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Love Thy Neighbor:
Bonding versus Bridging Trust

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Love Thy Neighbor: Bonding versus Bridging Trust*

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Abstract: We study how trust is generated in society. In a two-sector model, we analyze two communities. In the bonding community people do not trust people outside their regular networks. In the bridging community people choose to trust strangers when they meet them. The hypothesis is that when trust is only bonding, it cannot accumulate. Our theoretical contribution is to show that when trust is only bonding then the economy's level of trust moves to an unstable equilibrium that may under certain conditions fluctuate forever. If, however, trust is also bridging, then trust will accumulate. Future research should seek to establish the appropriate institutional framework for establishing the optimal mix between both bonding and bridging social capital in society.

JEL classification: A12, C61, D90, O41.

Keywords: Trust, two-sector model, chaos.

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1 Introduction

Our purpose in this paper, is to model the empirical claim in Putnam (2000), namely the distinction between 'bridging' and 'bonding' social capital – i.e., inclusive and exclusive types of social capital. Social capital is defined as 'the ability of people to work together for common purposes in groups and organizations' and may more specifically be defined as 'trust' (Coleman 1988)[1]. Trust is a narrower definition of social capital, which focuses on reciprocity. Trust is the expectation that arises within a community of regular, cooperative behavior, based on commonly shared norms[2].

In the following, we use his distinction specifically in relation to the main aspect of social capital, namely trust. Thus, when we speak of 'bridging' trust, we mean open networks that are 'outward looking and encompass people across diverse social cleavages'. In contrast, when we speak of bonding' trust, we refer to monopolistic-like and 'inward looking' networks that 'tend to reinforce exclusive identities and homogeneous groups' (Putnam 2000: 22). The claimed erosion of the American stock of trust is the main theme in Putnam's latest book, Bowling Alone (2000). Indeed, one may perceive the book as an impressive collection of statistical evidence, which is verified by numerous cases. This 'degradation of our public life' is reflected in a significant decline in political participation, church attendance, union work, the frequency of informal social relations, voluntary engagement in cultural life and so on (Putnam 2000: 403). Putnam questions the one-sided focus on positive trust (see especially Portes and Landolt 1996 and Portes 2000 for a critique). Here, he recognizes that trust is often created in opposition to something or somebody else (Putnam 2000: 361). In other words, negative trust of an excluding nature may arise in the form of excessive 'bonding trust', as found, for example, within certain religious networks.

This is not to say that society holds either bridging or bonding trust, exclusively. Bonding trust exists, for example, among close friends or relatives. However, the economic problem arises if the optimal balance between the stocks of bridging and bonding trust in a society is disturbed by 'too much' bonding trust without the presence of bridging trust as well. For example, bonding trust may arise within different ethnic groups. In this context, Putnam (2000: 340) remarks that a case very often referred to in the United States is that of the Ku Klux Klan. Another example is that of Italy, where bonding trust is thriving

[1] Various social capital overviews have been undertaken, see for example Boix and Posner 1998; Portes 1998; Woolcock 1998; Sobel 2002; Bjørnskov 2005; Ostrom and Ahn, 2000).

[2] The social norms can be based on religious or justice values but they also cover secular norms like professional standards and codes of behavior. These norms are created and transmitted through cultural mechanisms. The word 'culture' itself suggests that the ethical rules by which people live are nurtured through repetition, tradition and example. Therefore, human beings will never behave as purely selfish utility maximizers as postulated by economists. (For a critique of neoclassical economy, see Granovetter 1985 and Poulsen and Svendsen, 2004); for economic rationality discussions, see e.g. Becker 1996; Olson 1982, 1993, 1996, 2000; Green and Shapiro 1994; Fukuyama 1995a, 1995b; and Kurrild-Klitgaard and Svendsen 2003.)

among mafia groups in the South, resulting in nepotism and corruption, whereas strong civil traditions and bridging trust prevail in the North (Putnam 1993).

Greif (1989), on the other hand, argues that network closure (i.e. bonding trust in our setting) was critical to the success of the medieval Maghribi traders in North Africa. Each trader ran a local business in his own city that depended on sales to distant cities. The presence of bonding trust among the traders allowed them to coordinate so as to trust one another, and so profitably trade the products of their disparate business activities (cited from Burt, 2001: 51). Several recent studies report high economic performance from groups with external, i.e. bridging trust, than span structural holes, e.g. within business performance patent output in joint ventures (see Burt, 2001 for a review).

Overall, the point here is that in a complex society, it is extremely important to possess bridging trust elements enabling contact with people of different background and experience, that is, a group of people who demand less engagement than family and close friends. Where this is not the case, a group can risk becoming isolated, as in certain black urban neighborhoods, where industry and white middle-class families "have left the remaining population bereft of trust, a situation leading to its extremely high levels of unemployment and welfare dependency" (Portes 1998: 14). This leads us to what Portes calls 'negative social capital', and what Putnam (2000) calls 'bonding social capital'. The monitoring, which takes place in certain local communities, and which results in a binding and forced solidarity, has a positive function of social control. However, it may also have a negative effect on the individual in so far as it limits freedom of action. In this connection, Jeremy Boissevain reports on a village community on Malta, where neighbors know everything about everyone, and where the demand for participation in joint activities ultimately leads to a demand for conformity. The curtailed freedom of action, which follows from this, can help explain "why the young and the more independent-minded have always left" (Boissevain, in Portes 1998: 16). The networks can also assume a direct exclusionist and negative character. Beyond monopolization, this may also lead to a group more or less consciously isolating itself from its surroundings. An example is the Puerto Rican drug dealers in New York, who do everything to keep one another within the drug milieu, to the extent that it would be treason to mix with the whites in an attempt at social upward mobility (Portes 1998: 17), see Svendsen and Svendsen (2004).

Of course, different religious beliefs, for example, may differ so much that it is hardly possible to establish bridging trust. Such seemingly insurmountable religious/cultural barriers can clearly be identified in India, for example, with its violent and relentless conflicts. Also, following September 11, a vast majority of Americans (and Western Europeans in general) would not be willing to trust members of the Al Qaeda network or political leaderships hosting terrorist groups. Thus, an important observation is that bridging trust is much easier to build when we are dealing with agents with similar cultural and religious backgrounds and it becomes increasingly difficult as the number of common norms decline. This justifies our choice to model the individuals in our model as identical. In that way we consider the type of conflicts that fall within the surmountable part of this scale, where the total benefits exceed the total costs of creating bridging trust.

