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Food quality as a public good: cooperation dynamics and economic development in a rural community

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Abstract The present work deals with an initiative that aims at creating and promoting rural development through high quality. It is called "Presidia", it has been started by the Slowfood movement, and it relies on an approach to rural economies different from the standard spreading of industrialization. The phenomenon on focus is based upon the cooperative dynamics of several small producers, and thus some criticalities typical of social dilemmas have emerged in the case-based study on the field: they deal with the role played by cooperation-supporting institutions. Through an empirically grounded agent-based model which allows what-if analysis of some policy suggestions, different mechanisms for promoting cooperation among producers are thus investigated. Simulation results outline how single altruistic actions are not capable of sustaining a positive aggregate while single selfish choices can determine very negative outcomes, and how only the strong commitment of most central actors can protect the system from random fluctuations in cooperation levels. Two main results are finally discussed: informal control mechanisms do not ensure the desired level of cooperation and high quality; interaction structure codetermines the outcome.

Keywords Slowfood presidia · Voluntary public good provision · Agent-based models · Food quality · Rural development

1 Introduction

The recent evolution of agriculture has seen at work the interplay of dynamics of further spreading of industrialization in food production and dynamics of

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lengthening of transportation distances due to the involvement of peripheral areas and the reduction of transportation costs. Such a trend implies an increase in the complexity (Murdoch 2000: 410ff) and in the length of the whole food chain, from the production to the distribution to final customers.

But peripheral areas that are nowadays starting to be involved in the industrialization of the food sector are often areas characterized by fragile and sensitive environments which are threatened by the change implied by such a kind of development process. Similarly, such areas are generally characterized by traditional small producers: the evolution of technology (from biotechnology to the standards required by distribution chains) and the diffusion of industrialization promote the diffusion of larger producers capable of gaining stronger economies of scale and they, thus, negatively impact the social sustainability of the development process.

Thus it is not surprising that much attention has been posed on alternative initiatives for rural development, and in fact the just mentioned criticalities of the main development paradigm represent a chance for different models of rural development as the one studied in this paper.

Looking at the several examples of different approaches to rural development it can be noted that they all share some characteristics, the most important of which is that they are based upon a non price-based competition that enroots its competitive advantage in innovating the exploitation of local resources (Murdoch 2000: 415).

The innovation here referred to is of a particular kind which does not aim at labor saving but at transforming local resources, knowledge and social relationships in economic advantages. The means by which the local resource gives raise to the development process is quality, meaning quality of the processes of exploitation and transformation and thus of the resulting product.

Products in fact are, literally, the outcome of a production process which transforms natural and human inputs in an output the quality of which is not only dependent on the quality of the inputs that have been used but also on the quality of the rules and procedures which drive the production process. In other words, the crucial role played by transformation processes in quality creation is confirmed by the alimentary sector, in line with other experiences in quality control and certification in other economic industries where the quality of the outcome can be assessed and promoted only through the quality of the procedures governing production.

The phenomenon studied in this work is a rural development initiative, promoted by the Slowfood movement and named “Presidia”, aiming at preserving traditional foods at risk of extinction by creating production systems and markets for such products.

Presidia are based upon the cooperative behavior of several producers and quality is the key element guaranteeing the systemic welfare.

In the following of the paper a dilemma concerning the level of quality in one single example of Presidia will be studied through a field analysis and an agent-based simulation (Gilbert 2008; Gilbert and Troitzsch 2005), thus the paper is organized as follows: in the following section Presidia will be presented along the specific case that has been studied. Then, in the third section the research question will be introduced, and in the fourth one the model will be described. Finally model simulations results will be presented and some conclusions discussed.

2 The phenomenon on focus

The launch of Presidia is connected to the diffusion of a cultural movement called "Slowfood", which was started in northern Italy, in the small town of Bra in the region called Piedmont, in 1986.

Slowfood is nowadays a world wide cultural movement which aims at preserving and promoting a healthy and sustainable culture about eating and drinking, taking its name as a demonstration against fast foods. It focuses on the preservation of local traditions about food, as a protection of important cultural issues and as a guarantee for human health.

