, that generate strange attractors.

3.3 Global analysis of the basin of attraction

From a mathematical point of view it is interesting to study some global properties of the map. In this section we will show that the map is non-invertible and some global bifurcations may be explained by the folding action of the map on the plane. In particular, the global bifurcations, also called 'contact bifurcations' (see e.g. Mira et al., 1996), arising when the frontier of a basin or the boundary of an attractor has some contact with the critical lines of the map, induce important changes in the topological structure of the basin (in the former case) or in the attractor (in the latter case). This happens because the critical lines separate zones of the plane whose points have a different number of rank-1 preimages and then, after the occurrence of each contact, a set, say H, of points of a basin (or of an attractor) belongs to a different zone. Then the points of the set H have a different number of rank-1 preimages, that is, preimages may either appear or disappear. These preimages, which display the same asymptotic behavior as the points of H, may be located far from H, creating, for example, new disconnected components of a basin or holes in some old basin, thus causing the transition of a basin into a disconnected or a multiply-connected set.

In order to study the invertibility of the map analyzed in our paper, we have to find the preimages of a given point (k_{t+1}, L_{t+1}), that is, we need to look for the solutions with respect to the unknowns k_t and L_t of the dynamic system (13)-(14).

Let us observe that the system is equivalent to (plugging the expression of k_t from (13) into (14)):

$$k_t = k_{t+1}^{1-\alpha} \left(\frac{(2-L_t)^{\sigma(1-\varepsilon)+x}}{L_t^{\sigma}} \right)^{\frac{1}{\alpha(\sigma-1)}} \tag{19}$$

$$z(L_t) = \left(L_{t+1} k_{t+1}^{\alpha} \right)^{\sigma-1} \tag{20}$$

where:

$$z(L_t) := \frac{(2-L_t)^{x+\varepsilon(1-\sigma)}}{L_t} \tag{21}$$

The key role for the invertibility of our map is played by the number of solutions of equation (20): given the value of L_t, from (19), we find the corresponding values of k_t. From a direct study of the function z defined in (21), we have that if $\sigma < 1$, then z is surjective on R_+.That is, given two arbitrary nonnegative values of L_{t+1} and k_{t+1}, we find exactly a value of L_t. Hence, the map is invertible.

Otherwise, if $\sigma > 1$, the value of the parameter ε plays a fundamental role: if $\varepsilon < \frac{x}{\sigma-1}$, then z is decreasing in L_t in the interval $(0, +\infty)$ and the map is still invertible while, if $\varepsilon > \frac{x}{\sigma-1}$, then z is unimodal and admits a minimum at $L_{\min} = \frac{2}{\varepsilon(\sigma-1)+1-x}$:

$$z(L_{\min}) = M := \frac{1}{2}\left(2 - \frac{2}{\varepsilon(\sigma-1)+1-x}\right)^{x+\varepsilon(1-\sigma)} [\varepsilon(\sigma-1)+1-x]$$

The map has two different preimages if $L > \frac{M^{\frac{1}{\sigma-1}}}{k^{\alpha}}$ and zero preimages if $L < \frac{M^{\frac{1}{\sigma-1}}}{k^{\alpha}}$. Thus we deduce that the map is of the so-called $Z_0 - Z_2$ *type*, that is the plane is divided into two regions: $Z_{2,}$ where a point has two real rank-one preimages and Z_0, where a point has no real rank-one preimages. Z_2 may be viewed as made up of two sheets: one related to the first preimage, the other related to the second one. The two sheets join at a critical curve LC, which is a locus of points having two coincident preimages on the curve LC_{-1}.

From the previous analysis it follows that:

$$LC : L = \frac{M^{\frac{1}{\sigma-1}}}{k^{\alpha}}$$

Since the map is continuously differentiable, the (folding) set LC_{-1} can be obtained numerically as the locus of points (k_t, L_t) for which the Jacobian determinant vanishes:

$$LC_{-1} = \left\{(k_t, L_t) \in R^2 : \det(J(k_t, L_t)) = 0\right\}$$

With simple calculations, we have that:

$$LC_{-1} : L = \frac{2}{(\sigma-1)\varepsilon + 1 - x}$$

The line LC_{-1} divides the plane in two regions, R_1 and R_2, the first one with a positive determinant (orientation preserving), the second one with a negative determinant (orientation reversing).