As Putnam puts it when illustrating the widespread 'Toquevillean' civic virtues of early nineteenth-century Americans by recounting the instance of the founding of a community lyceum in New Bedford, Massachusetts, in 1829. The founder, Thomas Greene, formulated the purpose of such a lyceum in the following, instructive way:

> We come from all divisions, ranks and classes of society to teach and to be taught in our turn. While we mingle together in these pursuits, we shall learn to know each other more intimately; we shall remove many of the prejudices which ignorance or partial acquaintance with each other had fostered . . . In the parties and sects into which we are divided, we sometimes learn to love our brother at the expense of him whom we do not in so many respects regard as a brother . . . We may return to our homes and firesides [from the lyceum] with kindlier feelings toward one another, because we have learned to know one another better. (Cited in Putnam 2000: 23)

A policy recommendation along these lines may follow the one given by Putnam, namely that through a new political structure based on decentralization of political power and flexibility in the labour market, one must create fertile conditions for the creation of trust. The bridging consists in moving beyond "our social and political and professional identities to connect with people unlike ourselves" (Putnam 2000: 411). In other words, Putnam asks Americans in all societal sectors to create fertile soil for giving people the opportunity to meet one another in person. Only by so doing, does Putnam believe that the American stock of trust can be restored (ibid.: 412). In this way local, social networks create bottom-up social control: the order and social cohesion of the entire society is guaranteed in the sense that everybody is committed to everybody else. As Mauss puts it: "Although the prestations and counter-prestations take place under a voluntary guise they are in essence strictly obligatory, and their sanction is private or open warfare" (Mauss [1925] 1969: 3). In this way, Mauss actually provided a consistent explanation of Tönnies's Gemeinschaft and Durkheim's 'mechanical solidarity' – but not of the Gesellschaft and "organic solidarity"[3].

Whereas Putnam's quest in Bowling Alone was primarily by use of statistics – to operationalize, quantify and thereby measure a shrinking stock of bridging

[3]The solidarity theory by Durkheim (1893) was derived from Tönnies (1887), who was first to distinguish between "Gemeinschaft" (community) and "Gesellschaft" (association). Durkheim argues, that in a pre-industrial society, solidarity between few individual members is based on similarities due to little or no specialisation in the labor market. Thus, sharing the same beliefs and values in a society, where everybody knows each other or knows someone that knows another person, 'mechanical solidarity' will arise. In an industrial society, more fragmentation will occur because many people have specialised in undertaking specific functions and, with the biological methapor of 'organism', the different parts of the body work together to maintain the organism. In such a society, where not all people will know each other, 'organic solidarity' will arise.

trust in the United States since the mid 1960s, our method is somewhat different. Rather than relying fully on statistical material, we shall demonstrate theoretically how bridging trust is built and destroyed by people in situ – both historically and in contemporary 'love thy neighbor' society. To our knowledge, such theoretical analysis has not yet been undertaken. The presence of a social 'glue' in the form of bridging trust – defined as regular face-to-face, cooperative relations across social boundaries – may explain the paradox of voluntary collective good provision (see Coleman 1988a; Putnam 1993, 2000). More specifically, our theoretical contribution is, in the line of Putnam's empirical claim, to show that bonding trust, left alone, ultimately means that trust cannot accumulate.

In the following, we explicitly model Putnam's claim. To do so we use a framework of two-sector growth model similar to those of Drugeon, Poulsen and Venditti (2003) and Goenka and Poulsen (2004). Following Nishimura and Yano (1994), we model capital as a public good. Capital is identified with trust. We assume that individuals interact in two sectors. In sector 1 individuals interact only with people they know to produce output. In that sense we can say that the fraction of the stock of trust that is used in sector 1 is bonding. In sector 2 individuals also meet strangers. If they trust these strangers, then trust enter the production function of trust and is called bridging trust.

Using this framework, we model two different communities. In both communities trust contributes positively to the production of goods in society by facilitating the flow of information between individuals, giving credentials to individuals and speeding up economic transactions. In economic terms this translates into assuming the externalities enter the production of both goods. Furthermore, we can restrict these externalities to be positive. The first community, the bonding community is such that individuals only trust people they know already. Trust is purely bonding. As a result we show that the dynamics of trust accumulation follows two scenarii. In the first scenario, trust do not accumulate. The equilibrium growth rate of trust is unstable. In the second scenario, the growth rate of trust exhibits chaotic dynamic in a sense to be defined below. In contrast, we show that in the bridging community where individuals extend trust to strangers, trust accumulates. In fact, there is, under certain conditions, infinitely many stable growth rates suggesting that when trust is both bonding and bridging, trust accumulates. Hence our results are in line with the empirical claim made in Putnam (2000).

The paper is organized as follows. In Section 2 we present the common framework. In Section 3 we look at the dynamics of trust in the case of the bonding community. In Section 4 we show that trust accumulate in the bridging community. Section 5 concludes. Finally, all proofs are gathered in the appendix in Section 6.

2 The common framework of both models

Let us consider an economy composed of a continuum of identical individuals[4] indexed by h, where $h \in [0, 1]$. Each individual is infinitely lived and rational. He/she is endowed with an equal fraction of the aggregate stock of trust $k_0^h = \overline{k}$. We assume that individuals interact within two sectors. In sector 1 is the one in which individuals know each others. Some of society's overall level of trust is used to interact with friends, family or colleagues in producing output in that sector. This trust is bonding and is denoted by k_1. In sector 2 individuals meet only strangers. Bridging trust is used to interact outside the usual environment that is sector 1 to interact with strangers. It will be denoted by k_2. Each individual also has a fixed amount of time available, l_t,that for simplicity is normalized to unity. Each individual maximizes his (discounted) intertemporal welfare. At any point of time (which is discrete), welfare is measured by a utility function of current output per capita $u(y_t)$. We impose the following restriction on the utility function:

Assumption 1 :

$$u(y) = \frac{y^\alpha}{\alpha}, \text{.where } 0 < \alpha < 1$$

At time $t = 0$, the representative agent maximizes

$$U_0 = \sum_{t=0}^{\infty} \beta^t \frac{y_t^\alpha}{\alpha}, \tag{1}$$

where β is the discount rate, and $0 < \beta < 1$. We assume that, the production

of trust in both sectors depends on the aggregate stock of trust in any given period. We denote this variable by X, where $X = \int_0^1 k(h)dh$.