The Slowfood initiative called Presidia was based on the idea to create a sort of small productive clusters for products which were under the risk of extinction. Those clusters were named *Presidia* (*Presidium* is the singular noun), a Latin word that can mean garrison, defense, protection or aid.

A very important issue in the creation of Presidia is that, since the very beginning, they intended not just to preserve an alimentary product for the future. In fact, even if that was the final goal, the alimentary product has been ever conceived as the final result of a complicated process, and thus, to preserve and promote the product it is necessary to preserve and promote many local features, like the environment, the shared knowledge, the history, the social capital and so forth.

The Presidium for the breeding of the Piedmontese cow was one of the first ever created, dating back to 1998. The motivation for its creation was the extinction of the local breed of cows because of the higher productivity (in terms of quantity of meat, not in terms of quality) of international imported breeds.

At the end of the nineties the situation was critical: a few animals were surviving in a small number of farms. The Presidium started by defining a strict regulation to maximize the quality of the meat and by finding producers wanting to revitalize the breeding of such a kind of animal species.

The Presidium was, in 2005, composed by 19 producers and by one person responsible for its organization: he was a retired veterinarian who well knew the sector and the producers. At the end of the Presidium lied five slaughterers, who were also butchers, and who sold the produced meat to common consumers, restaurants and to other butchers.

Producers are grouped in an association called "Associazione La Granda", the activities of which are principally the promotion of the Presidium and controlling quality levels, as explained below. Producers are located in a rural area at the foot of the Alps, in Piedmont, precisely in the province of Cuneo and the area is almost twenty kilometers wide. Producers turnover reached almost 1.5 millions of Euro in 2005.

3 The research question

While interviewed Slowfood staff recognized the success of the Presidia initiative and its international expansion is programmed and executed, some issues of concern were raised.

In particular there is the problem of cooperation. For increasing production to levels high enough to sustain agreements with large-scale distribution, more relevant investment is asked of producers.

At the time of the field analysis the Piedmontese cow Presidium was bargaining a contract for providing meat to an innovative large-scale distributor that was going to buy the product directly from producers. It was both an interesting chance and a relevant risk.

Such an agreement, in fact, implies a strong increase in the breeding of cows and that could be achieved in two ways, by letting new producers enter the Presidium or by having existing producers find and invest in new resources. Both solutions were perceived by the president of the association of producers and by those responsible for the Presidium as factors stressing the mutual trust among producers.

In fact, the requested increase in production means something like doubling the breeding of cows in less than 2 years time, and it can be translated to at least doubling the number of producers (dependent on finding producers with similar productive capacity) or requesting existing producers to invest a greater than anyone has ever made before. Both solutions were problematic, in fact new members could cheat by not following productive regulations and selling their cows as bred according to them. That would generate serious threats to other producers' investments: cows bred without respecting productive regulations produce lower quality meat, and the image of the whole Presidium would be damaged. Whilst the opposite, if incumbent producers stay alone in the Presidium and make new investments to increase their production, the resources at stake double the monetary incentives to free ride.

That calls for an effective monitoring and control mechanism. While the sanction for traitors has always been and will be the exclusion from the association and from the Presidium, the monitoring control mechanism has always, since the beginning, been far more complicated.

The mechanism is severe, it has been an example for other Presidia, and it has been designed by those responsible for the Presidium. It is made of the following elements:

- the association keeps a unique genealogical record for all bred cows, taking record of their birth and death date and of their offspring;
- independent chemical laboratories make random inspections in Presidium producers' cowsheds, chemically analyzing what they find in mangers;
- when each cow is slaughtered, a piece of meat is used for organoleptic analysis;
- there are monthly compulsory meetings, in which producers meet to share information and to solve eventual problems;
- every semester producers meet and taste meat coming from all of them.

Such a structure of monitoring mechanisms is complicated, and expensive, but effective[1] also, working in conjunction with a sanctioning system in order to exclude defective producers from the Presidium.