Lemma 3 *The Jacobian of the map vanishes along* $L = \frac{2}{(\sigma-1)\varepsilon+1-x}$.

Proof. First, let us note that the system (13) into (14) can be expressed as follows:

$$k_{t+1} = V(k_t, L_t)$$
$$L_{t+1} = \frac{L_t k_t^{\alpha}}{V(k_t, L_t)}$$

where $V(k_t, L_t)$ is defined in equation (13). Consequently, the Jacobian matrix is given by:

$$Q := \begin{pmatrix} V'_{k_t} & V'_{L_t} \\ \frac{\alpha\frac{k_t^{\alpha}}{k_t}V(k_t,L_t)L_t - V'_{k_t}L_t k_t^{\alpha}}{V^2(k_t,L_t)} & \frac{k_t^{\alpha}V(k_t,L_t) - V'_{L_t}L_t k_t^{\alpha}}{V^2(k_t,L_t)} \end{pmatrix} =$$

$$= \begin{pmatrix} V'_{k_t} & V'_{L_t} \\ k_t^{\alpha}L_t\frac{\alpha\frac{V(k_t,L_t)}{k_t} - V'_{k_t}}{V^2(k_t,L_t)} & k_t^{\alpha}L_t\frac{\frac{V(k_t,L_t)}{L_t} - V'_{L_t}}{V^2(k_t,L_t)} \end{pmatrix}$$

with the determinant:

$$Det(Q) := \frac{k_t^{\alpha} L_t}{V^2(k_t, L_t)} \left[V'_{k_t} (\frac{V(k_t, L_t)}{L_t} - V'_{L_t}) - V'_{L_t} \left(\alpha \frac{V(k_t, L_t)}{k_t} - V'_{k_t} \right) \right] \quad (22)$$

It follows that $Det(Q) = 0$ on the set D if and only if the expression in brackets of (22) vanishes. Rearranging,

$$Det(Q) = 0 \Longleftrightarrow V'_{k_t} k_t - \alpha L_t V'_{L_t} = 0$$

Straightforward calculations complete the proof. ■

In the following numerical experiment, let us pose $\alpha = 0.43$, $\sigma = 1.4$, $x = 0.998$. For $\varepsilon = 5$, the normalized fixed point $(1, 1)$ is attractive and the basin of attraction of $(1, 1)$ is also shown, which is bounded by a smooth frontier, made up by the stable set of the saddle P (see Figure 4.a). As ε grows, LC tends to shift towards south-west. In Figure 4.b we show a contact bifurcation: a portion of the frontier has a contact with the critical curve LC, and crosses it, leaving a region H_0 whose points have a different fate (they do not belong to the considered basin). But H_0 belongs to the region Z_2 and thus has two distinct rank-1 preimages which together form a hole H_1 inside the old basin. Then this area H_1 has a sequence of preimages inside the old basin, and all such areas are holes of points having a different fate. So a simply connected basin is transformed into a multiply-connected basin. As this process goes on, the holes tend to get together and to generate some islands which break the basin of attraction and give rise to some disconnected components (see Figure 4.c). A further increase of the parameter ε generates a reversal of this process and the islands tend to join again and the basin of attraction tend to become connected again (see Figure 4.d).