We assume that trust depreciates and we denote by $\delta, 0 < \delta < 1$ the depreciation rate. Sector 1 is the output sector. Production of output requires bonding trust and that agents spend some of their of time in the output sector. The number of units of time allocated to the production level will be labelled by l_t^1. Sector 2 is the sector in which trust is produced. The number of units of time spend socializing in sector 2 will be labelled by l_t^2. Let c_t denote the current production of sector 1. Then the the stock of social capital for next period, $k_{t+1,}$ is

$$k_{t+1} = c_t + (1 - \delta)k_t. \tag{2}$$

The above can be formalized as follows

$$\begin{aligned} y &= F^1(k^1, l^1, X), \\ c &= F^2(k^2, l^2, X), \end{aligned}$$

[4] An important observation is that bounding trust arises often when individuals have similar cultural and religious backgrounds. Bridging trust is also easier to establish when individuals have similar cultural and religious backgrounds.

We assume that both production function satisfy the traditional assumptions of positive and decreasing marginal productivities. To rule out corner solution we also assume that the two production functions satisfy the Inada conditions. We also restrict external effects to be time augmenting. This is due to the fact that by giving credentials to individuals trust speeds up transactions.

Assumption 2: $F^i : \Re^3_+ \to \Re_+$, are continuous functions, $i = 1, 2$. For a given $X \in \Re_+$:

(i) $F^i(.,.,.)$ is C^2 on $\Re_{++} \times \Re_{++} \times \Re_+$;
(ii) $F^i(.,.,X)$ is homogenous of degree one and increasing over $\Re_{++} \times \Re_{++}$;
(iii) $F^i_{11}(.,l^i,X) < 0$, for all $k^i \in \Re_{++}$ and $\lim_{k^i \to 0} F^i_1(k^i, l^i, X) = \infty$;
(iv) $F^i_{22}(k^i,.,X) < 0$, for all $l^i \in (0,1]$ and $\lim_{l^i \to 0} F^i_2(k^i, l^i, X) = \infty$.
(v) External effects in sector 1 are Harrod-Neutral. $F^i(k, l^1, X) = \mathcal{F}^i(k, l^1 X)$, where $\mathcal{F}^1(.,.)$ is homogenous of degree 1 in k and $l^1 X$.

For all given $X \geq 0$, the social production possibility frontier, $T(k, y, X)$, is the value function of the following maximization problem:

$$T(k, y, X) = \max_{\{k^1, l^1\}} \mathcal{F}^1(k^1, l^1 X) \tag{3}$$

$$\begin{aligned} &\text{subject to} \\ &y = \mathcal{F}^2(k^2, l^2 X), \\ &k = k^1 + k^2, \\ &1 = l^1 + l^2, \\ &k^i \geq 0,\ l^i \geq 0,\ i = 1, 2 \end{aligned} \tag{4}$$

Assumption 3 : $T(k, y, X)$ is of class C^2 on $\Re_{++} \times \Re_{++} \times \Re_+$.

The set of feasible interior solutions to (3) is non-empty and convex and defined as

$$D(X_t) = \{(k_t, k_{t+1}) \in \Re_+ \times \Re_+ : (1-\delta)k_t \leq k_{t+1} \leq \mathcal{F}^2(k_t, X_t)\}.$$

Using the standard definition of the indirect utility function given by $V(k_t, k_{t+1}, X_t) \equiv [T(k_t, k_{t+1} - (1-\delta)k_t, X_t)]^\alpha / \alpha$, we can reformulate the representative agent's problem as

$$\max_{\{k_t\}_{t=0}^\infty} \sum_{t=0}^\infty \beta^t \frac{\left[\mathcal{F}^1(k^1_t - k^2(k, y, X), X)\right]^\alpha}{\alpha}$$

$$\begin{aligned} &\text{subject to:} \\ k_o &= \bar{k}, \\ (k_t, k_{t+1}) &\in D(X_t). \end{aligned} \tag{5}$$

$$\{X_t\}_{t=0}^{\infty} \text{ given.}$$

We define the growth factor of trust as

$$\frac{k_{t+1}}{k_t} = \gamma_t. \tag{6}$$

Definition 1 *An equilibrium path* $\{k_t\}$*, is a growth ray if there exists a growth factor* $\gamma \in [0, \overline{\gamma}]$ *such that for all* $t \geq 0$, $k_t = \gamma^t k_0$*, where* $k_0 \neq 0$*. It is an interior solution to Problem (5) if it solves a fixed point problem* $\{k_t\{X_t\}\} = \{X_t\}$ *together with the following necessary and sufficient conditions*
Euler equation:

$$-\gamma_t^{1-\alpha} V_2(1, \gamma_t, 1) + \beta V_1(1, \gamma_{t+1}, 1) = 0, \tag{7}$$

Transversality condition:

$$\lim_{t \to \infty} \beta^t k_t^{\alpha - 1} V_1(1, \gamma_{t+1}, 1) = 0. \tag{8}$$

Summability condition:

$$\sum_{t=0}^{t=\infty} \beta^t V(1, \gamma_t, 1) < \infty. \tag{9}$$

We define indeterminacy as follows.

Definition 2 *A growth ray* $k_t = \gamma^t k_0$ *is locally indeterminate if for every* $\epsilon > 0$*, there exists another equilibrium sequence* $\{k_t'\}$ *with* $\acute{\gamma}_t = \acute{k}_{t+1}/\acute{k}_t$ *such that* $|k_1 - k_1'| < \epsilon$ *with* $k_0 = k_0'$.

