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Abstract

The paper investigates the extent to which the emerging notion of "social capital" is analytically treatable within a microeconomic approach, and what the consequences, in terms of results achieved by microeconomic tools, are. First, after a critical examination of the recent socio-economic literature on Social Capital, a microeconomic-grounded definition, shaped around the elements of reciprocal trust and voluntary cooperation, is provided. Secondly, the implications of the definition, which attempts to synthesise the key micro issues of social capital as it is usually presented, are then discussed. Consequently, a model rooting on elements of mixed-public good, non-cooperative agreements and dynamic optimal control is constructed and presented. Finally, the set of possible model extensions and main critical points are sketched. The concluding section also sheds light on the directions of our future research.

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0. Introduction

The present contribution originates from an interest on the definition and analysis of the so called "social capital", as it has been defined by economists, sociologists and other social scientists. Grounding on the literature developed during the last decade, our present aim is to explore new perspectives, rooting mainly on a microeconomic perspective.

The literature on social capital (SC hereafter) revolves around the following (interconnected) key issues:

1. The attempt to define the concept of social capital within the economic arena, both on mainstream and on more unconventional sides;

2. The debate over the effects of social capital on economic activity, at microeconomic and macroeconomic level;

3. The possible ways of measuring social capital

Our approach is strictly microeconomic in nature. We especially focus on issue one, attempting to investigate what the agent's[2] incentives and motivations behind the *formation and accumulation* of social capital are, and two, since the model we frame is essentially based on microeconomic theory. The development of a sound theoretical basis is deemed as a necessary step for a consistent and necessary empirical measurement, stage of analysis which is here mentioned for its relevancy but not extensively tackled.

Social Capital is here intended as the public element in an impure public good model, accumulated as a capital stock through investments by agents, cooperating for some common goals.

The socio-economic literature identifies three main approaches to social capital analysis (Piselli, 2001): our contribution lies within the "ego centrist" paradigm, that is within an approach (a "research tradition") grounded on methodological individualism. Another approach may be called "socio -centric", since it involves the analysis of the social capital stock produced by a society, without investigating what the incentives in SC creation are, but focussing on the effects of SC on welfare. A further line of analysis is possibly termed "development and institutions oriented", and it mainly stems from the famous contributions associated to the work of Fukuyama (1995) and Putnam (1993). The interest is there on "culture" and "institutions". No attempt is made to analysing what the causes of SC formation and development are: the interest is again on effects

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[2] We deal primarily with firms. Nonetheless, our analysis may be thought more generally as of dealing with economic agents cooperating for the formation and accumulation of social capital.

and on comparative analyses between areas and regions[3]. The main risk of this approach is to explain social phenomenon only by the (observed) status quo culture, with minor attention to economic and political dynamic elements (Trigilia, 2001).

Although we will define below differences in frameworks and meaning, our approach is consistent to the line followed by the "father" of SC, the sociologist Coleman (1990, 1988), who founds his reasoning on rational choice theory[4]. Among the many possible definitions of SC which may be derived from Coleman's work, two[5] emerges as more important to us: (i) SC as appropriable social organizations, more specifically *"social organizations formed with a specific limited objective, which come to outlive that objective and serve as more generalized mechanism for a wider range of objectives"* (ii) SC as intentional social organizations. Both deal with an idea of SC as an engine for encouraging exchanges and production in social networks.

The paper is structured as follows. Section 1 critically describes the results of the recent literature on SC within the economics arena. The most relevant definitions are presented and discussed. We then draw out a specific definition on which to build the analysis. Section 2 continues in describing the analytical framework we rely on and the specific model we here present. The model draws upon models of public good-mixed good production and non-cooperative agreements (Cornes and Sandler, 1986), and on optimal control theory (Conrad and Clark, 1989). Section three discusses the most relevant extensions to the model, mainly focussing on the role played by discount rates, returns to scale in production, agent's conjectures, relative effects of

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[3] Bagnasco (2001) and Piselli (2001) criticises the approach, stressing its deficiencies in terms of: limited use of the concept, no attention on microeconomic incentives and dynamic evolution, vague focus on "social culture", lack of emphasis on policy actions modifying the "cultural environment". Both re-conduct SC to a sort of "shared culture", without investigating its real nature as a dynamic and multi-faceted phenomenon in continuous evolution, creation and destruction.

[4] As many lines of economic research within the new welfare economics arena, his aim consists in extending the narrow neoclassic paradigm for including interdependencies in agent's actions and the analysis of cooperation toward common goals. The focus is nonetheless on individuals and social interactions. Bagnasco (2000, 2001) underlines the relevance of the Coleman's contribution, on methodological grounds, in comparison to the recent developments by Putnam and Fukuyama, who set actors out of the scene, and treat social capital elements as exogenously determined by a give social structure, without analysing the creation and sustainability of SC. The latter perspective is definitely a wider and more fruitful research perspective, wherein voluntary schemes of associations are treated not as SC themselves, but rather as the "production" of latent SC (Rudd, 2000). We also agree with Bagnasco that the agent's based (interactionist-egocentrist) paradigm is more fruitful for allowing an inter-disciplinary collaboration integrating independent approaches (economics, politics, sociology, ecc.).

[5] A" list" of Coleman's SC definitions is reported by Fedderke et al. (1999, p.712).

substitution and complementarity between forms of capital. Section 4 concludes by discussing results and giving some suggestions for further research.

1. On Social Capital: the economic arena and the microeconomic framework

From the main branches of analysis on SC, the concept emerges as intrinsically vague, and much work is needed for drawing out a set of specific definition in both the micro-based and macro-based frameworks. Any specific definition needs the assessment of specific individual and network objectives. Following Paldam and Svendsen (2000), we argue that results achieved so far are promising, but more theory-close measures and models are needed for generating a sound base for SC economic analysis.

The main problem concerning the economic analysis of what has been termed "social capital" is in fact that the literature is strongly heterogeneous, and the notion of SC is not always clearly assessed and described for being operative on theoretical and applied grounds. This is probably caused by the emphasis on inter-disciplinary research and the limited (so far) width of economic literature. Then, some definitions are too biased toward sociological sides; others are too vague (low specificity in terms of tools and objectives). Our first goal is thus one of drawing out of the literature the (economic) definitions we retain consistent, then presenting our own definition, on the way toward an operational economic approach to SC[6].

