

ODD protocol

Overview

Purpose: The model was created to explore the effectiveness of policy instruments to advance the decoupled green-growth of clusters. We have used it study the specific case of transition of peripheral-region clusters. We conducted in-silico experiments, where we investigated the effects of a) local innovation grants, b) fines on pollution c) financial incentives for attracting 'green' entrants, and d) an instrument mix of incentives and fines, on the cluster's transition.

Essentially, the agents in this model are on a type of technological treadmill (Cochrane, 1958), where they must engage in green-tech innovation, or get disrupted (Christensen, 2013) and perish. The objective of the agents in the simulation is to survive, and grow, for as long as possible. The agents exist in an environment where demand for their products and processes is positively correlated with their sustainability. Consequently, each agent's survival depends on its ability to increase, or at least maintain, knowledge of green-technologies, and their financial capital and reputational capital. The challenge facing agents is that with time, the knowledge, financial and reputational capital stocks they hold diminish, while the pollution climbs.

Transition is achieved through successful incremental and radical sustainable-innovation with green-technologies. Creating or adopting new knowledge is key to survival. New knowledge is created or adopted through green-innovation projects. Agent survival and growth requires innovation at a rate that prevents knowledge-value depletion and reduction in demand for products/processes. Green-innovation projects endow agents with rewards in the form of capital assets and lower pollution.

1. Entities:

- Agents: The agents in this model represent firms. The model is comprised of two breeds or types of agent – incumbents and entrants. There are four types of firms in the model:
 - a) Incumbents: these firms are of the breed incumbents.
 - b) Spinoffs: a spin-off firm is created from the agent that initiated a successful radical innovation project. Spinoffs are of the breed incumbents.
 - c) Split-firms: a firm-agent splits into two split-firms when its knowledge capital, financial capital, or reputational capital crosses the threshold of 100. Split-firms are of the breed incumbents.
 - d) Entrants: extra-cluster firms that enter the cluster when certain conditions are met. They are of the breed entrants.
- State variables: All firms have financial, reputational and knowledge capital (knowledge capital refers to knowledge about green-technology), some level of pollution, size (which is function of financial capital), shape (which is circle for incumbents, triangle for spinoffs, square for split firms, pentagon for entrant firms), colour (which is green for relatively green firms, red for the rest), and counters for the number of successful radical and incremental innovation projects they have been part of.
- Environment: Global variables that drive the behaviour and dynamics of agents are:

- 1) Probability of collaboration: This is the probability of firms collaborating for a (green) innovation project. Defined as ratio of number of firms collaborating in an innovation project to the total number of firms. The range of values for this variable is obtained from the range of values for "Innovative SMEs collaborating with others" for modest regions, from the European RIS 2019-2020 scoreboard.
- 2) Probability of radicalness: The probability of a (green) innovation project being a radical one. Defined as the ratio of number of successful radical innovation projects to total number of successful projects. The range of values for this variable is obtained from the range of values for "Sales of new-to-market and new-to-firm innovations" for modest regions, from the European RIS 2019-2020 scoreboard.
- 3) Probability of innovating: The probability of a (green) innovation project succeeding. Defined as the ratio of number of successful projects to total number of projects. The initial value for this variable is obtained from the lowest value for "Product or process innovators" for modest regions, from the European RIS 2019-2020 scoreboard. We do not maintain a range for the probability of innovating, as we treat it as an emergent variable shaped by agents' innovation activities.
- 4) Innovation potential: This is the ratio of the number of successful projects to the total number of firms at a point time.
- 5) Decay rate: This is the rate at which the agents' three capital asset stocks decline with each time-step, and also the rate at which the agents' pollution rises with each time-step.

We created this model to simulate the green-growth of any type of cluster in any region. For the purpose of this study, we simulate the conditions firms face in a peripheral region, using certain global variables (like in Dilaver et al. (2014)). As per Isaksen & Trippel (2014), peripheral regions have few large firms. Consequently, we only have a small percentage of large firms in the cluster, at initialisation. Among all types of regions, networking and collaboration are supposed to be lowest in peripheral regions. Consequently, for the variable probability of collaboration, we chose the lowest range of value from the European RIS 2019-2020 scoreboard (which is for "modest" regions in the scoreboard). Peripheral regions also have low levels of innovation, and any innovations are usually incremental. Hence, we chose the lowest (range of) values for both probability of innovating, and probability of radicalness (again, from modest regions). In short, agents in the model will collaborate and innovate at rates that are characteristic of peripheral firms. To simulate conditions of metropolitan or specialized regions, we simply need to change the range of values for the above global variables. By maintaining the ranges for probability of collaboration and radicalness, we ensure that the agents always behave as peripheral firms. We do not maintain a range for the probability of innovating, as we treat it as an emergent variable shaped by agents' innovation activities. The main agent variables and state variables are summarised in the table 1 below