3 The Bonding Community

3.1 The Model

This community can be viewed as an embodiment of Durkheim's pre-industrial society. In such a community, solidarity between few individual members is based on similarities due to little or no specialization in the labor market. Thus, sharing the same beliefs and values in a society, where everybody knows each other or knows someone that knows another person, 'mechanical solidarity' will arise. We omit the time subscripts whenever they are not necessary. We assume that production of output in sector 1 requires the use of bonding trust. The production technology used in sector 2 is linear[5]. Trust also generate positive externalities that affect the production of both sectors.

$$\begin{aligned} c &= F^1(k, l^1, X), \\ y &= \mathcal{A} l^2 X. \end{aligned}$$

[5] This assumption guarantees that private returns are constant in sector 2. The same result would be obtained had we assumed that the sector 2 were to use a factor in fixed supply and labor as inputs.

Assumption 3: $\mathcal{A} > \delta$.

For this class of economies, the Production Possibility Frontier (P.P.F.) is given by the following maximization problem:

$$\begin{aligned} T(k_t, y_t, X_t) &= \max_{l_t^1} \mathcal{F}^1(k_t, l_t^1 X_t) \\ & \quad \text{subject to} \\ y_t &= \mathcal{A} l_t^2 X_t, \\ 1 &= l_t^1 + l_t^2, \\ k_t &\geq 0, \ l_t^i \geq 0, \ \{X_t\}_{t=0}^{\infty} \text{ given.} \end{aligned} \tag{10}$$

Under Assumption 2, we can apply the implicit function theorem to solve for the demand of labor in the investment good sector. For all given $X \geq 0$, we find that

$$l^2 = \frac{y}{\mathcal{A}X}. \tag{11}$$

We can use (11) to write the value function of Problem (10) as

$$T(k, y, X) = \mathcal{F}^1 \left(k, \frac{\mathcal{A}X - y}{\mathcal{A}} \right). \tag{12}$$

For interior solutions to (10) for all given $X_t \geq 0$ the feasible set $D(X_t)$ can then be restricted to

$$\{(k_{t,} k_{t+1}) \in \Re^+ \times \Re : (1-\delta)k_t \leq k_{t+1} \leq \mathcal{A}X_t + (1-\delta)k_t\}.$$

3.2 Uniqueness and instability of the growth ray

Denoting the maximum growth factor by $\overline{\gamma}$, we see that $\overline{\gamma} = \mathcal{A} + 1 - \delta$. Therefore the transversality condition (8) is satisfied if the following assumption holds:

Assumption 4: $\beta \overline{\gamma}^{\alpha} < 1$.

Lemma 3 *There exists a unique interior equilibrium balanced growth factor* γ *that satisfies the conditions of Lemma* 1.

We now show that if $V_{21}$is monotonic increasing the growth rate is determi-

nate.

Proposition 4 *Suppose that* V_{21} *is strictly monotonic increasing for all* $\gamma_t \in (0, \overline{\gamma})$, *then the balanced growth path is locally unstable (i.e. locally determinate).*

Proof. See the Appendix. ■

Proposition 4 implies that unless an economy starts initially in the interior equilibrium, it will never converge to it. Suppose that the economy is initially in the equilibrium and that $\gamma > 1$. In this case the stock of trust grows at a constant rate $\mathcal{G} = \gamma - 1 > 0$. Suppose now that an exogenous shock hits the economy, then the economy will converge either to the equilibrium where $\underline{\mathcal{G}} = \underline{\gamma} - 1 = -\delta$ or towards $\overline{\mathcal{G}} = \mathcal{A} - \delta$. In the first equilibrium, as time goes by the stock of social capital will disappear. In the second equilibrium, the stock of trust would grow at a positive rate but all productive resources would be allocated to the production of social capital at the expense of consumption.

We now need to consider what happens in this framework if V_{21} is not strictly monotonic increasing. this is the purpose of the next subsection.

3.3 Chaos

In this paper we will use the notion of chaos in the sense of Geometric Sensitivity and Ergodic Oscillations. The notion of geometric sensitivity can be defined as follows:

Definition 5 *(Nishimura and Yano (2000)). The dynamic system* (I, θ)*, exhibits Geometric Sensitivity (GS) if there exists a constant* $h > 1$ *such that for any* $\tau \geq 0$ *there exists* $\varepsilon > 0$ *such that for all* x *and* $x' \in I$ *with* $|x_t - x'_t| < \varepsilon$ *and for all* $t \in \{0, 1, ..., \tau\}$

$$\left|\theta^t(x) - \theta^t(x')\right| \geq h^t \left|x - x'\right|.$$

As I is bounded, the geometric magnification of the effects of a small perturbation cannot last indefinitely. Furthermore, the dynamic system (I, θ) has no locally stable cyclical path.

There is also the notion of *ergodic chaos*. Ergodic chaos is a stronger property than topological chaos in the sense that it is "observable chaos".

Let Υ be a σ-algebra on I. [6] Define a probability measure $\mu : \Upsilon \rightarrow \Re^+$ such that (*i*) $\mu(\varnothing) = 0$ and (*ii*) $\mu(\cup_{n=0}^{\infty} Y_n) = \Sigma_{n=0}^{\infty} \mu(Y_n)$, (*iii*) $\mu(I) = 1$, where $\{Y_t\}_{n=0}^{\infty}$ is a countable collection of disjoint sets in Υ. We can now define the concepts of ergodic chaos in the following way:

Definition 6 *The dynamic system* (I, θ) *exhibits ergodic chaos if there exists a probability measure* μ *on* I *which is absolutely continuous, invariant and ergodic.*

Lasota and Yorke (1973) establish that if θ is a *piecewise* C^2 and *expansive* mapping then there exists an absolutely continuous invariant measure

Definition 7 *A mapping* θ *defined on* $[a, b]$ *is piecewise* C^2 *and expansive if:*

[6] A $\sigma-$algebra is a collection of subsets Υ of I such that (*i*) I is inside Υ, (*ii*) the complement of any set Y included in Υ is also in Υ, (*iii*) the union of any countable collection of subsets in Υ is inside Υ.

1. *There exists a finite set* $x_0 = a < x_1 < x_2 < ... < x_n = b$,

2. *For all* $j = 0, 1, ..., n$, θ *is* C^2 *on* (x_j, x_{j+1}) *and can be extended as a* C^2 *function to* $[x_j, x_{j+1}]$,

3. $|\theta'(x)| \geq h > 1$ *for all* $x \in (x_j, x_{j+1})$.