Among the various definitions we came across in the literature, the followings are the most relevant for defining the boundaries of the issue at stake:

- *"A variety of different entities with two elements in common: they all consist of some aspects of social structure, and they facilitate certain actions –whether personal or corporate actors-within the structure"* (Coleman, 1988)
- *"Those features of social organization, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinate actions"* (Putnam, 1993)[7]
- *"A glue that holds societies together"* (Serageldin, 1996)

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[6] We believe that many economic definitions and approaches to SC may coexist. The strength of economic analysis would be the finding of a set of definitions, starting from different approaches, consistent with the economic goals of theoretical and applied research.

[7] This is A definition which encourages connecting each other non-commensurable elements, as beliefs, behaviour rules, and inter-personal networks (Dasgupta, 1999).

The main problem we encountered is that such established definitions are mainly deriving from sociological and hybrid socio-economic approaches. This is of course not bad on its own, but it is useless for our specific objectives. Economic tools may provide "heavier" theoretical contributions to the social capital debate and to the understanding of social mechanisms, which play here a crucial role. Three main points thus have to be stressed. First, we argue that the two dimensions of SC, the macro and the microeconomic ones, should be clearly separated out[8]. Secondly, more specific definitions of SC- we mean consistent with research aims- are to be envisaged. Third, (different) models[9], consistent with given and assessed definitions, are to be framed. We believe that on such basis the idea of SC may emerge out of the cloud it is in now.

We will proceed along a micro path, providing a definition of SC, and consequently a consistent model derived from the set of assumptions made. We intend to establish a framework (an arena) for developing a new line of microeconomic research on SC, but which is also capable of having connections with other definitions and economic approaches.

Building on the above definitions, SC is possibly identifiable with the "culture" of a group of agents (culture of reciprocity and cooperation). Further, the definition of social capital as a stock of intangibles is not completely shared vision. On the contrary, some Nobel economists have argued that the term "capital" [10] is inconsistent with the definition of SC usually encountered in the recent literature. For instance, Arrow (1999) and Solow (1999) sharply conclude that probably the emphasis on *capital* is misplaced. SC derives instead from an association to the concept of human capital. In their view, the fact that elements as trust, willingness and capability of cooperating, propensity to invest in a common effort have on the hand a clear cut effect on total productivity, but on the other hand economics cannot consistently deal with SC as a proper form of capital.

Thus, economic theory faces two problems. The first is to assess whether or not SC as intended in the literature can be modelled and studied as capital. The second is to achieve definitions of SC consistent with the modern economic science, concerning all its branches.

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[8] In fact "The nature of the micro to macro level linkages and the nature of causality from social interaction to trust, trust to social capital and social capital to economic and political performance are readily obscured given he myriad perspectives on SC" (Rudd, 2000, p. 137). Operationalising concepts of Sc are thus necessary for a better understanding and clarification of issues.

[9] Of both analytical and qualitative nature, of course.

We believe that for solving the first preliminary step, new definitions are to be found, discussed, and analysed as far as the consequences for economic research are concerned. Our opinion, we will see, is that the emphasis on capital is correct, *only if* the boundaries of the definition in terms of theoretical elements are clear and transparent. Thus, many alternative and consistent definitions may emerge following our suggestion.

One possible (preliminary) analytical definition of Social capital as a stock is presented by Glaeser et al. (2000), regarding an application of community social capital in urban environments. They sharply note the proper nature of SC in a micro arena, that is "*while we have theory and evidence on the effects of SC, we are just beginning to identify the underlying mechanism that create SC in the first place*" and "*aggregate definitions* –although useful- *may serve as barriers to the development of an economic framework for modelling the causes of investment in SC*" (Glaeser et al., 2000, p.3).

Nonetheless, the authors fail to develop a consistent dynamic model taking into account of strategic and dynamic incentives toward investment in SC. Overall, their interest appears biased toward empirical analysis.

Another intelligent and comprehensive discussion and analysis of the "capital" features of SC is presented by Robison *et al*. (2000). The authors (i) claim that SC possess most capital-like properties and (ii) defend the SC paradigm. Their effort is devoted to the analysis of capital like properties, listed as the vector of [transformation capacity, durability, flexibility, substitutability, opportunities for decay (maintenance), ability to create other capital forms, and (dis)-investments opportunities], with reference to SC analysis. They conclude by recommending that the SC metaphor should be taken seriously[11]. It is a sort of intangible commodity used in the production of other goods and services. It is a human made capital input, and it represents an accumulation of foregone consumption; agents make voluntary and costly efforts to increase *their* SC[12]. We agree with the analysis of capital like properties, and we will underline below the extent to which our definition is consistent to such benchmark properties. We also agree with them when affirming: "*properly limited social capital definition will save SC from battles it should not fight and uniforms it should not wear*". Unless the concept is used with some degree of specificity

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[10] A stock of assets subject of an accumulation process, eventually associated to a depreciation rate, with a specific productivity impact on economic output, measurable in terms of net benefits (market and non market) over time.

[11] They correctly state: "*Social scientists do not need another word for all institutions that further economic and social development, especially if that word implies characteristics of capital that not all institutions have*".

[12] The active role of agents in cooperation is emphasized by Oughton and Whittam (1997).

making it comparable to theoretical models (intended as ideal benchmarks), it will come to have little analytical, and consequently applied, value.

Nonetheless, they fail in recognising a more specific (core) element of SC, which entangles together the three keystones of cooperation, dynamic accumulation and self-enforciness of agreements. Their simplistic emphasis on "sympathy" (and emotive relationships) alone fails to consider the structure of incentives SC must rely on in order to provide sustainable benefits to participants, and risks of shifting attention to non-economic areas of study.[13]. It only focuses on an important but well-known and analysed element, that of non market values existing within and beyond market exchanges. "Selfish" preferences may-not paradoxically-well be consistent with altruistic motivations[14]. Different specifications of the utility function can accommodate for different altruistic motivations (McConnell, 1997).