2. Process overview and scheduling: With each time step, the following processes occur (in this order):

- The model checks if the number of agents in the simulation is less than the variable “number of projects in a tick”, or if the number of ticks is over 300. If either condition is true, the simulation stops; otherwise, it proceeds to the following processes/submodels.
- Update values: The capital-stocks of all agents decay as per the decay rate. Agents’ pollution increases as per the decay rate. Innovation potential and Cluster-strength values are updated.
- Fines: If fines are to be applied, the model checks if any agent’s pollution level is above 33. If yes, the transgressing agent is fined as per the fine level.
- Check death: The model checks if any agent’s financial capital or reputational capital is below 10, or if pollution is higher than 100. If any of the conditions are true, the agent ceases to exist.

Table 1. The agents’ own and global variables that guide agent behavior.

Variable	Definition
Agents' own	
Financial capital	Financial capital in possession of an agent.
Knowledge capital	Knowledge possessed by an agent about green-technologies.
Reputational capital	Reputation, trustworthiness of an agent.
Pollution-level	Represents how polluting an agent’s operations are.
Radical number	The number of successful radical innovation projects an agent has participated in.
Incremental number	The number of successful incremental innovation projects an agent has participated in.
Global	
Probability of collaboration	This is the probability of firms collaborating for a (green) innovation project. Defined as ratio of number of firms collaborating in an innovation project to the total number of firms. The range of values for this variable is obtained from the range of values for "Innovative SMEs collaborating with others" for modest regions, from the European RIS 2019-2020 scoreboard.
Probability of radicalness	The probability of a (green) innovation project being a radical one. Defined as the ratio of number of successful radical innovation projects to total number of successful projects.
Probability of innovating	The probability of a (green) innovation project succeeding. Defined as the ratio of number of successful projects to total number of projects.
Innovation potential	This is the ratio of the number of successful projects to the total number of firms at a point time.
Cluster strength	This is the number of agents in the cluster, at any given point in time.
Decay rate	This is the rate at which the agents’ three capital asset stocks decline with each time-step, and also the rate at which the agents’ pollution rises with each time-step.

- Entrant: In case entrants are allowed to enter, entrants may enter the cluster if incentives are high enough. In one tick, only one entrant may enter the cluster.
- Collaborate: The probability of radicalness is updated (as long as it is below the maximum value of 0.55 (as per the EU innovation scoreboard)). To start an innovation project, an initiator agent collaborates with between one and five agents that possess the highest levels of knowledge capital. Some of the projects are randomly chosen to be radical innovation projects.
- Innovate: The probability of innovating is updated. The partners in an innovation project commit capital to the project. The capital an agent commits to the project is proportional to its capital stocks, and the number of successful projects it has been part of. In case grants are to be provided for innovation projects, the model checks if any project qualifies for it, and infuses financial grants into the project.

The projects succeed or fail. With each successful project, the probability of collaboration is increased by the value of number of partners / total number of agents. This updating is done till the probability of collaboration reaches the value of 0.27 (as per the EU innovation scoreboard). The partners of the project are given capital increments and pollution decrements as reward. Rewards for successful radical projects are higher than for successful radical projects. Successful radical projects also lead to a spin-off being created from the project initiator.

- Split large firms: The model checks for any agents with financial, reputational or knowledge capital-stocks are above 100. These agents are split into two firms. They are however counted as one firm by the model.