[1] According to the presidium coordinator and to producers, the mechanism has worked well because it has helped, in the past, in identifying two producers who were not "capable" of following productive regulations and who have been expelled.

Facing the just described challenge (i.e., weakening of trust due to an increase in production) and considering that the adopted control mechanism is difficult and expensive to extend for future needs, the question to be answered is, is it needed? It is not known what the future structure of the Presidium will be, but it is possible to understand the existing one and to investigate if the severe and expensive monitoring and control system is really necessary.

4 The model

In order to answer the research question, the methodology that has been adopted requires a model for proceeding with the "what-if" analysis of the mechanism controlling the level of quality of production in the Presidium. The what-if analysis exploits the agent-based model in order to give a precise answer to the theoretical scenario in which the Presidium works without the complicated control mechanism just described and actually at work.

The main idea in modeling the target system is the fact that the respect of regulations and the consequent high level of quality in cows' meat is a public good shared by producers. But high quality is subject to free ride: regulations are expensive to respect, because many other means to breed a cow are available at a minor cost and the evaluation of meat quality is made by end customers in respect to the whole production.

High quality is thus, by all means, a public good for Presidia producers because it is non rival (i.e., the consumption of the good by one producer does not prevent simultaneous consumption by others and does not decrease the amount of the good available to others), non excludable (i.e., it is not possible for a single producer to exclude others from its consumption), and its provision is expensive (i.e., it is not a natural resource available for free, but it is the systemic outcome of individual investments).

The problem considered here is thus a particular case of social dilemma, that is to say a situation in which short-term, narrow, private interests collide with collective ones.

To obtain data about the existing Presidium composition, two main sources of empirical information have been used. The first one is the usage of unstructured interviews with Presidium main stakeholders, from whom came the information described above, aiming to generally understand how the Presidium works, the typical problems of the sector, the control mechanism, and other general issues of the Presidium. The second one has been represented by surveying the 19 producers with a questionnaire, divided into two parts, aimed at understanding each producer's production capacity and the social network among producers.

Data about production capacity has been cross checked with data recorded by the association. Data about the social network has been a more complicated issue. The part of the questionnaire devoted to retrieve such data was built to understand the frequency of meetings with other Presidium producers, excluding occasions related to the Presidium life (i.e., excluding monthly and semester meetings of the association which belong to the formal monitoring mechanism). Whenever a couple

of producers answered a different frequency for meeting with the other, the average value of the two frequencies has been considered to build the model as the equal probability of meeting between producers.

It is worth adding that some producers were interviewed by telephone to check their answers in the paper based questionnaires, which has suggested that the frequency of meetings depends on two factors, proximity and age.

The data collected are depicted in Fig. 1, where the network of producers is drawn. Vertexes of the network obviously represent producers, and the size of them is a representation of their production capacity, outlining the heterogeneity of the distribution of such a value. Despite the heterogeneity, production can not be considered polarized in few subjects but, on the contrary, it is spread in the network.

Finally, to complete the description of the model, producers' behavior still needs to be discussed.

When a defection from cooperation by a producer becomes known, the problem is other producers' reaction: if the defector cannot be certainly identified and punished, expelling him from the Presidium, information about defections can spread in the network of producers according to their reactions. It is in fact plausible that the information about defections depends upon contacts between producers, when it is most probable the exchange of information.

In simulations we use the data collected in the field, that is to say the frequency of meetings used as probability and the production capacity. Each simulation step is a basic time unit, which represents a week because the highest frequency of meeting that has been found is of once per week. The fact of using probability means that,