Li and Yorke (1978) show that if θ is also a unimodal map then this measure is ergodic.

Definition 8 *Assume there exits a constant* $c \in [a, b]$, $a < c < b$. *Then a mapping* θ, *defined on* $[a, b]$ *is unimodal if*

1. θ *is continuous on* $[a, b]$,

2. θ *is strictly increasing on* (a, c) *and strictly deceasing on* (c, b).

Nishimura and Yano (2000) establish that a map that is expansive is also chaotic in the sense of GS. We state the Lasota and Yorke (1973) and Li and Yorke (1978) results as well as the result on GS in the next theorem.

Theorem 9 *(Lasota and Yorke (1973), Li and Yorke (1978), Nishimura and Yano (2000)):*
Let (I, θ) *be a dynamic system. If* $\theta : I \to I$ *is expansive and unimodal then* θ *is chaotic in the sense of ergodic oscillations and GS.*

Let us investigate the occurrence of chaos.

Proposition 10 *If* V_{21} *is not strictly monotonic increasing for all* $\gamma_t \in (0, \overline{\gamma})$, *then if*

$$\beta > \frac{\gamma_t^{\alpha} V_{21}(1, \gamma_{t+1}, 1)}{V_{21}(1, \gamma_t, 1) + V_{23}(1, \gamma_t, 1)},$$

the growth ray exhibits chaos in the sense of Geometric Sensitivity and ergodicity.

Proposition 10 implies that the growth factor of social capital will fluctuate forever. Because of geometric sensitivity, unless the policy maker knows exactly the initial growth factor of the social capital stock, he cannot predict the long run evolution of the system. Hence any policy designed to increase the growth factor of social capital would have unpredictable consequences in the long run.

4 The Bridging Community

4.1 The Model

This community can be viewed as a metaphor for Durkeim's industrial society. In such a society more fragmentation occurs than in the bonding community, because many people have specialized in undertaking specific functions and, with the biological methapor of ‘organism’, the different parts of the body work together to maintain the organism. In such a society, where not all people will know each other, ‘organic solidarity’ will arise. As above we assume that sector 1 is the output sector. It uses bonding trust and the time individuals who know each other spend interacting together.

In the bonding community, we assume that social capital is solely the product of the of interactions between individuals who know each other. Therefore, individuals generally experience repeated face-to-face interaction with the same individuals. This situation changes in the bridging community where individuals tend to interact also with strangers. Here, members get to trust strangers and therefore trust is arguably produced using a fraction of the current stock of trust and the amount of time individuals spend interacting with strangers. As in the bounding community, trust also generates positive externalities that affect the production of both sectors. We again restrict the spillovers to be time augmenting.

Before we go on we state the following result.

Lemma 11 *Drugeon, Poulsen and Venditti (2003) and Poulsen (2001)* $k^i(k_t, y_t, X_t)$ *and* $l^i(k_t, y_t, X_t)$, $i = 1, 2$, *are homogenous of degree* 1 *and* 0, *respectively and* $T(k_t, y_t, X_t)$ *is homogenous of degree 1. Furthermore* $T_{22} < 0$ *and the sign of* T_{21} *is positive (negative) if the capital labor ratio in sector 2 is higher than in sector 1.*

Proof. See Drugeon and Venditti (1998) and Drugeon, Poulsen and Venditti (2003), Poulsen (2001). ■

This is the equivalent to the result first established by Benhabib and Nishimura (1985) in an optimal growth model The consumption good sector is said to be more social capital intensive if the net social capital stock, k^1/l^1, in the output sector is higher than the net social capital stock in the investment good sectork^2/l^2.

Corollary 12 *Suppose the consumption good sector is capital intensive. Then,* $T_{23} > 0$*.*

Proof. See Drugeon and Venditti (1998) and Drugeon, Poulsen and Venditti (2003), Poulsen (2001). ■

4.2 Uniqueness and Indeterminacy

Under Harrod-Neutrality, $\overline{\gamma} = \mathcal{F}^2(1,1) + 1 - \delta$ and $\underline{\gamma} = 1 - \delta$. For the model to display endogenous growth we need $\overline{\gamma} > 1$. To ensure existence of an interior growth ray with endogenous growth we also need $\mathcal{F}^2(1,1) > \delta$. In this case the model does not have a steady state. The transversality condition (8) is satisfied along a growth ray if the following assumption holds:

Assumption 4b: $\beta[\mathcal{F}^2(1,1) + 1 - \delta]^\alpha < 1$.

Proposition 13 *There exists an interior growth ray,* $\widetilde{\gamma} \in (1, \overline{\gamma})$ *if* $\mathcal{F}^2(1,1) > \delta$ *and*

$$\beta[\mathcal{F}_1^2(k^2(1,\widetilde{\gamma},1), l^2(1,\widetilde{\gamma},1)) > 1.$$

Proof. See Goenka and Poulsen (2004). ■

In what follows we show that local indeterminacy arises no matter which sector is more social capital intensive. Drugeon, Poulsen and Venditti (2003) show that the allocation of productive resources between the two sectors affects the uniqueness property of the growth ray. Furthermore, a necessary condition for the occurrence of multiple growth ray is that the investment good sector is capital intensive at the private level at the growth ray. The multiplicity results are not affected by the time structure of the model. We therefore refer the reader to this paper for a more detailed exposition.

Proposition 14 (*i*) *A necessary condition for the growth ray to be locally indeterminate is*

$$\left.\frac{V_{23}}{V_{12}}\right|_{(1,\widetilde{\gamma}+1-\delta,1)} < 0. \tag{13}$$

(*ii*) *A necessary and sufficient condition for the growth ray to be locally indeterminate is*

$$\left|\frac{1}{\beta\widetilde{\gamma}^{\alpha}} + \frac{V_{23}}{\beta\widetilde{\gamma}^{\alpha}V_{12}}\right|_{(1,\widetilde{\gamma}+1-\delta,1)} < 1.$$

Proof. See Goenka and Poulsen (2004). ■

Proposition 14 and the uniqueness result of Drugeon, Poulsen and Venditti (2003) imply that when the consumption good sector is more social capital intensive, then the stock of social capital grows at a constant rate $\mathcal{G}$. It may stay there forever if $V_{21}(1,\gamma,1) < 0$, i.e., if social capital does not depreciate too slowly and if the marginal utility of consumption is relatively inelastic[7]. In this case there exists an infinity of social capital sequences all growing asymptotically at the same rate.