Design concepts

1. Basic principles: The model is based on theoretical postulations regarding agent actions required to cause the growth of green-clusters in peripheral regions, based mainly on Tödtling & Trippel (2005), Isaksen & Trippel (2014), and Grillitsch & Hansen (2019). The model's features, processes have been inspired by models from Dilaver et al. (2014), Vermeulen & Pyka (2014), Canals et al. (2008) and others.
2. Emergence: Emergent patterns of interest are:
 - a) Pollution levels: Since we are interested in the transition to a more sustainable cluster, we will be tracking the pollution levels of the cluster, which is the sum of the pollution levels of all the agents that make up the cluster.
 - b) Cluster strength: Green-growth requires not just a sustainable cluster, but a sustainable cluster that grows in size. Consequently, we will be tracking the variation in cluster strength, which is the number of agents existing at any point in time (note: split agents are counted as one agent).

c) Knowledge capital: If the cluster is to become more sustainable, its stock of knowledge-capital on green-technologies must increase. We track the cluster's knowledge capital, which is the sum of the knowledge capital stock of every agent in the cluster.

d) Financial capital: Green-growth requires not just environmental sustainability but economic sustainability as well. We track the cluster's financial capital, which is the sum of the financial capital stock of every agent in the cluster.

e) Reputational capital: Successful decoupling not only involves reducing pollution, but also increasing agents' reputations – its sustainability credentials – in the cluster and sector. We track the cluster's financial capital, which is the sum of the reputational capital stock of every agent in the cluster.

f) Ratio of pollution to financial capital: Green-growth requires economic growth to decouple from pollution. We track this ratio to see if as the cluster's pollution levels go down, its financial capital stock goes up.

Besides these six parameters, we also track the number of successful projects and the number of successful radical projects. The desired end state, where the simulated cluster has achieved green-growth, is one where pollution has significantly declined, cluster strength has increased or at least remained the same, capital stocks have increased, and the ratio of pollution to financial capital is trending down. The least desired state is when the agents have died out as pollution increased and capital stocks have been depleted.

3. Adaptation: Firms die if their financial capital or reputational capital goes under 10, or if pollution-level goes above 100. Firms split into 2 when any of financial, knowledge or reputational goes above 100.

As the innovation potential rises, more firms will take up radical projects (i.e. number of radical projects will increase). Initially, most projects are of incremental nature, and green-technologies are assumed to be available "off-the-shelf" (greening through importation (Grillitsch & Hansen, 2019)). However, the peripheral agents can develop better green-technologies through radical innovation projects. With more and more incremental projects, the firms improve their knowledge of green-technologies, so they can then progress to radical projects. With successful radical projects, the firm-agent moves onto a new S-curve and new green-technology that surpasses the sustainability of technologies in possession.

4. Objectives: Essentially, the agents in this model are on a type of technological treadmill (Cochrane, 1958), where they must engage in green-tech innovation, or get disrupted (Christensen, 2013) and perish. The objective of the agents in the simulation is to survive and grow for as long as possible. The agents exist in an environment where demand for their products and processes is positively correlated with their sustainability. The challenge facing agents is that with time, the knowledge, financial and reputational capital stocks held by each agent diminish, while the pollution climbs. Consequently, each agent's survival depends on its

ability to increase, or at least maintain, knowledge of green-technologies, and their financial capital and reputational capital. Creating or adopting new knowledge is key to survival. New knowledge is created or adopted through incremental and radical green-innovation projects. Agent survival and growth requires innovation at a rate that prevents knowledge-value depletion and reduction in demand for products/processes. Green-innovation projects endow agents with rewards in the form of capital assets and lower pollution

5. Stochasticity: Initial levels of firms' capital stocks, the initial levels of pollution, the initial selection of large firms, whether projects are radical or incremental, innovation projects succeeding, the entrance of entrants, whether entrants are large or small, and projects being given financial grants, are all random processes.
6. Observation: Observations include graphical displays of all the above-mentioned emergent patterns of interest.

Details

1. Initialization:

- The Probability of collaboration is set at 14% (roughly, mid-point of the range), probability of radicalness is automatically set at 28% (roughly, mid-point of the range), and probability of innovation is automatically set at 2.2% (lowest value in the range). The decay rate is set at 0.01%. The number of projects in a tick is set at 5. The maximum possible project size is set at 6 partners. Initial cluster-strength is set at 50. The percentage of large firms is set at 3%.
- Incumbent firms are created. Incumbent firms are circular in shape.
- 3% of incumbent firms are randomly selected to be "large firms" and given the highest financial and reputational capital stocks (which are some random numbers between 50 and 100 for both types of capital). The rest of the small- or medium-sized firms are given lower levels of financial capital and reputational capital (some random numbers between 10 and 50). Size of the firms is set at 5% of the financial capital of a firm. Radical number and incremental number are set to zero.
- Initial pollution levels (random numbers under 100) are assigned to all incumbents. For incumbents with pollution-levels under 50, knowledge capital is set as a random value between 25 and 75. For incumbents with pollution-levels over 50, knowledge capital is set at 25. Incumbent firms are given the colour green if pollution is less than 25; red if it is higher than 25.