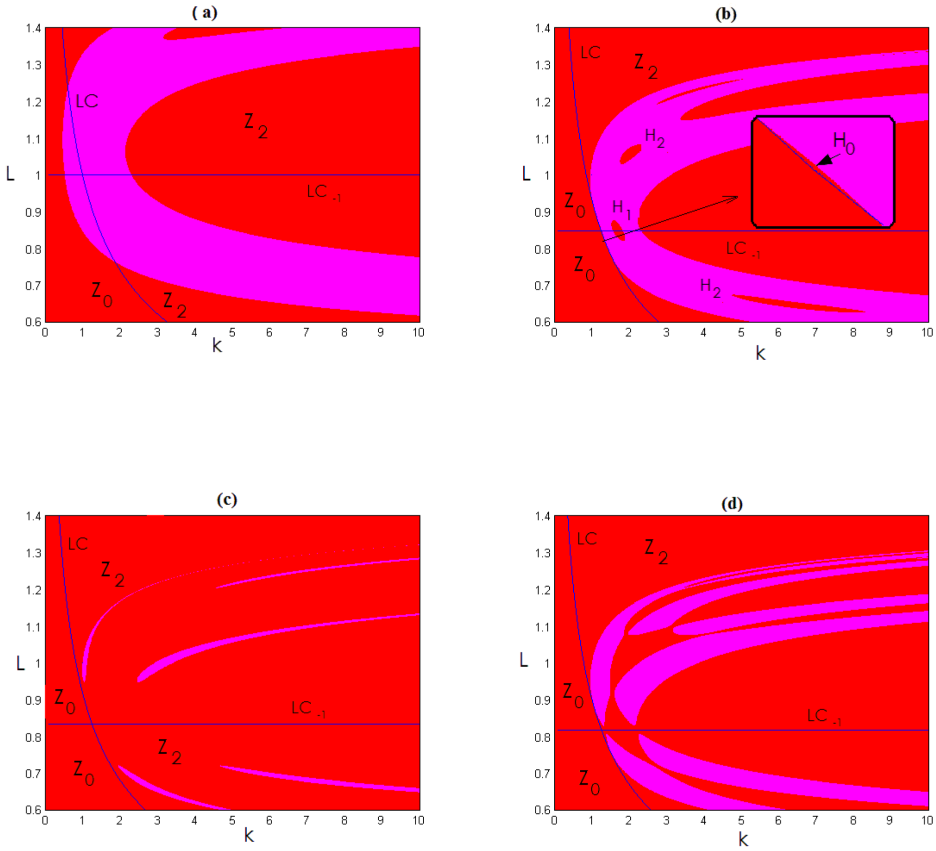

Figure 4: *The morphology of the basin of attraction of* $(1,1)$ *for different values of the parameter* ε*: a)* $\varepsilon = 5$*, The basin of attraction of (1,1) is connected; b)* $\varepsilon = 5.889$*, the basin of attraction is characterized by holes; c) for* $\varepsilon = 6$ *the basin of attraction is made up by disconnected components; d)* $\varepsilon = 6.1052$ *the process goes toward the formation of a new connected basin of attraction around the no normalized steady state.*

Beyond the mathematical interest, this phenomenon has an important economic implication: when holes characterize the domain of attraction of the normalized fixed point, the dimension of the (local) indeterminacy tends to decrease. In fact, because of the dynamic property of the map, portions of the phase plane are ruled out by the basin of attraction of $(1,1)$. Thus, given the value k_t, some levels of L_t are no more consistent and the coordination may arise only on one of the values in the basin of attraction of (1,1).

Furthermore, the non invertibility play an important role in the evolution of the Neimark Sacker bifurcation. We avoid to give a detailed description of the phenomenon (see for example Abraham et al. 1997) , anyway, if we start from the bifurcation value $\varepsilon_{n.s.}$ and we let ε increase, the dynamics become less regular because the invariant curve has a contact to the critical curve LC_{-1} and this collision induces a wavy shape of Γ (see Figure 5).

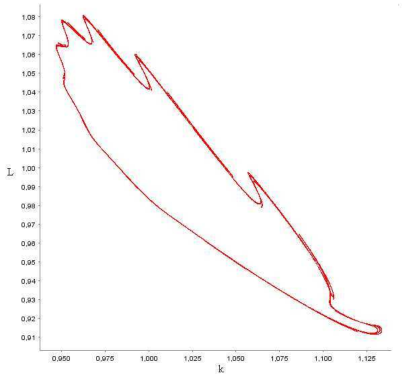

Figure 5: *Parameter values:* $\alpha = 0.7$, $\varepsilon = 5.425$, $\sigma = 1.4$, $x := 0.99$. The invariant curve after the collision with the critical curve LC_{-1}.