If the investment good sector is more social capital intensive then Drugeon, Poulsen and Venditti (2003) have established the following result

Proposition 15 *(i) A sufficient condition for the occurrence of at least three growth rays is that*

$$\left.\frac{\mathcal{F}_{11}^1\mathcal{F}_{12}^1\mathcal{F}^1}{q\Delta k^1}\left(\frac{k^2}{l^2} - \frac{k^1}{l^1}\right)\right|_{(1,\widetilde{\gamma}-1+\delta,1)} > \frac{1-\alpha}{\beta\widetilde{\gamma}^{\alpha}}.$$

---

[7] Goenka and Poulsen (2004) shows that $V_{21} < 0$ if $T\left[T_{12} - (1-\delta)T_{22}\right] + (\alpha - 1)T_2\left[T_1 - (1-\delta)T_2\right] < 0$. Under the results of Lemma this requires both that

$$\delta > 1 + \frac{T_{12}}{T_{22}}$$

and

$$\frac{T\left[T_{12} - (1-\delta)T_{22}\right]}{T_2\left[T_1 - (1-\delta)T_2\right]} > 1 - \alpha.$$

(ii) A necessary condition for the occurrence of at least three growth rays is that the investment good sector is more capital intensive.

Proof. See Drugeon, Poulsen and Venditti (2003). ■

This would imply that there exists at least one equilibrium with a low growth rate, one equilibrium with a medium growth rate and one equilibrium with a high growth rate for social capital. If the medium equilibrium is stable then it follows that the low one and the high one are unstable. The economy 's stock of social capital would be growing at a positive growth rate. We can now establish the following result.

Corollary 16 *Suppose there exists three equilibria. Then a necessary condition for the stock of social capital to grow forever at the constant rate* $\widetilde{\gamma} - 1$ *is*

$$\widetilde{\gamma} > \left(\frac{1-\alpha}{\beta}\right)^{1/\alpha} > 1$$

Proof. See the Appendix. ■

5 Conclusion

Our purpose was to analyze how trust is generated in society. To do so, we modeled the empirical claim in Putnam (2000), namely the distinction between 'bridging' and 'bonding' social capital – i.e., inclusive and exclusive types of social capital. Defining social capital as the level of trust in this setting, we analyzed two communities in a two-sector growth model. In the bonding community people did not trust strangers and people outside their regular networks. In the bridging community people would, in contrast, tend to trust strangers.

The two-sector model showed that when trust is only bonding then the economy's level of trust moves to an unstable equilibrium growth rate. When, however, trust is also bridging in our so-called 'love thy neighbor' society, then trust will accumulate and there will under certain conditions be infinitely many stable growth rates. These theoretical insights are in line with Putnam's original empirical claim. An important issue for future research will therefore be to establish the appropriate institutional framework for establishing the optimal mix between both bonding and bridging social capital in any society. Hopefully, such insight will be able to guide future research and decision-making towards the crucial role of political decentralization, entrepreneurship and voluntary organizations. Ultimately, the presence of trust in society can be seen as the missing link for understanding both economic and civic well being. A more fully understanding of trust accumulation and cooperation across narrow group and national boundaries may, indeed, promise a bright new millennium for the wealth of nations and regions.

6 Appendix

Proof of Lemma 3

Looking at (7) we see that along the growth ray the Euler equation simplifies to

$$-\frac{T_1(1,\gamma,1)}{T_2(1,\gamma,1)} = \frac{\gamma^{1-\alpha}}{\beta}. \tag{14}$$

Using the definition of $T(k,y,X)$ given in (10), the Euler equation reduces to

$$\left[\mathcal{A}\mathcal{F}_1^1/\mathcal{F}_2^1 + 1 - \delta\right] = \frac{\gamma^{1-\alpha}}{\beta}$$

Let us define the following two functions:

$$\begin{aligned} \varsigma(\gamma) &= \frac{\gamma^{1-\alpha}}{\beta}, & (15)\\ \xi(\gamma) &= \mathcal{A}\mathcal{F}_1^1\left(1, \frac{\overline{\gamma}-\gamma}{\mathcal{A}}\right)\left[\mathcal{F}_2^1\left(1, \frac{\overline{\gamma}-\gamma}{\mathcal{A}}\right)\right]^{-1} + 1 - \delta. & (16) \end{aligned}$$

Under Assumption 2, $\mathcal{F}^1(k, l^1X)$ is homogenous of degree one. So, we can rewrite (14) as

$$\mathcal{A}\frac{\mathcal{F}^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})}{\mathcal{F}_2^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})} = \mathcal{A}\frac{\mathcal{F}_1^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})}{\mathcal{F}_2^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})} + \overline{\gamma} - \gamma_t. \tag{17}$$

At $\gamma = \overline{\gamma}$ taking the limit of (17) on both sides we obtain

$$\lim_{\gamma\to\overline{\gamma}} \frac{\mathcal{A}\mathcal{F}^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})}{\mathcal{F}_2^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})} = \lim_{\gamma\to\overline{\gamma}} \mathcal{A}\frac{\mathcal{F}_1^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})}{\mathcal{F}_2^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})}. \tag{18}$$

However under Assumption 3 (ii) and (vi)

$$\lim_{\gamma\to\overline{\gamma}} \mathcal{A}\mathcal{F}^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})\left[\mathcal{F}_2^1(1, \frac{\overline{\gamma}-\gamma_t}{\mathcal{A}})\right]^{-1} = 0^+. \tag{19}$$

This is equivalent to

$$\lim_{\gamma\to\overline{\gamma}} \xi(\gamma) < \overline{\gamma}. \tag{20}$$

We can rewrite Assumption 4 as

$$\frac{\overline{\gamma}^{1-\alpha}}{\beta} > \overline{\gamma}.$$

Or using the definition of $\zeta(\gamma)$ given in (15) as

$$\lim_{\gamma\to\overline{\gamma}} \zeta(\gamma) > \overline{\gamma}. \tag{21}$$