This is an element of the issue which concerns the level of individual utility function, and which obviously contains both market and non-market or extra market elements. Nonetheless, the analysis of Social capital should move toward the (less studied) space of interrelations between agents in a dynamic scenario where both market and non-market benefits are relevant. In this sense, SC could play the role of private solutions to both market and state failures in providing impure public good, given the existence of static and dynamic externalities. It is then strictly close to a private provision of collective (capital) goods, where the good is not a final objective, but is *instrumental* to the production of other inputs and outputs. In the words of Nyberg (1997, p.84) "*The players can be thought of as engaging in team production where they share the fruits of joint efforts but where individual effort levels are difficult to observe or they could be viewed as participants in transactions that involve asset specific investments and are subject to opportunistic behaviour*". This is the environment we think of when modelling SC. A framework of analysis which does not deal with altruistic motivations (or "sympathy"), but with individual incentives (motivations) toward investing in mixed public-private activities.

The last point is also underlined by Fershtmann and Weiss (1998). Those activities, which affect members of a given community but cannot be fully priced, are not efficiently regulated by private markets. We also rule out the possibility (motivating it) that third party enforcement is consistent

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[13] Although they recognise that "*one important difference between social capital and some other forms of capital is that SC exists in a social relationship*". Thus, it is not storable in individuals alone.

[14] We may also consider the difference, following Oughton and Whittam (1997), between self-interested maximising behaviour and Kantian rationality. Nonetheless, we argue that the rational choice theory as developed within modern

with a capital like idea of SC . Thus, social rewards schemes (incentives) may provide feasible mechanism that may replace laws and regulation (state intervention). The analysis should revolve around the limits and effectiveness of social strategic incentives as corrective tools.

Summing up so far, it is evident that the literature presents interesting theoretical contributions, which drive social capital go toward an economic sound and consistent definition. Nonetheless, we argue that the attention should be focussed, building on the assessment of specific capital features, on alternative aspects, dealing intrinsically, and bringing together, (i) cooperative incentives and (ii) dynamic paths of capital accumulation. What lacks is in fact a more detailed analysis embodying the main implications of the notion concerning "cooperation" and "capital accumulation", trying to link individual-level rational choices and collective decision making.

What we attempt to establish is a theoretical framework where the notion of Social "capital" (Galassi, 2001) acts as a solid root for microeconomic analysis, thus extending, on the basis of a specific definition, the spectrum of analyses coping with the social capital issue.

As far as our attempt of giving a definition is concerned, we begin by considering two key issues which arise up from the literature on SC. The aspects are those of "trust" and "ease of cooperation". Paldam (2000) specifically provides the following definitions, revolving around the notion of trust, cooperation and network:

Definition 1 on <u>Ease of cooperation</u>: "Social capital is the ability of a person belonging to a population to work voluntarily together with others (belonging to the same population), for a common purpose in groups and organizations"

Definition 2 on <u>Trust:</u> "Social capital is the quantity of trust a person (belonging to a population) has in other members of the same population".

Paldam also poses the following hypothesis. The *Assumption* is the relationship between the concepts above presented. That is, "trust"⇔"ease of voluntary cooperation" +- e_i, where e_i is a small error[15].

The author correctly defines SC as the glue generating excess cooperation; we here add "in excess with respect to an equilibrium intended in a Cournot-Nash meaning.

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microeconomics is not restrictive and can accommodate *most* assumption of agent's behaviour. For a more general treatment, see McFadden (1999).

[15] "It would appear that trust is primary to most cooperation. However, by working together people further build trust, so the two concepts have some interactive simultaneity. Trust and the ease of voluntary cooperation are thus two interlinked concepts." (Paldam, 2000, p. 636).

Trust and ease of cooperation are two elements that simultaneously interact in the production of private and public good, or forms of capital. We support the hypothesis that "norms of reciprocity, trust and institutions, as human artifacts, matter in the production of quasi public and pure public good" (Rudd, p. 132)[16]. The Trust element is also pointed out by La Porta et al (1997), in their analysis of Trust in large organizations. They claim that trust should be associated to greater cooperation, and is more essential in ensuring cooperation between strangers rather than people who interact frequently and repeatedly. This means that trust is most needed to support cooperation in large and voluntary associations (networks of firms), where members interact infrequently to achieve private goals, which nonetheless need common forms of capital. This last consideration is essential to our purposes and definition of SC, moving away from "family" based and "associative" based concepts as present in Robison et al. (2000) and Putnam (1993), and from analysis of Trust and cooperation relying on "honesty" treated as a sort of public good (Nyberg, 1997).

Our intention to focus on those two elements, trust and cooperation, specifically focussing on the voluntary nature of actions undertaken and on the incentives schemes that support investment decisions in environment where both market and non market returns are present, with the aim of drawing out of them an analytical definition and a theoretical framework.

For instance, the situation faced by firms (agents) may be depicted as follows: on the one hand a firm has the option of investing either in standard technology or in incremental innovations which do not require cooperative efforts within the network (the firm internalises investments and associated returns). Both options may be termed as Business as usual (BAU) scenarios. On the other hand, the firm may invest in R&D involving radical innovations: in other words, innovations that involve structural breaks from the BAU (discrete changes concerning technological/organisational development) or that involve skills, knowledge and competences, which the firm only partially owns. In both cases, the innovation change require a cooperative effort, and the investment is one on an impure public good, where the ratio between private and public components of welfare may be assumed constant. Each unit of investment produces x units of private and z units of public benefit; the opportunity cost of the "radical cooperative

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[16] The author gives a sound definition of SC, but still unspecific, which is close to our idea: "*SC is a productive asset that enables individuals to better fulfil their aspirations through access to goods and services via their social network and through collective action*". Opportunity costs of investing in SC are present since "*both time and effort are indeed expended on transformations and transactions to build social assets- norms, rules and institutions- today that increases income in the future through increased productivity*" (p.135-136).

innovative" path is, in the short run, the value of investing in BAU options. Dynamic opportunity costs are also present and matter.