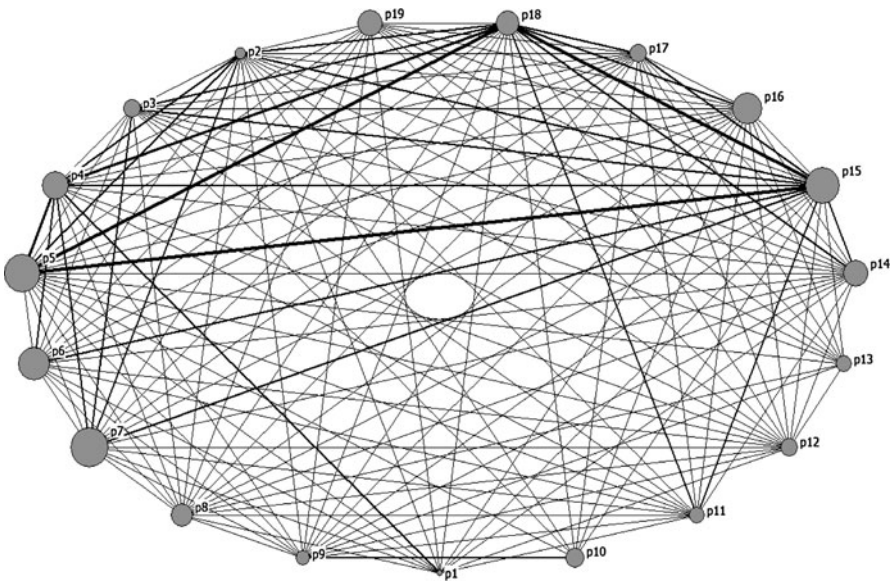

Fig. 1 The network of presidium producers. *Notes*: Each link thickness represents the frequency of interaction between the connected producers; the size of vertexes representing producers depends on their production capacity

for instance, two producers who are used to meet once per month, have a little less than 0.25 probability to meet each simulation step.

Each producer has to choose at each simulation step between producing high or low quality cows. The yearly production capacity that has been measured via questionnaires has been divided by 52 to represent the number of cows slaughtered each week.

It is worth noting that those are simplifications: it is obvious that it takes longer than a week to breed a cow and that it is not possible to breed and slaughter fractions of it. But that should not change results, because even the choice of defection cannot be so discrete but continuous, for instance by partially respecting Presidium regulations, and information about defection can, as well, spread continuously and not only when cows are slaughtered. The model needs a higher level of simplicity and the used structure still represents the real weight of each producer on the aggregate outcome.

Having sketched producers' behavior, it is worth noting how it is impossible to collect data regarding it in the field. In fact, the absence of a formal control system is purely theoretical, and thus there is neither data available nor collectable on such conditions.

It is then possible to use idealized kinds of behavior such as the ones identified in the relevant literature about social dilemma (Kahan 2005). Producers, in particular, can be altruists, always respecting regulations, or reciprocators (Axelrod 1984), respecting regulations if others do. There cannot be selfish producers who never respect regulations: the participation to the Presidium is voluntary and producers are selected before entering, thus the assumption about the absence of complete selfishness could be realistically considered the starting point of our analysis though what we focus on is the potential emergence and spreading of opportunistic behavior.

In such a way, by considering those kinds of behavior, the research question can be better specified: is the expensive and complicated formal control mechanism necessary or is an informal one such as reciprocation sufficient to ensure cooperation?

Reciprocators are modeled reacting upon singular and immediate defections of neighbors, and the adopted choice can be considered an extreme case of intolerant conditional cooperation that helps in pointing out the effects of the informal control mechanism.

Finally, and before proceeding to analyze simulation results, it is worth adding that both altruists and reciprocators are modeled as non "stupid", that is to say that both kinds of behavior stop the cooperation (i.e. to produce high quality) if the average quality of the Presidium production drops under 50 per cent. In that case almost surely the Presidium fails because consumers will stop buying its low quality meat, and that knowledge is common to all producers and implemented in the algorithms.

5 Simulations results

It is worth starting by studying the worst case scenario, with all producers behaving as reciprocators. That is to say that each one of them, if they receive information

about a deception (i.e. the fact that one producer has broken regulations) react by producing low quality, but if further information about deceptions does not reach producers, they will turn back in following regulations at the next step.