So (20) and (21) imply that, as $\gamma_t \to \overline{\gamma}$, we have $\lim_{\gamma\to\overline{\gamma}} \zeta(\gamma) - \lim_{\gamma\to\overline{\gamma}} \xi(\gamma) > 0$. A sufficient condition for the existence of $\gamma \in [1, \overline{\gamma}]$ is then

$$\zeta(\underline{\gamma}) - \xi(\underline{\gamma}) < 0.$$

This is equivalent to

$$0 < \beta \left[\mathcal{F}_1^1(1, \frac{\mathcal{A}-\delta}{\mathcal{A}}) \left[\mathcal{F}_2^1(1, \frac{\mathcal{A}-\delta}{\mathcal{A}}) \right]^{-1} + 1 - \delta \right].$$

If we differentiate (15) with respect to γ, we find that

$$\acute{\zeta}(\gamma) = \frac{(1-\alpha)\gamma^{-\alpha}}{\beta} > 0.$$

So, the uniqueness of the balanced growth path depends on whether or not $\xi(\gamma)$ is strictly decreasing. Recall from (16) that

$$\xi(\gamma) = \mathcal{A}\mathcal{F}_1^1 \left(1, \frac{\overline{\gamma}-\gamma}{\mathcal{A}}\right) \left[\mathcal{F}_2^1 \left(1, \frac{\overline{\gamma}-\gamma}{\mathcal{A}}\right) \right]^{-1} + 1 - \delta.$$

If we differentiate this function with respect to γ we find that

$$\acute{\xi}(\gamma) = \frac{-\mathcal{F}_{12}^1 \mathcal{F}_2^1 + \mathcal{F}_{22}^1 \mathcal{F}_1^1}{(\mathcal{F}_2^1)^2} < 0.$$

Hence, we see that the sufficient condition for a unique balanced growth path is satisfied. The uniqueness result follows.

Proof of Lemma 4:
Using the definition of $V(k_t, k_{t+1}, X_t)$ we can derive

$$V_2 = -\frac{(\mathcal{F}^1)^{\alpha-1}\mathcal{F}_2^1}{\mathcal{A}}. \tag{22}$$

Using (22), we can derive V_{21} as

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}\mathcal{F}_2^1 \left[\mathcal{A}\mathcal{F}_1^1 + (1-\delta)\mathcal{F}_2^1\right]}{\mathcal{A}^2} - \frac{(\mathcal{F}^1)^{\alpha-1} \left[\mathcal{A}\mathcal{F}_{12}^1 + (1-\delta)\mathcal{F}_{22}^1\right]}{\mathcal{A}^2} \tag{23}$$

and V_{23} as

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}(\mathcal{F}_2^1)^2}{\mathcal{A}} - \frac{(\mathcal{F}^1)^{\alpha-1}\mathcal{F}_{22}^1}{\mathcal{A}} > 0. \tag{24}$$

Using (24) and (29) we can compute $V_{23}(1, \gamma_t, 1)$ as

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}(\mathcal{F}_2^1)^2}{\mathcal{A}} + \frac{(\mathcal{F}^1)^{\alpha-1}\mathcal{F}_{12}^1}{\bar{\gamma} - \gamma_t}. \tag{25}$$

Differentiating the Euler equation, we get

$$\frac{d\gamma_{t+1}}{d\gamma_t} = \frac{V_{12}(1,\gamma,1) + V_{23}(1,\gamma,1)}{\beta\gamma^{\alpha} V_{12}(1,\gamma,1)}. \tag{26}$$

Adding (25) to (31) along an equilibrium path we can compute $V_{23}(1,\gamma,1) + V_{21}(1,\gamma,1)$ as

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}\mathcal{F}_2^1\left[\mathcal{A}\mathcal{F}_1^1 + \mathcal{F}_2^1\left(1-\delta+\mathcal{A}\right)\right]}{\mathcal{A}^2} + \frac{(\mathcal{F}^1)^{\alpha-1}\mathcal{F}_{12}^1\gamma_t}{\mathcal{A}(\bar{\gamma}-\gamma_t)} > 0. \tag{27}$$

It follows that we have the sign of $d\gamma_{t+1}/d\gamma_t$. depends on the sign of $V_{21}(1,\gamma,1)$. The necessary and sufficient condition for the growth ray to be locally stable is

$$\left|\frac{1}{\beta\gamma^{\alpha}} + \frac{V_{23}}{\beta\gamma^{\alpha}V_{12}}\right| < 1. \tag{28}$$

Using the Euler theorem on homogenous function, we have

$$-\mathcal{F}_{12}^1\left(\frac{\mathcal{A}k}{\mathcal{A}X-y}\right) = \mathcal{F}_{22}^1. \tag{29}$$

Substituting this into (23) we can rewrite it as

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}\mathcal{F}_2^1\left[\mathcal{A}\mathcal{F}_1^1 + (1-\delta)\mathcal{F}_2^1\right]}{\mathcal{A}^2} - \frac{(\mathcal{F}^1)^{\alpha-1}\mathcal{A}\mathcal{F}_{12}^1\left[\mathcal{A}X_t - k_{t+1}\right]}{\mathcal{A}^2\left(\mathcal{A}X_t - y_t\right)}. \tag{30}$$

Along an equilibrium path (30) can be reduced to

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}\mathcal{F}_2^1\left[\mathcal{A}\mathcal{F}_1^1 + (1-\delta)\mathcal{F}_2^1\right]}{\mathcal{A}^2} - \frac{(\mathcal{F}^1)^{\alpha-1}\mathcal{F}_{12}^1(\mathcal{A}-\tilde{\gamma})}{\mathcal{A}\left(\bar{\gamma}-\tilde{\gamma}\right)}, \tag{31}$$

where

$$\mathcal{F}^1 = \mathcal{F}^1(1, \frac{\bar{\gamma}-\gamma_t}{\mathcal{A}}).$$

(31) implies that, for $\gamma \in [\mathcal{A}, \bar{\gamma})$, we have $V_{21}(1,\gamma,1) > 0$. So, for all $\gamma_t \in [\mathcal{A}, \bar{\gamma})$, (31) and (31) imply that

$$\left|\frac{1}{\beta\gamma^{\alpha}} + \frac{V_{23}}{\beta\gamma^{\alpha}V_{12}}\right| > 1. \tag{32}$$