The framework as depicted above may characterise different real-world situations where inter-firm cooperation is the primary and leading key to successful performance of the network, which we may also intend, without entering the debate over taxonomy, as either a "cluster" or a "district" of firms. What matters is that at some point agents need to join their efforts for achieving benefits which derives from and build on public-like forms of investments. This necessity of joining efforts to establish voluntary cooperative schemes by which achieving goals specific to the network but appropriable by participants, characterises most forms of (i) voluntary agreements, (ii) inter-firms intra district cooperation, (iii) inter-firms inter-district cooperation[17]. The relevance of (i)-(iii) as engines for innovation and growth at regional level has increased over the last decades, following (I) the less prominent role of the state as "regulator" (top down approach) and (II) the reshaping of governance and business strategies within the post-fordist society. Socio-economic changes occurring in the post fordist (post industrial) era shifts the focus of interest from man made forms of capital to human, environmental and social capital assets (Gerelli, 1999). Further, market and non-market "horizontal" networks play a major role with respect to "vertical" and hierarchical relationships, bringing about a new scenario described by a cultural change in local and national production. Finally, intentional (multilateral) externalities turn over standard Marshallian "unintentional" externalities in explaining growth and innovation processes. The community benefits from positive network externalities; nonetheless, differently from unintentional exogenous spillovers, the voluntary and intentional production of joint social benefits is costly. Therefore, incentives matter.

Thus, it emerges as clearly relevant the role of "intentional cooperative strategies" as a form of demand for "new institutions"- rooting on new rules-, endogenously created and bottom up driven. Those bottom up coalitions share the risks of investing in community specific knowledge (vs firm specific assets). Moreover, coalitions should usually rely on informal rules and non coercitive incentives for sustaining *effective and efficient* agreements.

The public element of welfare function of a firm participating to the network agreement is, in our framework, the stock of SC on which the decision of action relies. SC is nonetheless strictly

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[17] In reality, the unit of analysis may be conceived both as a firm, an association and any legal private body operating within the boundaries of the network.

entangled to private components of welfare (it is not a pure "independent" public good[18]). The scenario is common to most situations characterising the post fordist - post Keynesian era, where the hierarchical nature of economic activities has been (partially) replaced by horizontal -market-network- structures and the role of the state as a third party enforcer has decreased in importance, leaving more space to voluntary schemes, which entails a stronger cooperative effort for producing private-public elements of benefit[19]. As Oughton and Whittam sharply point out (1997, p.4): "*it is evident that the relative decline in the significance of internal economies of scale in production and the associated movement way from large scale production toward flexible small production has been one of the factors associated with the change in the size distribution of firms (…) at the same time there are clear signs that external economies of scale are playing an increasingly important role in some regional economies (…)*". Cooperation between firms may generate gains via the establishment of collective external economies.

It is beyond the scope of this paper a normative comparison of market and state failures with respect to the production of mixed capital good. We underline the voluntary element of the agreements in cooperation and production: SC is *self- enforcing*, *self-financing*, in opposition to *third-party enforcement frameworks[20]*.

Further, since the accumulation of SC is by definition self-monitoring, it can be considered a factor that affects to some degree the level of monitoring costs. The costs are decreased if the cooperative agreement reaches an equilibrium which self-sustains itself on a bundle of incentives. For example, some authors argue that: "*Social capital may be treated as the background factor*

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[18] Piselli (2001) e Bagnasco (2001) incorrectly defines SC as a public good. Nonetheless, they seem aware of the impure nature of SC. Piselli, following Coleman (1990), points out that SC, as a situational and dynamic good, is a necessary *by product* of other activities, but whose property rights are not assignable to agents outside the common effort they pursue. Further, if we omit the possibility of externalities generated by SC toward "outsiders", the returns are not purely public, since only insiders (investors) benefit from it.

Bagnasco stresses the fact that SC is a "resource for action" and an appropriable social structure. He quotes Coleman (1990) in saying that: "*lodged neither in individuals nor in physical implements of production, (but inherent) in the structure of relations between persons and among persons*".

[19] Thus, the value of SC as here intended increases. It is evident that SC is not a sufficient condition for development and innovation, but is surely a necessary pre-condition.

[20] For the sake of the present analysis, we assume that the third party enforcement by the social planner is not a feasible option. This assumption is nonetheless realistic in most cases. The third party enforcement acts as a theoretical benchmark useful to "measure" the degree of easy riding, in other words the distance between full cooperative and non-cooperative steady state equilibria.

(trust) that reduces the amount of free riding in certain well-defined games, for a given amount of third-part enforcement" (Paldam and Svendsen, 1999)[21].

Accordingly and consequently, agents invest in SC since the stock produced reduces transaction costs. We may say that the formation of SC lies in between the *market* and *hierarchy* structures. Investments are made with the sole support of market institutions (where agents voluntary participate in exchanges), nonetheless, investments are asset specific and the opportunity cost of non investing in SC is sunk, specific to the voluntary agreement under analysis[22]. As Paldam (2000, p.631) states: "*Social Capital is defined relative to a certain population*"[…] "*the population is thus characterised by a level of social capital and a structure of individual social capitals. Social capital deals with cooperation in groups and networks within groups of people*". Further (p.632):"*SC implies two learning processes within the population. One deals with the individual adjusting to the common level, while the second deals with the adjustment of the level over time*" and "*the key point is that the group members (…) are voluntary participants in the group*".

Along this line of reasoning, SC emerges as a stock of accumulating capital deriving from a process of voluntary cooperation for the fulfilment of common objectives[23].

Thus, it may be included in a production function together with other inputs, linked with them to different degree of complementarity. For instance:

$$Y = F(K, L, H, Q) \text{, con } \frac{\partial Y}{\partial Q} > 0 \text{, and } \frac{\partial^2 Y}{\partial Q^2} < 0$$

dove *L*=labour, *K*=man made capital, *H*=human capital, *Q*=SC

The effects of SC are thus analysed according to the shape of cost functions, returns to scale, factor productivity, market and shadow prices of capital investments.