3.4 Welfare analysis

What are the welfare levels associated to our multiple equilibria, within the decentralized economy under study? Are they Pareto-rankable? Let us recall that agents' utility depends on three major components: their leisure when they are young, their consumption level and quality of social environment when they are old. Therefore, in principle, a trade-off exists between working and enjoying leisure for the young: working more means more consumption when they are old and, therefore, (ceteris paribus) a higher utility. However, working more at time t also implies less leisure for the young and a poorer social environment at $t+1$; this leads (ceteris paribus) to a lower utility level. What is the prevailing effect? Let us focus on the more interesting case, that is, the scenario where the private and the relational goods are substitutes ($\sigma > 1$) and the relevance assigned to the quality of the social environment is high (i.e. $\varepsilon \geqslant \frac{\sigma - x}{\sigma - 1}$). In such a context, the normalized fixed point $(L,k) = (1,1)$ (which is a saddle) and an attractive fixed point $(L,k) = (L^{**},1)$, with $L^{**} < 1$, coexist; agents can coordinate their choices to converge either to $(1,1)$ or to $(L^{**},1)$.

In Figure 6 we show the time evolution of utility levels evaluated along two trajectories starting from the same initial level of k ($k_0 = 0.4908$). Each point of the paths illustrated in Figure 6 represents the utility levels of the generation of individuals born at time t[16]. The path characterized by lower utility levels

[16]For example, at $t = 1$ we find the utility level of the generation of individuals young at $t = 1$, which is given by the sum of the utility deriving from leisure at $t = 1$ and from consumption and socially enjoyed leisure when they are old, discounted according to the

is associated to the trajectory (with $L_0 = 0.9812$) approaching the saddle $(1, 1)$ while the other refers to a trajectory (with $L_0 = 0.97$) starting from the basin of attraction of the sink $(L, k) = (0.9697, 1)$.

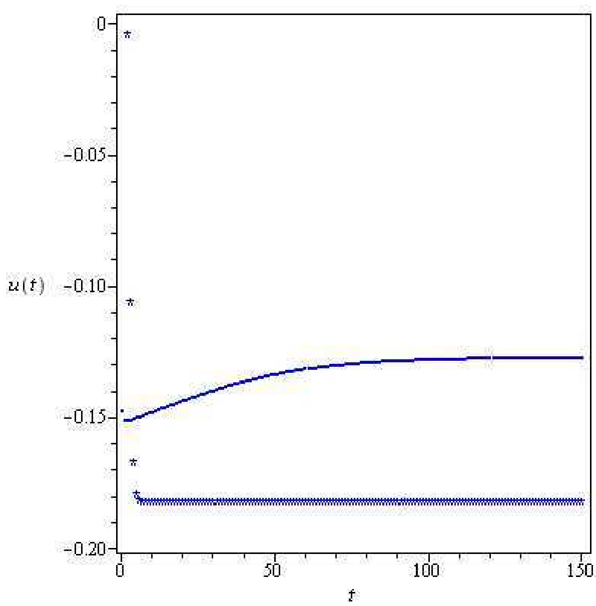

Figure 6: *The time evolution of the utility levels evaluated along two trajectories approaching the saddle* $(1, 1)$ *and the sink* $(L, k) = (0.9697, 1)$.

Being $k = K/L$, the fixed point $(L, k) = (0.9697, 1)$ is characterized by lower levels of labour input L and capital accumulation K with respect to fixed point $(L, k) = (1, 1)$. So, the latter fixed point is a *social poverty trap* in the sense of Antoci et al. (2007) characterized by higher (w.r.t. $(L, k) = (0.9697, 1)$) levels of private consumption and capital accumulation and by lower levels of relational consumption and welfare.

Our model sheds light on the well-known *happiness paradox* which seems to characterize contemporary affluent economies. In particular, it offers a dynamic explanation of this paradox based on the crucial role played by young agents' time allocation decisions. The 'bowling alone' phenomenon described by Putnam with regard to the social trend characterizing the American society in the last decades of the twentieth century can be viewed as an unintended but inevitable consequence of the time allocation decisions[17].

discount factor $\frac{1}{1+\theta}$.

[17] In the last thirty years, the US experienced an increase in hours worked per adult. Bilancini et al. (2011) show that two stylized facts such as a decline in both reported happiness and social capital in the US are significantly connected at the individual level. Costa and Kahn (2003) and McPherson et al. (2006) confirm the occurrence in this country of a significant declining trend for some key relational variables.