The resulting simulation is as follows: we hypothesize that one producer defects, and according to producers' behavior and the possibility to meet and thus to be updated about others deception, we investigate how deceptions spread in the Presidium.

Knowing that if high quality production falls below the 50 per cent a strong feedback comes from the market and the Presidium fails, and knowing that producers interaction depends upon their probability of meeting that is simulated by using a random numbers generator, all results are reported as probabilities of the Presidium to survive, computed as average values over 1,000 runs with different seeds considered by the random number generator.

Figure 2 presents the probability of survival of the Presidium after 10 weeks of a producer's deception. The probability of survival equals the probability of high quality production, which is the public good of the Presidium. Those values are represented as empty (white) columns. The fact of having columns with different values depends on a producer's position in the social network, and it will be studied below, but for now is important to underline that each data means the probability of the Presidium to survive if that specific producer defects at the beginning of the simulation. For instance, that means that if the producer called P10 defects, the probability of the Presidium survival will be slightly higher than 25 per cent, while if P4 defects the Presidium does not have any probability of survival.

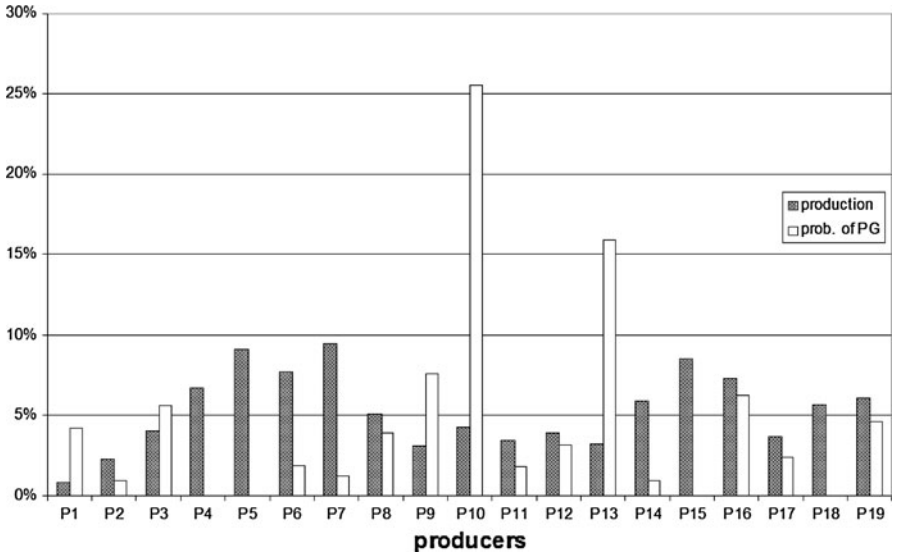

Fig. 2 Producers productive capacity and probability of public good (PG) provision in the presidium with reciprocation. *Notes*: Results are presented after 10 time steps from a producer's deception; simulations are run with all producers reciprocating

Darker (grey) columns in Fig. 2 represent the producers' percentage of total production capacity. This data is drawn to make clear how even if heterogeneous, production capacity does not differ very much and it does not seem to be particularly relevant for aggregate dynamics, at least considering producers one by one.

As said, thinking about the working mechanism behind the model and studying its results, it seems that a very important issue to explain the latter is related to producers' position in the social network. For making such an analysis on a social network, many statistical tools and techniques are available (Social Network Analysis—SNA—see Schott 1991; Wasserman and Faust 1994).

SNA gives plenty of tools for investigating several issues related to the structure of social networks but here, after several analyses made with different tools, we present results obtained with "K-core analysis" (Schott 1991: 110ff; Wasserman and Faust 1994: 266–267; Doreian and Woodard 1994), which helps in pointing out cohesive subgroups in social networks.

The network has thus been studied according to the degree of connectivity of nodes. The analysis proceeds by grouping nodes depending on the differences in their degree value and, to further investigate the presence of sub groups, by filtering links with lower values.