The SC investments may be treated as shifting downward the cost function of the firm, as a type of *collective external economies,* involving both scope and scale economies (Oughton and Whittam, 1997). In this sense, SC as a stock captures the idea that collective external economies of scale are realised by cooperation over input activities, such as research, technological

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[21] We will see that this definition is partially in line with our framework.

[22] The degree of specificity decreases if the investment produces economies of scope, that is the same stock supports more than one "production aim".

[23] Paldam (2000) stresses that even in business hierarchies social capital cannot be enforced but must be developed accordingly to incentives, costs and benefits of dynamic cooperation. See also Leenders and Gabbay (1999).

development, organisational innovation, training and advertising, wherein fixed costs are pooled among agents who join.

Consequently, the notion of social capital is in our opinion strictly linked to the public good and externalities environments. It is external to the firm but internal to the network established. Models of public, mixed and club goods are so useful to shape the problem at hand. SC is non-rival and non-excludable for the club members; to the extent that its provision is complementary to private good provision, a framework of impure public good emerges.

We use all of the notions developed and presented so far for framing our model analysis. An analysis which, differently from the current literature on SC, tackle the issue by using a deductive analytical approach, but proceeding complementary along with the deductive qualitative reasoning and the applied approach. The role for an analytical approach is, in our opinion, be demonstrated by the literature on game theory and non-cooperative games. Within repeated games, the dynamic interplay of actions may encourage cooperative behaviour. In the branch of evolutionary game theory, Axelrod (1981) has demonstrated that cooperation may dynamically evolve if encouraged (triggered) by a sub class of cooperative players within a larger group of "deviants" and shows that, under specific conditions, reciprocal cooperation is a stable equilibrium. The results depend, as it is well known, on the discount factor used by agents. The level of discount factor, nonetheless, represents preferences and is exogenously determined (in most models we know); what lacks is an analysis of what incentives (preferences) and relationships between capital stocks (technology) lie behind the decision of investing in a common stock with sunk costs and multi-service outputs.

Looking at the recent literature on SC, Paldam (2000) stresses: "*In the language of game theory, social capital is the excess propensity to play cooperative solutions in prisoners' dilemma games.*" Arrow (1999) also points out that: "[*that] Trust can promote economic progress […] has been given some theoretical foundation by reputation effects in game theory*".

The following section, which starts by a definition of SC following the reasoning developed so far, presents and discusses the framework of the model.

2. The model

2.1 The microeconomic definition of Social Capital

We begin by giving our definition of SC, as a concept linked to trust and cooperation, at a microeconomic level. The definition builds up on the discussion presented so far.

Definition: *SC is an intermediate (complementary) capital good privately and intentionally produced, which endogenously accumulates given the flow of agents investments in voluntary cooperative effort. SC is the equilibrium stock of the public component of an impure good, sustained by a set of incentives. The "production" and accumulation is self-enforcing and sustained by reciprocal benefits of cooperation.*

In this meaning, SC as here defined gives force to the "Glue" metaphor, since it emerges as the stock of intangible capital, which increases the returns of production activities and is sustained by cooperative efforts . That is, it provides valuable market and non-market "services", specific to the agreement in force. Cooperation is sustained by non market investments, but the aim revolves around private appropriable benefits.

It is clear that the above definition attempt to move toward a microeconomic approach, differentiating the present analysis from what found in the literature so far[24].

For what concerns the capital like properties, SC as here defined owns a transformation capacity, in the sense that its accumulation is targeted toward the production of other forms of capital (man made or organizational) or final outputs. It is durable as long as incentives exist to sustain it. In our case, the degree of durability is such that the stock elapses with the cooperative agreements established for specific objectives. This is the eventual "cost" faced by easy riders. Then, the breaking down of a coalition ends up the value of the stock. It is true that some "individual" knowledge may survive to the ending up of cooperation, but this goes beyond the scope of the present model and beyond our definition. Third, in "our" definition of SC, it accumulates or de-cumulates depending on the structure of individual incentives (benefits and costs), and it is subject to decay as a renewable "collective resource". In fact, decay depends on endogenous factors as easy riding (non consistent actions of investment between agents) and on exogenous

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[24] Although the approach is sharply different, our definition is somewhat close, but less vague, to that given by La Porta et al. (1997): "*SC as a propensity of people in a society to cooperate to produce socially efficient outcomes and to avoid inefficient noncooperative traps such as that in the prisoner's dilemma*"

factors as well[25]. Contrary to Sandler's analysis of intergenerational club goods (1982), depreciation occurs for a lack of strategic investment (reduced investment) in cooperation in any time t, rather than for "utilization" (crowding externality). In other words, depreciation derives from "non use" rather than excessive use, as for many forms of collective manmade capital. Depreciation reflects the fact that much of SC investment is community-network specific.

Then, SC stocks create other capital[26]. The only capital like property it lacks is alienability, since we have shown that the stock of SC is intrinsically a relational dependent stock. It is not owned by individual agents or by the agents as a group, it is "asset specific" and an instrument for the purposes of the alliance[27]. Nevertheless, we argue this "inalienability" is its main specificity as an intangible asset. Inalienability is entangled to non marketability, in that agents invest in some imperfectly observable assets: costliness and imperfect observability found the process of systemic easy riding with respect to investment decisions. Thus, is social capital capital with respect to our definition? We believe it is. We encourage checking any given definition according to capital like properties for clarifying concepts and discussion.

The main strength of the present analysis is the treatment of investments in a mixed-public capital asset, which accumulates (de-cumulates) along a dynamic long run path. Then, we deal with private optimal solutions and non-cooperative steady state equilibria, with the aim of investigating the existence and the properties of steady state equilibria. We also present the social planner maximisation, but only as a benchmark reference (we rule out by definition the possibility of third party enforcement)[28].

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[25] The point is emphasised by Piselli (2001), who stresses that SC is created by interactive and dynamic strategies, and is mined by individual behaviour and exogenous factors. Investment flows are thus necessary for maintaining the stock.