We find a similar, though in this case *transitory* (see Figure 7), result when we consider two trajectories both converging to the sink $(L, k) = (0.9697, 1)$. Also here, we see that there is a *transient* where more work implies a reduction in welfare: the red line, associated to $L_0 = 0.975$, is clearly below the blue line.

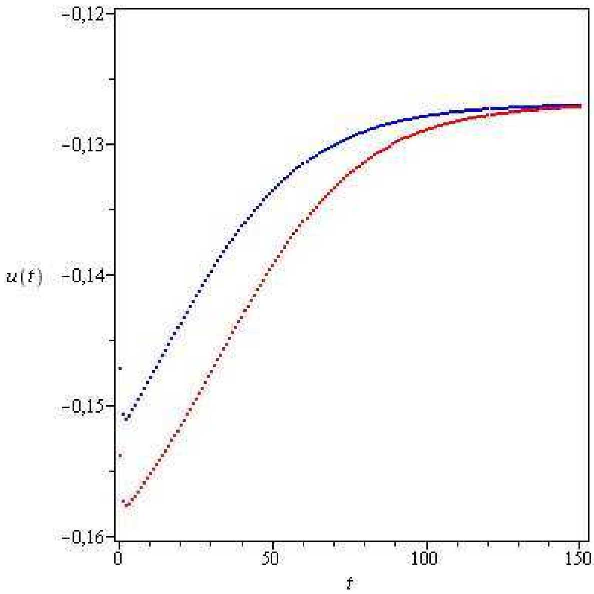

Figure 7: *The time evolution of utility levels evaluated along two trajectories approaching the sink* $(L, k) = (0.9697, 1)$.

4 Concluding remarks

A growing literature in economics, social psychology and sociology has been emphasizing the crucial role that, within affluent, contemporary economies, relational consumption plays in affecting individuals' time allocation decisions (between labor and leisure) as well as their subjective well-being (see on this Becchetti et al., 2008). Due to a series of complex socio-economic and cultural reasons - such as a growing pressure on time (Antoci et al., 2008), the diffusion of television (Putnam, 2000) as well as women's increased labor force participation rate (Costa and Kahn, 2003) -, a significant substitution process has been taking place in the developed world starting from the '70s: people tend to reduce their socially enjoyed leisure and increasingly replace (non-market) relational goods with market provided, private goods (see on this also Frey and Stutzer, 2005). This process also possesses a *self-enforcing* nature: since buying some private goods (e.g. luxury goods) is often expensive[18], people work even

[18] It is worth adding that this process is also supply-driven, as in affluent societies advertising campaigns significantly contribute to reinforce people's tendency to over-consume market provided private goods in general and so called *positional goods* (driven by status concerns)

more (and consume even less relational goods) today to afford more and better private goods tomorrow. By so doing, they act myopically, by neglecting the impact of short-term choices on their long-term subjective well-being, as under-consuming relational goods today implies living in a poorer and less rewarding social environment both today and tomorrow. As we observed above, the occurrence of such dynamic leisure externalities help us shed light on the (inherently dynamic) happiness paradox which has been characterizing advanced economies in the last decades (see on this Easterlin, 1974).

In this paper, we showed that introducing the relational dimension into an OLG framework leads to dramatically different predictions, in terms of possible dynamic scenarios, compared to standard specifications of the same model. Our analysis reveals that a far richer dynamics takes place when socially enjoyed activities play a role for both the young (in their time allocation decisions) and the old. Specifically, we found that when the old perceive private and relational consumption as substitutes (rather than as complements), new dynamic outcomes - such as local indeterminacy, non-linear phenomena (including chaotic dynamics) and even multiple equilibria with global indeterminacy - may arise. Hence, the economy may end up in a 'hedonic poverty' trap ultimately due to people's decisions to allocate too much time to labor and private goods consumption and under-consume relational goods. Initial conditions and young agents' evaluation of the quality of the social environment in the future play a decisive role in the determination of these results. It is crucial to make clear that all this becomes a possibility insofar as we incorporate relational consumption into the overall framework, without any need to suppose that exogenous shocks occur or specific stochastic processes take place in the economy. In other words, properly considering the role of relational goods and their (intergenerational) impact on the quality of the social environment ends up opening new dynamic possibilities, with more instability than in the standard framework where relationality plays no role and individuals are supposed to exclusively care about private material goods.

in particular.

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