The analysis has been carried out using a visual tool, NetDraw, which helps in filtering and analyzing the network. Moreover, over the next different figures the nodes' positions, which are based upon a visualization algorithm that depicts closer vertexes more connected in terms of links strength and not the actual spatial disposition of producers, will not be changed in order to help the reader identifying different nodes more easily, and only the most relevant figures are presented for space sake.

Figure 3 points out that producers labeled as P9, P10 and P13 have a peripheral position in the network. Figure 4, on the contrary, applying K-core analysis on the filtered network where only links representing at least three meetings per month are considered, shows the presence of a singular central group of producers (P4, P5, P15 and P18). The remaining nodes, the ones in between, are mainly linked with the central group.

We can investigate the presence of a central node of the subgroup in Fig. 4 by further filtering the links: the result is the presence of three central and highly connected producers (P5, P15 and P18). Their internal connection structure is simple: one central vertex (producer P18) frequently interacts with the other two.

An interesting point to note is that P18 is the president of the producers association, elected by other producers. Moreover it is worth noting how even when searching for subgroups and producers' roles, there is no clear correlation between producers' size and position (see Fig. 1).

Hence, it is possible to use the K-core analysis results to better interpret differences found in first simulation outcomes. Consider Fig. 2 and the following ones, focusing on extreme cases. It is possible to notice that defections coming from producers P4, P5, P15 and P18 determined the end of Presidium, by guaranteeing zero per cent of public good probability. It has been found that those producers are the four most connected in terms of meeting frequencies. On the other side, in Fig. 2

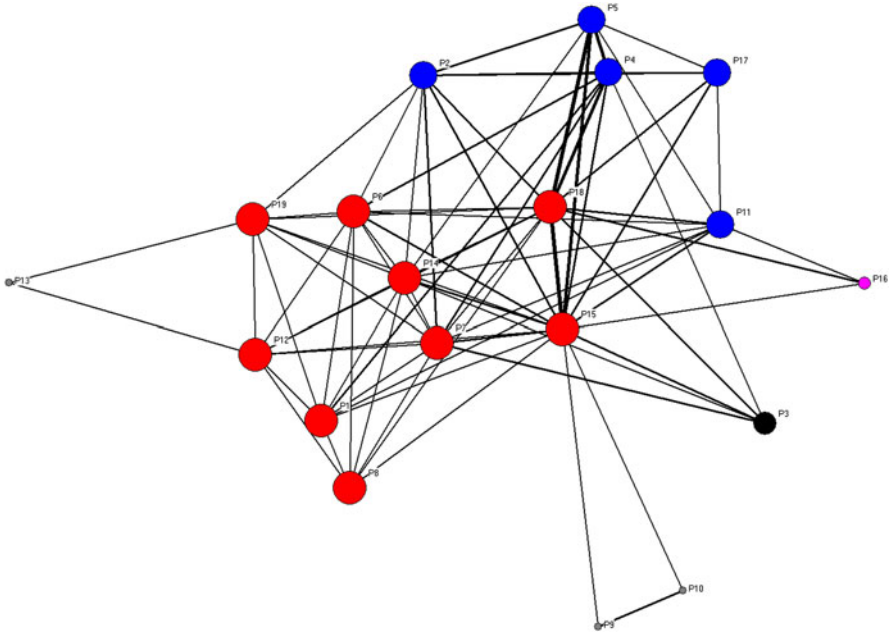

Fig. 3 Presidium producers' network, K-core analysis, links between producers meeting at least once per month