[26] Maintenance poses the problem of being purely public within a club. Two issues emerge. One of preference revelation, the other concerning the financing of maintenance activities by either marginal or average contributions.

[27] This point is also highlighted by Robison et al. (2000).

[28] Take as example the formation of voluntary agreements aimed at achieving environmental targets in terms of reduced pollution, increased recycling, etc...Voluntary agreements are alternative economic tools to taxes and standards, which are instead implemented by state authorities. Their effectiveness depend on the extent to which voluntary cohesion sustain incentives for providing a mixed good (with entangled elements represented by technology and environmental public goods). Thus, private and social benefits are to be generated by a self-enforcing deal, which needs to round on a sustainable set of reciprocal incentives. Other examples may be provided.

The model builds up and brings together, attempting to shape an original framework for an analytical treatment of SC, the contributions given by Cornes and Sandler (1986), Dockner et al. (1996a,b), Glaeser et al., (2000).

The key elements on which the model is centred are:

- The dynamic accumulation of SC
- The Stock equilibrium of SC
- The Individual and social trajectories of Investments
- The nature of (Consistent) conjectures on cooperative investments
- The degree of Complementarity between private and public returns of capital

Taken together, they constitute- we believe- the added value of the present analysis.

The steps of voluntary cooperation in the model are the following:

➤ At a first stage agents voluntarily join to share the production costs of a good/service, of private and /or public nature, expecting to receive a vector of dynamic benefits[29]. This constitutes the main trade off between present costs and future benefits. We suppose that the agents are N firms[30] who voluntary join a network.

➤ At a second stage the agents, which have formed a club, consider both private and public benefits arising jointly from cooperation. In our example of a network of firms, each firm invests in two kinds of capital, y_i and R_i. The first one (y_i) has private characteristics (it has no effects on the other firms inside the network). The second one(R_i), on the contrary, has the characteristic of an impure public good: it has either a private component, z_i (which has no effects on the other firms) and a public component, s_i (which has effects also on the other firms). We can think of the investment in the private kind of capital, y_i, as an investment in what we have previously termed BAU (business as usual) capital stock, and at the investment in the "impure public" capital, R_i, as investment in R&D involving <u>radical</u> innovations. In this case we can take as example of the "public component", s_i, the already mentioned formation of voluntary agreement among the firms to achieve environmental targets. Hence, the public component, s_i, is SC in the meaning of "cooperation" and "trust".

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[29] Notice that in our framework SC deserves economic analysis only if it refers to situations wherein the cooperative behaviour of economic agents is intentional and voluntary.

[30] Each firm is indexed by the subscript i=1,…,N.

From above we can assert that each unit of investment by the firm i in R_i is such that:

$$z_i = aR_i \qquad 0 \leq a \leq 1 \ given \qquad (1)$$

$$s_i = bR_i \qquad 0 < b \leq 1 \ given \qquad (2)$$

We are hence, assuming that whenever a firm invests in one unit of R_i, she invests in a (given) units of a private characteristic z_i and in b (given) units of social capital[31] s_i.

Notice that from (1) and (2) we obtain:

$$z_i = a\frac{s_i}{b} \Rightarrow z_i \ and \ s_i \ are \ complements \qquad (3)$$

Moreover, since each firm's choice about s_i has effects on her own benefit function and on the other firms' benefit functions, we define:

$$S_{\neq i} = \sum_{j \neq i} s_j = \sum_{j \neq i} bR_j \qquad \forall i,j \qquad (4)$$

and:

$$S = \sum_{i=1}^{N} s_i = \sum_{i=1}^{N} bR_i \qquad (5)$$

From equations (1), (2) and (4) the contribution of the firm i of an extra unity of R_i has therefore three effects: (i) an increase in i's private benefit due to z_i; (ii) an increase in i's benefit due to s_i; (iii) an increase in total amount of the public component available to any firm.

Each firm's benefit function related to the investment in the impure public capital R_i can be, therefore, defined as:

$$B_i = B_i\big[(s_i + S_{\neq i}), z_i\big] \qquad \forall i \qquad (6)$$

it depends on the firm's choices about z_i and s_i and on the other firms' choices about $S_{\neq i}$.

For what concerns the investment cost function in impure public capital (R_i) of the firm i in the period t, $C_i = C_i(I_{Ri})$, we have to consider that the variation of the R_i stock over t is given by:

$$\frac{\partial R_i}{\partial t} = I_{Ri}^t - dR_i^t = R_i^t - dR_i^t \qquad (7)$$

Where δ is the (exogenous) depreciation rate[32]. Hence, firm's investment cost function in R_i can be defined as:

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[31]Notice that, from equation (2) we assume that s_i can never be zero, since we suppose that each firm inside the network invests at least a minimum positive amount in "relations" towards the other firms.

$$C_i = C_i(I_{Ri}) = C(\dot{R}_i + \boldsymbol{d}R_i^t) \qquad (8)$$

Moreover, from equation (2) we get, in each period:

$$\frac{\partial R_i}{\partial t} = \frac{1}{\boldsymbol{b}} \frac{\partial s_i}{\partial t}$$

and:

$$\dot{s}_i = \frac{\partial s_i}{\partial t} = \boldsymbol{b} \frac{\partial R_i}{\partial t} = \boldsymbol{b}\left(I_{Ri}^t - \boldsymbol{d}R_i^t\right) \qquad (9)$$

Then, we have to consider the opportunity cost of any investment in the impure public capital, that is the value of investing in the private kind of capital, y_i.

Following Glaeser et al. (2000) we put the opportunity cost of investment equal to r.

In this paper, just for the sake of simplifying the preliminary analysis, we assume that firms are symmetric: they have identical investment cost functions.

Being the agreement a sort of club composed of N firms , each individual firm may suffer from congestion externalities. In this work we do not explicitly deal with congestion costs, focussing instead on dynamic properties of public stock accumulation. The issue may well be treated in further extensions of the model. Along the same line of reasoning, the number of firms can be allowed to enter as a variable in the model (in this case we would have a further optimality condition concerning N).