2. Input data:

- Cluster strength (range of 30 to 100).
- Percentage of large firms (range of 1% to 5%).
- Probability of collaboration (range of 0 to 27%)
- Probability of radicalness (range of 0 to 55%)
- Number of projects in one tick (range of 5 to 8)
- Maximum number of partners for initiator (range of 1 to 8)
- Incentive-levels for entrants (range of 0 % to 25%), if applicable.

- Grant-levels for innovation projects (range of 0 % to 25%), if applicable.
- Fine-levels for polluting firms (range of 0 % to 25%), if applicable.

Table 2. Possible values of variables, and the values at time of initialisation

Variable	Possible values
<u>Agents' own</u>	
Financial capital	Model sets to any random value between 50 and 100 for large firms. Model sets to any random value between 10 and 50 for small or medium firms
Knowledge capital	Model sets to 25 if pollution greater than 50. Model sets to some random value between 25 and 75 if pollution is lower than 50
Reputational capital	Model sets to any random value between 50 and 100 for large firms. Model sets to any random value between 10 and 50 for small or medium firms
Pollution-level	Model sets to any random value under 100
Radical number	Model sets to zero at initialisation
Incremental number	Model sets to zero at initialisation
Colour	Green for agents with pollution lower than 25 Red for agents with pollution higher than 25
Size	Model sets size at 5% of financial capital
Shape	Extant agents are circular in shape, Spinoffs are triangular, Entrants are pentagonal
<u>Non-agent variables</u>	
Probability of collaboration	Any value between 1% and 27%. For our experiments, we set initial value as 14% (roughly mid-point of the range)
Probability of radicalness	Any value between 1% and 55%. For our experiments, we set initial value as 28% (roughly mid-point of the range)
Probability of innovating	Model sets Initial value at 2.2%
Innovation potential	Initial value is 0.01
Cluster strength	Any value between 30 and 100. For our experiments, We set initial value as 50
Percentage of large firms	Any value between 0 % and 5%. For our experiments, we set initial value as 3%
Decay rate	Can be any value between 0 and 1%. For our experiments, we set a rate of 0.1%
Maximum possible project size	For our experiments, projects have between 2 and 6 members
Number of projects in one tick	Can be any value between 5 and 8. For our experiments, we use a value 8
Grants for innovation projects	For our experiments , we set a range of between 0% and 25%
Fines for polluters	For our experiments , we set a range of between 0% and 25%
Incentives for entrants	For our experiments , we set a range of between 0% and 25%

Table 2 above shows how the possible values variables can take, and how they are initialised in the model.

3. Sub-models:

1) Update values

In this sub-model, the capital-stocks of all agents (whether incumbent, split-firm, spinoff or entrant) are reduced as per the decay rate, and pollution is increased. The three assets decrease by the formula $C(1 - dr)$, while the pollution increases by the formula $P(1 + dr)$. “C” is the value of the capital-asset in the prior time-step, “P” is the pollution-level of the agent in the prior time-step, and “dr” is the asset decay rate (also see table 3). For our experiments, we use a decay rate of 0.001, i.e. 0.1% (see table 2 above).

This exponential asset decay, and associated pollution increase, has to do with the performance of green-technologies moving along an S-curve (Sahal, 1981). The sustainability of a green-technology initially climbs, matures and then, stagnates or depletes. To reflect this move towards stagnation or depletion, we have the agents’ knowledge capital decreasing with each tick. As the performance of green-technologies deteriorate with time, knowledge associated with those technologies lose value; hence the reduction in knowledge assets. With the green-technology knowledge they possess getting outdated, agents’ products and processes become dirtier, and the pollution level of each agent increases. Agents’ financial capital decreases when demand for their products/processes comes down. As agents’ green-technology knowledge becomes outdated, the sustainability of their products and processes come down. This causes the relative competitiveness of products/processes to go down; reducing demand for them. Lower demand forces agents to use their reserves to survive; hence the reduction in financial capital each tick. With declining value of green-technology knowledge, declining sustainability for their products/processes, the reputational capital of the agents decreases each tick.