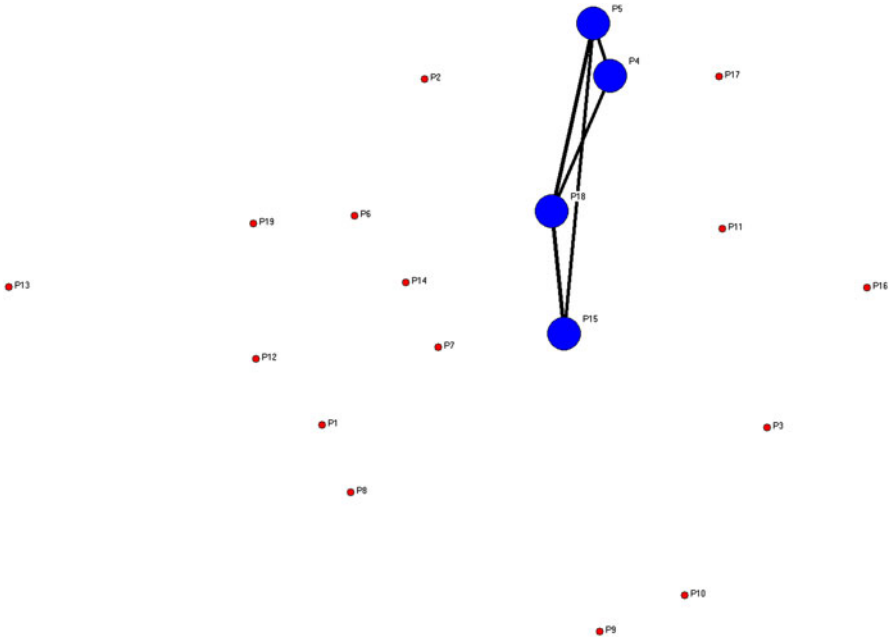

Fig. 4 Presidium producers' network, K-core analysis, links connecting producers who meet at least three times per month

we noted P9, P10 and P13 as the three with minimal negative impact on the Presidium. They are the least connected producers, as can be seen in Fig. 3. For all other producers similar arguments can be made.

Summarizing, it is clear that negative impact is positively correlated with producer's connectivity, and the causal mechanism is now quite simple to understand looking at the model. Defections coming from less connected producers have less a chance to diffuse, while if most central producers defect, the reciprocating reaction of other producers met by them will surely determine the end of the Presidium.

New simulations can thus be made, starting to consider not only the presence of reciprocating behavior, but also the one of altruism. If we study the impact of altruism in the Presidium, for each producer, we can notice that there is not a significant impact on survival probabilities.

The lack of positive impact of individual altruism is a very important result. In fact, considering the opposite result found in considering the negative impact of individual defections, we face a dilemma in which single altruistic actions are not capable of sustaining a positive aggregate, while single selfish choices can determine very negative outcomes. Such an asymmetry is typical of social dilemmas where the positive collective action is defined by the copresence of many opportune micro behaviors.

If we consider groups of altruists (i.e., several altruists at the same time in the system), results can change. But how many altruists could have been expected among Presidium producers? There is no empirical data to evaluate each producer's expected behavior, that is to say, to understand that he would unconditionally cooperate in the case of absence of formal control mechanisms in the Presidium. From the analysis of individual behavior in a well known experiment of voluntary public good provision (Andreoni 1995) it seems that there are approximately 1.4 reciprocators for each altruist (for instance in the just referred experiment, our analysis estimates a 35% of reciprocators and 25% of altruists, and such a distribution seems to be approximately confirmed by other analyses such as the ones reported in Burlando and Guala 2005).

Considering that ratio between reciprocators and altruists, it can be expected to find eight altruistic producers in the Presidium. The issue, obviously, is which ones? Figure 5 presents a summary of possible scenarios. The worst case scenario is the one with all producers reciprocating: the probabilities obtained by considering this case are presented in the top-left part of the figure.

As a best case scenario it is possible to ideally think that is the situation in which all producers are altruists, but it is not plausible and the outcome in that case would always be complete cooperation.