As we consider social capital as a public-collective good, an analysis of sub optimal provision is necessary. In our case, the distance between optimal (social planning – centralised solution) and private investments (decentralised solution) equilibria is studied within a dynamic environment, attempting to elicit what elements are the most relevant in explaining private behaviour and private incentives toward social-optimal investments.

The sub optimality of Nash Cournot equilibria is an outcome that we would expect to arise also within the social capital framework; in fact, equilibria generated by perfect observability on market returns generally lead to Cournot adjustment process, where each agent myopically chooses her action as a best response to his partner's action (Fershtmann and Weiss, 1998; Conley and Dix, 1999). The core point is how to model relationships between agents and between

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[32] Since R_i is characterised by both a private component, z_i and a public component, s_i (social capital), also the depreciation rate will concern both the depreciation of usual capital and the depreciation of social capital, as we have previously explained (that it is a depreciation which derives from non use rather than excessive use).

present and future times, and what linkages to establish between forms of capital goods, in order to study the elements behind private (marginal) benefit and costs.

This is the well-known *easy riding*[33] problem, which is intrinsic to issues of cooperation and accumulation of public (*common resource*) forms of capital.

In the present work we just set up the problem of the choice of the optimal level of social capital (s_i) both in the decentralised and in the centralised case, and we postpone the solutions of the problems to the next paper.

Our final goal is to analysis the incentives behind the investment in social capital as here defined. The aim is to highlight what the incentives for a dynamic (self enforcing) positive accumulation of SC are, leading toward an equilibrium at time T with desirable properties in terms of social welfare.

2.2 The decentralised case

We assume that firms have a known lifespan of T periods and that they discount the future with discount factor ρ.

Each firm looks for the optimal magnitude of the choice variable s_i in each point of time in the given interval of time [0,T].

We have to deal with three variables, R_i, z_i, s_i. Which of these should be considered as state variables and which as control variables?

Since equation (9) constitutes an equation of motion for s_i, we can take s_i as a state variable.

Since R_i can affect s_i via (2) and then dynamically via (9), it constitutes a control variable.

As to the remaining variable z_i, equation (3) shows that its values, at any time t will become determined once the values of the state and the control variable are known.

In particular, via (3) we have that at any time t z_i^t is determined by:

$$z_i^t = a \frac{s_i^t}{b}$$

We may thus view the variable z_i as neither a state variable, nor a control variable, but like just a function of the other two variables, s_i and R_i.

So the problem of firm i can be modelled as follows:

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[33] Where the degree of easy riding may be quantified in an index, which lies between zero and one, which is in other terms the "distance" between the Pareto cooperative optimal outcome and the Nash Cournot equilibrium (Cornes and Sandler, 1989)

$$\int_0^T \{B_i[(s_i + S_{\neq i}), z_i] - rC_i(I_{Ri})\}e^{-rt}\,dt$$

s.t.:

$$s_i^t = \boldsymbol{b}R_i^t$$

$$\dot{s}_i = \frac{\partial s_i}{\partial t} = \boldsymbol{b}\left(I_{Ri}^t - \boldsymbol{d}R_i^t\right)$$

and:

$$s_i(0) = \bar{s}_i \qquad\qquad s_i(T)\ \textit{free} \qquad (\bar{s}_i,\ \text{T}\ \textit{given})$$

$$\boldsymbol{l}(T) = 0$$

2.3 The centralised case

In this case the whole network aims at the optimal magnitude of the choice variable for each firm (s_i), in each point of time in a given interval of time [0,T].

Thus, the problem *of the network* can be sketched by the following model:

$$\int_0^T \{B_i[Ns_i, z_i] - NrC_i(I_{Ri})\}e^{-rt}\,dt$$

s.t.:

$$s_i^t = \boldsymbol{b}R_i^t$$

$$\dot{s}_i = \frac{\partial s_i}{\partial t} = \boldsymbol{b}\left(I_{Ri}^t - \boldsymbol{d}R_i^t\right)$$

and:

$$s_i(0) = \bar{s}_i \qquad\qquad s_i(T)\ \textit{free} \qquad (\bar{s}_i,\ \text{T}\ \textit{given})$$

$$\boldsymbol{l}(T) = 0$$

4. Further extensions

5.

In order to reach the purposes highlighted above concerning the analysis of what the incentives for a dynamic positive accumulation of SC are, we will specifically consider the following elements which concern (i) the nature of produced benefits (ii) the structure of internal and

external costs and (iii) the form of agent's conjectures. we argue that points (i)-(iii) are all relevant issues for what concerns the creation and sustainability of SC at micro level.

The list of key issues is thus the following:

1. The relationship of complementarity between the two characteristics of the good considered as impure public (z_i and s_i). Complementarity theoretically enhances the probability of achieving a social optimum outcome, affecting the sign and slopes of reaction functions. Intuitively, since, for each firm i, the two components of the impure public capital (R_i) are complements an increase of the other firms' investment in the public component (S_{1i}) may induce firm i to increase her own investment of the complementary private component (z_i) and, hence, of the impure public capital (R_i). In this way, through the extra investment in R_i, firm i necessarily determines an increase of the public component too, via the process $s_i = \boldsymbol{b}R_i$. Hence her reaction curve may have positive slope, with evident positive implications on the easy riding problem.

2. The income effect with reference to mixed/public good models (Cornes and Sandler, 1989).

3. We will study the sensitivity of results to different assumptions over returns to scale modelled in benefit and cost functions. The expected results are that increasing returns to scale of the firms' net benefit functions will induce firms to choice a level of SC closer to the social optimum. Actually, increasing returns to scale incentive joined production and hence joined investment by the agents. In this case the Nash individual equilibrium could coincide with the social equilibrium.

4. *Non-zero conjectures.* The hypothesis on which the Nash Cournot equilibrium is grounded is one of zero conjectures. The agent expects no reaction by the rest of the community to its own change in fundamental variables' choices . Such assumption can be criticised and found empirically inconsistent. Thus, one of our aims is to incorporate, in a second stage, non-*zero conjectures*, for carrying out a comparative analysis. Theoretically, the outcomes are expected to be much worse or much better, since agents reacts more intensively.