Also in this sub-model, the innovation potential is updated as the ratio of the sum of all innovation projects existing agents have been part of, to the number of agents existing (as long as the numerator is greater than zero). Thirdly, cluster-strength is updated as the number of agents (minus the new agents caused due to firms splitting).

2) Fines

If the observer has activated fines, this sub-model is run. The sub-model checks if any agent’s pollution level is above 33. If yes, the transgressing agent is fined as per the fine level set by the observer.

3) Death

This sub-model checks if any agent’s financial capital or reputational capital is below 10, or if pollution is higher than 100. If any of the conditions are true, the agent ceases to exist.

Table 3. How capital assets and pollution decrease/increase with time, or increase/decrease with successful green-innovation

Variable	Decrement (each time-step)	Rewards (from innovation)
Financial capital	Decreases at a rate between 0 and 1% (as set by user). We use a rate of 0.1%	Increases by 25% with incremental innovation. Doubles with radical innovation.
Knowledge capital	Decreases at a rate between 0 and 1% (as set by user). We use a rate of 0.1%	Increases by 25% with incremental innovation. Doubles with radical innovation.
Reputational capital	Decreases at a rate between 0 and 1% (as set by user). We use a rate of 0.1%	Increases by 25% with incremental innovation. Doubles with radical innovation.
Pollution-level	Increases at a rate between 0 and 1% (as set by user). We use a rate of 0.1%	Decreases by 25% with incremental innovation. Halves with radical innovation.

4) Entrant

If entrants are allowed by the observer this sub-model is run. This sub-model offers incentives to entrant firm-agents that come into the cluster. Incentives refer to financial capital that is bestowed to the entrant, immediately upon entrance. Incentives range from 0 % to 25% of the financial capital a large or small entrant possesses at entry.

The probability of a new agent entering the cluster is positively correlated to the incentives set. Only one entrant may enter the cluster in each tick, and it may be a large or small agent. Entrants upgrade the knowledge assets of the cluster by bringing in new, higher-value green-technology knowledge in their possession. Entrants' knowledge capital, ranging between 75 and 100, is higher than of cluster agents. An entrant's pollution-level is the same as the lowest pollution-level among cluster-agents. Entrants' experience with successful incremental and radical innovation will be random values between the mean and maximum experience among the cluster-agents. Once they enter the cluster, entrants will behave like any other cluster agent. If they fail to innovate, they can turn dirty, become too asset poor, and cease to exist. For this scenario, we varied incentive levels from 0 to 25%, with jumps of 5%.

5) Collaborate

This sub-model assigns some firms as "project initiators". To start an innovation project, an initiator agent collaborates with between one and five agents that possess the highest levels of knowledge capital. Any firm-agent can initiate a green-innovation project. At a time, an agent can only be a member of one project. The number of projects successfully initiated in a tick is the product of probability of collaboration and a random positive integer below the variable "number of projects in a tick", which is input by the observer.

Some of the projects are randomly chosen to be radical innovation projects. In the beginning stages, there are very few radical projects initiated, most of them being incremental innovation projects. The chances of an initiated project being a radical project are positively correlated with

the innovation potential. With time, if there are several successful incremental innovations, the innovation potential rises, and so can the number of radical projects.

Also in this sub-model, the probability of radicalness is updated as the ratio of the number of successful radical projects to the total number of successful projects (if the number of successful radical projects is greater than zero). This updating is done only until the probability of radicalness reaches its maximum value of 0.55 (as per the EU innovation scoreboard).

6) Innovate

This sub-model begins with updating the probability of innovating by calculating the the ratio of the number of successful projects to total number of projects (as long as the number of successful projects is greater than 0).

In this sub-model, after agents have collaborated on project, they are to innovate using green-technologies that present the possibility of new capital rewards and reduction in pollution. To execute the project, project-partners commit capital to the project. The chances of project success are directly proportional to the amount of knowledge, financial, and reputational capital committed by each collaborator to the project, the total number of successful radical/incremental projects that the partners have been a part of, and the global variable probability of innovating. Chances of project success are lower when the project is a radical one. The capital an agent commits to the project is proportional to its capital stocks, and the number of successful projects it has been part of. This way, richer, more experienced agents are able to commit more capital to the project, increasing chances of success.