The most plausible best case scenario is the one with a set of eight altruistic producers composed of the most central producers. This one is the case reported in Fig. 5 at the bottom on the left. Otherwise from what was said before, in this case the probabilities of survival are very high. But that positive result is strictly dependent on the fact of choosing the eight most connected producers. In fact, the bottom-right part of the figure shows probabilities in the case in which the eight altruistic producers are the first seven and the ninth most connected. Probabilities of

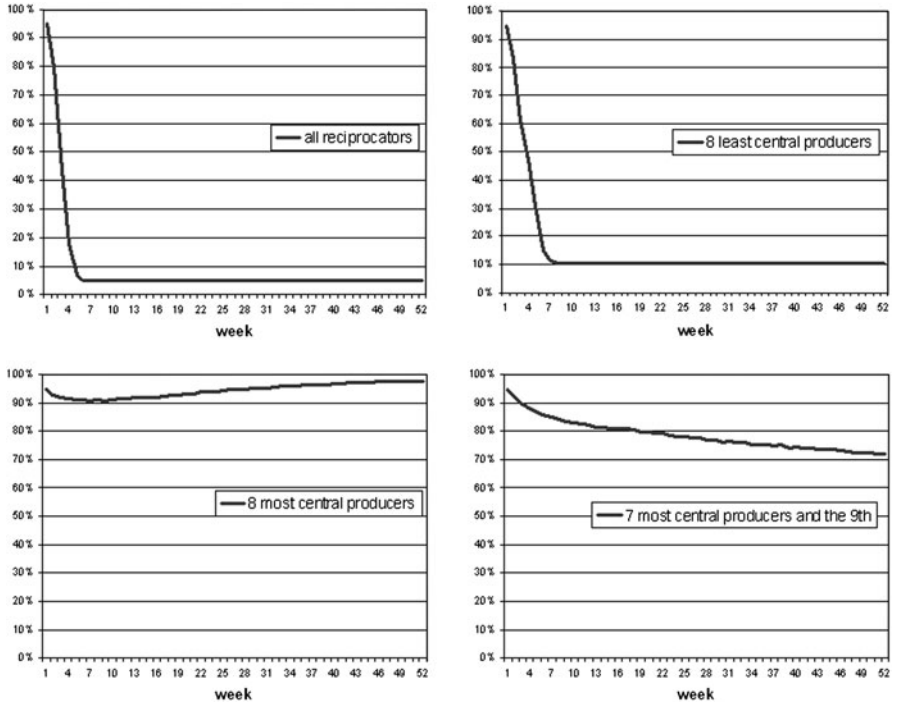

Fig. 5 Probability of public good provision over time: different behavior configurations in producers' set

survival strongly decrease, even if just the eighth most connected producer has been substituted by the ninth.

It is clear how the best case scenario, the one with the eight central producers behaving altruistically, is the only one that can stop defections from spreading, so that, going forward in time, the probability of Presidium survival raises because defections are permanently wiped out from the producers' network.

6 Conclusions

The main result of simulations is that the absence of mechanisms for cooperation enforcing means high risks for the survival of the considered system. If, as it seems probable, in the near future the system is characterized by a diminution of trust among producers and by an increase of incentives to free ride, the system's future will probably be strictly dependent on the capacity to keep the monitoring system described here or to find another institutional mechanism capable of guaranteeing high quality.

The presence of reciprocating behavior that is commonly seen as a means to enforce cooperation and a sort of individually based, autonomous and informal control mechanism, in a system like the considered one, seems to be not effective. On the contrary, the commitment of the most "central" agents can be effective in guaranteeing the provision of public goods.

While individuals' behavior, reciprocation included, is the outcome of an evolutionary process which promoted simple and effective rules of behavior (Sadriech et al. 2001: 84–85) and which had been driven by reasoning, by social norms (Sadriech et al. 2001: 99), by simple processes of reinforcement learning in several contexts (Erev and Roth 2001: 215), and by processes of imitation of behavior patterns and of social learning (Laland 2001: 243; Mellers et al. 2001: 271ff), the interaction structure seems to be probably caused by external factors such as age and geographical proximity. Due to the short history of the system considered here, its social network has not yet coevolved along behavior in order to promote cooperation and that is the reason why a formal control mechanism is still needed to ensure mutual trust, to preserve a high quality level and to promote local development.

However, many issues still remain open: the most important one is our lack of knowledge about the elements required to improve the effectiveness of the formal control mechanism in the studied organization and in similar ones.

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