The present analysis provides a basis for (i) extending the model by incorporating new assumptions and changing existing ones; (ii) extending the interrelations between different arising definitions of what has been so far too vaguely and ambiguously defined as social capital.

The main relevant extensions we propose to study in the future are:

- The sensitivity of easy riding to the number of agents involved. Both the Pareto outcome and the Nash Cournot equilibrium may be affected by a change in N, depending on the nature and degree of income effects;

- The analysis of Steady state outcomes, which can follow the study of equilibria with defined time T. Equilibrium states and paths of investments may change. The gap between social and private outcomes may also be affected.

- Leader-follower games may be structured to study the potential value and "social role" of first "investors";

- Different Discount rates may be incorporated. The issue regarding the choice of discount rates is central to dynamic (optimisation) problems (Weitzman, ?): in alternative to standard exponential rates, rates which give more weight to the future, such as the hyperbolic one, can be introduced. Further, agents may be assigned different levels of discount rates, or private rates be different from social ones.

Those listed are the main paths of research for the theoretical frame as here designed.

A note on measurement, the third issue listed at the beginning, to conclude this section. As far as measurement is concerned, we here want to stress how a proper measurement effort is fully dependant on a clearer definition of what we mean by social capital, in its various possible forms, and on a clear assessment of its private and public elements of benefit (social welfare characteristics). Thus, models as designed by theory are instrumental to applied analysis. Further, in a micro-based framework, both the political and the economic jurisdiction of the SC network must be carefully established and assessed before starting any analytical and measurement effort. Glaeser et al (2000, p.5) also note "*the path form individual to aggregate social capital is difficult, because of the extraordinary importance of SC externalities. The complexity of aggregation means that the determinants of SC at the individual level may not always determine SC at the society-level*". For a sound microeconomic analysis, both at theoretical and empirical level, a defined population of interest should be selected by assessing the "social network" boundaries.

As far as the measurement of SC is concerned, the main ways of approaching SC quantification at microeconomic level are by:

- Case studies;

- Revealed preference approaches (observing agent's behaviour)

- o Quantifying by observing choices (i.e. investment choices, participation rates, etc…)
- o Quantifying by "Counting" to assess institution's density (i.e. Putnam's instrument)
- Stated preferences methods (directly revealing behaviour when observation is difficult or we lack behavioural "tracks")
  - o Quantifying by direct methods (i.e. Interviewing and asking agent's)

Although less exploited, the microeconomic framework appears more consistent and promising for SC measurement efforts on both qualitative and quantitative grounds. It remains obvious that different methods are complementary and all exploitable as tools, provided they are consistent with economic theory.

6. Conclusions

We have presented a self contained microeconomic definition of SC attempting to shed light on the foggy framework which emerges from the literature which has developed so far. Although more detailed and operational definitions are emerging within the economic theory, a clear assessment of SC concept-like seems distant both on economic and interdisciplinary grounds.

Assuming that agents cooperate for producing joint benefits associated to capital goods linked by diverse degree of complementarity and substitutability among internal and external benefits, the SC definition which emerges is intuitively linked to that of a core equilibrium (eventually) sustained by a structure of incentives. The issue at stake is to analyse such structure of incentives, examining the role of benefit and cost variables, for giving a clearer understanding on the failures and success of voluntary social capital accumulation.

Thus, the definition here presented starts analysing *individual agents*. SC emerges as the sustained joint effort instrumental (capital stock) to the production of quasi-*rents*[34] associated to the private component of the mixed good[35], from which non participants are excluded. The capital-like property lies in its instrumental value, which also differentiate the analysis from one of cooperation for producing public goods. If a comparison is to be made, SC shares some similarity with the idea of common goods, for which the efficient production is theoretically

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[34] We define quasi-rents, according to economic theory, as extra-returns associated to man made capital-like forms other than land and natural resources.

[35] Which may be alternatively modelled as a club good in further analysis whenever congestion costs are thought as being relevant.

assured both by completely private or community property rights. Thus, incentives to join depend on dynamic quasi-rents produced by that *capital*, which rely on partial exclusion, since are generated within a self-contained network[36].

It is worth noting again that the main tasks for the economic analysis on SC are, in our opinion, (i) the definition of specific (bounded) SC concepts, and (ii) the consequent analysis of the relevancy of different conceptual definitions for economic theory. This is the only way for making SC an operational and robust field of research at micro and macro level.

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[36] In the sense that participants, as long as they join the voluntary network, possess property rights on the intangible capital. Property rights are not alienable (re-sellable) by individual agents, at least in our present formulation.

An alternative concept of SC may instead emerge from a different framework, which we may here briefly sketch, since it may possess some degree of interrelations with our. Given (i) a social level of quasi-rents and (ii) a given distribution of quasi-rents *and* of capabilities and potentialities to access such quasi-rents, SC is possibly defined as the institutional setting which promotes the maximum degree of potential accessibility (opportunities) to the set of available social economic quasi-rents. Within this "institutionalist" approach, SC has capital like properties insofar it produces opportunities for achieving quasi-rents. It does not produce quasi-rents. Nonetheless, put dynamically, the perspective has to deal with the opportunity cost of quasi-rents distribution. In other words, two paths may be highlighted: one is associated to rent depletion as opportunities are exploited; this is a sort of zero-profit (extra profits or quasi-rents) equilibrium in the long run. Whether or not is a stable or steady final state is relevant and then should be studied, by using different approaches. In fact, the second possible path is one where a certain degree of exclusion from accessibility is instrumental to the maintenance of incentives for growth. Thus, "excessive" access to quasi-rents faces costs in terms of dynamic dis-incentives. This means that a notion of "optimal" rent (and optimal level of "access" to resources) emerges, which is structurally linked to an analysis of how assets are accumulated by society from the short to the long run. Even without dealing with the idea of "optimality", the depletion of quasi-rents at any time t may undermine the future level of accessibility, as long as the incentives for society (groups of agents) to grow are reduced. This is a well known trade off which is also present, for example, in the Schumpeterian theory of innovation and growth, elements which are jointly driven by quasi-rents production and accumulation.

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