If the observer has activated grants, this sub-model checks if any of the projects in the tick qualify for grants. Grants refer to financial capital that is given to a particular project, which is added to the financial capital that has already been committed to a project, by project partners. Grant levels range from 0 % to 25% of the financial capital that has been committed to the project. In each time-step, during the act of innovation, the model will check if particular projects can receive grants. The chances of a project receiving a grant are positively correlated with capital stocks committed to it, and the number of successful incremental/radical projects that the partners have been part of (following Banal-Estanol et al. (2016)).

When a project succeeds, a few things happen. Firstly, the probability of collaboration increases (by the ratio of the number of partners in the project to total number of agents). The increment occurs with each success, as long as the probability of collaboration stays under the upper limit of its range (see table A1 in the appendix). Secondly, the probability of innovating is updated (by calculating ratio of successful projects to total number of projects undertaken), as long as it stays under the value of one. Thirdly, depending on the type of project that succeeded, the radical number or incremental number for each project partner is increased by one. Finally, if the project that succeeded is a radical one, probability of radicalness is updated (by calculating ratio of successful radical projects to total number of successful projects). The increment occurs, as long as the probability stays under the upper limit of its range. By maintaining the ranges for probability of collaboration and radicalness, we ensure that the agents always behave as

peripheral firms. We do not maintain a range for the probability of innovating, as we treat it as an emergent variable shaped by agents' innovation activities.

Successful innovation rewards all participating agents equally (like in Vermeulen & Pyka (2014)), with capital-assets and lower pollution. After each successful project, the agents will have their financial, knowledge and reputational capital doubled (in case of a radical project), or rise by 25% (in case of an incremental project). Pollution is halved (in case of a radical project), or decreases by 25% (in case of an incremental project) (see table 3). If the successful project is a radical one, a spin-off firm-agent is created from the agent that initiated the project. This spin-off will have 25% of the parent's knowledge and financial capital, pollution-level, and past experience with successful projects; and 50% of reputational capital.

In case the project that succeeded is a radical project, a spinoff is created. The spinoff is formed from the project initiator. The spinoff has the same properties (reputational capital, knowledge capital etc.) as the parent, except it has 25% of the financial capital (and size) of the parent. Spinoffs are triangular in shape.

7) Split large firms

This sub-model checks if for any agent, its either financial, reputational or knowledge capital has goes over 100. If that is the case, the particular firm splits into 2, creating a "split firm". The parent agent's financial and knowledge capital, its pollution, and its past experience with successful projects are split into two and each half is inherited by the two new firms. After the split, the two agents are still counted as one agent, so splitting does not result in growing cluster strength.

Experiments

In the ABM, we conducted experiments to simulate the effects of three individual instruments, and an instrument-mix, on agents' innovating behaviour and on the consequences for green-growth in clusters located in peripheral regions. The three instruments are 1) Financial incentives used to attract external actors having experience with the imported green-technologies, 2) Grants provided to qualifying innovation projects being run by cluster actors, and 3) Imposition of fines on cluster actors that cross a certain level of pollution. The instrument-mix we explore is both Incentives and fines being applied simultaneously. The four experiments we conducted are summarised in table 4 below.

Table 4. The experiments conducted in the model, by introducing different instruments

Experiments	Description	Instrument settings
Imposing fines on polluting firms	Fines refer to financial capital that is instantly reduced from an agent's stock when its pollution-level is equal to, or crosses, 33.	Fine levels range from 0% to 25% of an agent's financial capital.
Introducing grants for local innovation projects	Grants refer to financial capital that is given to a particular project, added to the financial capital that has already been committed to a project.	Grant levels range from 0% to 25% of the financial capital that has already been committed to the project
Introducing incentives for attracting entrants	Incentives refer to financial capital that is bestowed to the entrant, immediately upon entrance.	Incentives range from 0 % to 25% of the financial capital held by the entrant
Introducing instrument-mix of incentives and fines	In this final scenario, every time-step, some entrants may enter the cluster and receive incentives, and some agents may get fined.	Incentive levels range from 0 % to 25% of the financial capital that has already been committed to the project. Fine levels range from 0 % to 25% of each agent's financial capital.