Suppose now that $V_{21}(1,\gamma_t,1) > 0$ for all $\gamma_t \in [0,\mathcal{A})$ i.e. suppose that

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}\mathcal{F}_2^1\left[\mathcal{A}\mathcal{F}_1^1 + (1-\delta)\mathcal{F}_2^1\right]}{\mathcal{A}^2} > \frac{(\mathcal{F}^1)^{\alpha-1}\mathcal{F}_{12}^1(\mathcal{A}-\gamma_t)}{\mathcal{A}\left(\bar{\gamma}-\gamma_t\right)}$$

for all $\gamma_t \in [0,\mathcal{A})$ and that $\gamma \in [0,\mathcal{A})$. Since by assumption $V_{21}(1,\gamma,1) > 0$ it follows that the growth ray is determinate (i.e. unstable).

Proof of Proposition 10:

Recall from Proposition that V_{21} can be derived as

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}\mathcal{F}_2^1\left[\mathcal{A}\mathcal{F}_1^1+(1-\delta)\mathcal{F}_2^1\right]}{\mathcal{A}^2}-\frac{(\mathcal{F}^1)^{\alpha-1}\left[\mathcal{A}\mathcal{F}_{12}^1+(1-\delta)\mathcal{F}_{22}^1\right]}{\mathcal{A}^2} \quad (33)$$

We know from Proposition **??** that

$$\theta^{'}(\gamma_t)>0 \text{ if } V_{12}(1,\gamma_t,1)>0 \text{ for all } \gamma_t\in[1-\delta,\mathcal{A}) \quad (34)$$

Suppose now that $V_{21}(1,\gamma_t,1)<0$ for some $\gamma_t\in[1-\delta,\mathcal{A})$ i.e. suppose that

$$\frac{(1-\alpha)(\mathcal{F}^1)^{\alpha-2}\mathcal{F}_2^1\left[\mathcal{A}\mathcal{F}_1^1+(1-\delta)\mathcal{F}_2^1\right]}{\mathcal{A}^2}<\frac{(\mathcal{F}^1)^{\alpha-1}\mathcal{F}_{12}^1(\mathcal{A}-\gamma_t)}{\mathcal{A}\left(\bar{\gamma}-\gamma_t\right)}$$

for some $\gamma_t\in[0,\mathcal{A})$.

It follows that there exists at least one $\gamma_t\in[0,\mathcal{A})$ such that $V_{21}(1,\gamma_t,1)=0$. Assume for simplicity that there exists only one such point. If we rewrite the Euler equation as

$$g(\gamma_t)+f(\gamma_{t+1})=0$$

where $g(\gamma_t)=\gamma_t^{1-\alpha}V_2(1,\gamma_t,1)$ and $f(\gamma_t)=V_1(1,\gamma_{t+1},1)$ we see that the first order difference equation $\gamma_{t+1}=\theta(\gamma_t)$ is no longer defined[8] for at least $\gamma_t\in[0,\mathcal{A})$. However $g^{'}(\gamma_t)=(1-\alpha)\gamma_t^{-\alpha}V_2(1,\gamma_t,1)+\gamma_t^{1-\alpha}V_{22}(1,\gamma_t,1)<0$. It follows that we can define the following first order difference equation

$$\gamma_t=\tau(\gamma_{t+1}).$$

where $\tau=g^{-1}(f(\gamma_{t+1}))$.

We can compute

$$\tau^{'}(\gamma_{t+1})=\frac{\beta\gamma_t^{\alpha}V_{21}(1,\gamma_{t+1},1)}{V_{21}(1,\gamma_t,1)+V_{23}(1,\gamma_t,1)}.$$

Given that there exists a unique $\gamma\in[0,\mathcal{A})$. such that $V_{21}(1,\gamma,1)=0$ and that

$$\begin{aligned} V_{21}(1,\gamma_t,1) &< 0 \text{ for all } \gamma_t\in[0,\gamma),\\ V_{21}(1,\gamma_t,1) &> 0 \text{ for all } \gamma_t\in(\gamma,\overline{\gamma}), \end{aligned}$$

then if $\theta(1-\delta)=\theta(\overline{\gamma})=0$, $\theta(\gamma_t)$ is unimodal. If

$$\beta>\frac{\gamma_t^{\alpha}V_{21}(1,\gamma_{t+1},1)}{V_{21}(1,\gamma_t,1)+V_{23}(1,\gamma_t,1)}$$

for all $\gamma_t\in(\underline{\gamma},\overline{\gamma})$ then $\theta(\gamma_t)$ is expansive.

Proof of Corollary 16:

[8] For a more detailled exposition see Goenka and Poulsen (2004 b).

From Proposition we have three equilibria if

$$\frac{\mathcal{F}^1_{11}\mathcal{F}^1_{12}\mathcal{F}^1}{q\Delta k^1}\left(\frac{k^2}{l^2}-\frac{k^1}{l^1}\right)\Big|_{(1,\widetilde{\gamma}-1+\delta,1)} > \frac{1-\alpha}{\beta\widetilde{\gamma}^{\alpha}}. \tag{35}$$

If we define the following two functions

$$\eta(\widetilde{\gamma}) = \frac{\gamma^{1-\alpha}}{\beta},$$
$$\kappa(\widetilde{\gamma}) = \mathcal{F}^2_1 + 1 - \delta\big|_{(1,\widetilde{\gamma}-1+\delta,1)},$$

then we see that 35 is equivalent to

$$\kappa'(\widetilde{\gamma}) > \eta'(\widetilde{\gamma}).$$

It follows that a necessary condition for $\widetilde{\gamma}$ to be stable is

$$\widetilde{\gamma} > \left(\frac{1-\alpha}{\beta}\right)^{1/\alpha}.$$

For endogenous growth we need $\widetilde{\gamma} > 1$.

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