

## Report on NetLogo simulation model:

### “Study of indirect cooperation in a Kibbutz economy”

#### Introduction: the choice of setting.

A kibbutz (in [Hebrew](#): קיבוץ, קבוצה, clustering, gathering, plural: *kibbutzim*) is a collective, traditionally agricultural community, based on voluntary participation of individuals and on collective ownership of property and of means of production.

This type of social organization was born in Israel in the first decades of the XX century following the innovative ideas of the European Zionist movement. The kibbutz evolved and flourished socially, culturally and economically for several decades until it reached its peak in the second half of the 20<sup>th</sup> century.

Nowadays the picture of the Israeli kibbutz appears to be highly heterogeneous; many kibbutzim have been partially or completely privatized and farming has been to a great extent replaced by industrial specialization and various other economic activities. Consequently, the internal organization of the kibbutz has also profoundly changed.

In the original kibbutz system, the individual sphere was far less important than the collective one and personal needs were considered as secondary with respect to the community welfare. Even the education of the young was entrusted to the community; children were brought up together, seeing their parents daily but living in separate homes together with their peers.

*Fig. 1. Kibbutz children*



*Fig.2. Field Workers*



*Fig.3. Kibbutz in the desert*



*Fig.4. Community life on Fridays*



## Why can the kibbutz be a relevant context for the study of cooperation?

Work in the original kibbutzim was not remunerated in terms of wage, but according to the idea of community welfare, following *motto*: “Each gives according to his skills and receives according to his own needs”

For this reason, it is interesting to understand what elements may drive the individual contribution to production, other than direct monetary incentives, for example:

- 1) Imitation of cooperative behaviour
- 2) Ideological issues
- 3) Communal welfare (altruism)
- 4) Others (reputation, quality of life)

Such conditions along with virtuous examples of communal life, may as well naturally lead to the rise of opportunistic behaviour of a *free riding* type: part of the kibbutz members may take advantage of the kibbutz motto and slowly start to work less and less, while maintaining their life standard unchanged.

## Under what conditions does the system collapse?

Some plausible causes for the failure of the kibbutz may be for example:

- a) too high a number of opportunistic agents
- b) negative externalities (“free disposal” property is being assumed)
- c) the decline of ideology

## **The model**

In our model cooperativeness is indirect, and it is determined by the way in which each agent participates in the production process.

Basic mechanism:

- agents are divided into two breeds: ideologists (red) and opportunists (blue); they differ from one another by their production function;
- each agent produces daily a certain amount that contributes to the level of production of the sector in which he/she works;
- average supply is computed and on the basis of the share of the received product ideologists and opportunists modify differently their level of happiness; this in turns influences production in a

positive way for ideologists and in a negative way for opportunists that become happier;  
- productivity is updated, and agents will move away from high productivity sectors to low productivity ones.

Agents are of two different types: ideologists and opportunists; the composition of the population can be changed using the slider in the interface, which allows the user to test how the system works with different percentages of ideologists and opportunists.

Each person has: - an individual production function  
- a randomly assigned productivity level which is continuously updated during the production process;  
- happiness, here represents the extent to which a person is satisfied with what the kibbutz gives; a certain level of needs which represent a rigid demand for products and services.

Our kibbutz is divided into four different production sectors, each with a minimum productivity requirement:

- 1) milk sector, which exchanges its output with the external market, and therefore has greater productivity requirement
- 2) education
- 3) household
- 4) health

The sectors have different colours, respectively light blue, yellow, pink and green; sectors 2,3 and 4 pertain to the inner services in the kibbutz, which aim to offer to its members anything they may need: kinder garden, primary and possibly secondary education, a public dining room (the "chadar ochel"), laundry, doctor and nursery, library, cultural activities and leisure.

In this setup agents are divided among the four working sectors by random assignment so that each sector contains both ideologist and opportunist workers; each agent has a random level of happiness and of productivity.

What do agents do in our kibbutz in the "go procedure"?

**to go**

**if ticks >= 1700 [stop]**

**produce**

**grow**

**change-production**

**update-productivity**

**compute-sector-productivity**

**change-patch**

**collapse**

**dismiss**

**tick**

**do-plots**

**end**

First of all agents **produce** according to their initial productivity level and production functions are the same among breeds.

**to produce**

```
ask turtles [ifelse initial-productivity <= 25
  [set production (2 + random 7)
    ask patch-here
    [set pcolor (pcolor - 0.002)
      if pcolor < max-color [set pcolor max-color]]]
  [set production (10 + random 6)
    ask patch-here
    [set pcolor (pcolor - 0.006)
      if pcolor < max-color [set pcolor max-color]]]]
```

When agents produce, the colour of the sector they belong gets darker.

Average supply is computed both for the entire economy and for each sector by dividing the sum of individual production respectively by the total number of agents and by the agents in the sector in the following way:

```
set average-supply ((sum [production] of ideologists + sum [production] of
opportunists) / (count turtles))
set average-supply-sector1 ((sum [production] of turtles with [sector-number =
1]) / (count turtles with [sector-number = 1]))
set average-supply-sector2 ((sum [production] of turtles with [sector-number =
2]) / (count turtles with [sector-number = 2]))
set average-supply-sector3 ((sum [production] of turtles with [sector-number =
3]) / (count turtles with [sector-number = 3]))
set average-supply-sector4 ((sum [production] of turtles with [sector-number =
4]) / (count turtles with [sector-number = 4]))
end
```

Every day each opportunistic individual compares his/her needs (i.e. demand) with the amount of goods and services received; if happiness today is greater than happiness yesterday, they **grow**, and vice-versa they become smaller if happiness has decreased.

The ideologists' **growth** function works in a quiet different way. We've introduced two different scenarios: "Russia" and "Italy"; the user can change the scenario directly from the interface using the "chooser".

**to grow**

```

ask ideologists [if model = "Russia"
  [ifelse (sum [production] of turtles with [sector-number = 4]) > (500 -
(300 + random 100))
    [set happiness-today (happiness-yesterday + 10)
    set size (size + 0.01)]
    [set happiness-today (happiness-yesterday - 10)
    set size (size - 0.01)]]]

```

```

ask ideologists [if model = "Italy"
  [ifelse average-supply > needs
    [set happiness-today (happiness-yesterday + (7 + random 3))
    set size (size + 0.01)]
    [set happiness-today (happiness-yesterday - (7 + random 3))
    set size (size - 0.01)]]]

```

In the “Russia” mode agents look at the overall production in the milk sector, and if this is large enough compared to a given (partially random) threshold, they become happier.

In the “Italy” mode instead, ideologists compare the average supply with their needs therefore taking into account the overall level of welfare.

Ideologists and opportunists differ in the way they react to changes in levels of satisfaction. Ideologists are assumed to have a higher responsiveness to happiness and they increase their contribution to production both when they are satisfied or unsatisfied.

When they become happier they increase their production by a greater amount, while the amount is smaller when their happiness is low.

Opportunists on the other hand reduce their production when they are satisfied and this is the clue showing that the difference in behaviour has an impact on the system. In fact, the underlying assumption is that opportunistic agents are the free riders of our economy, in that they exploit the work of others, and the more they receive, the less they contribute.

The different levels of responsiveness can be changed and tested from the interface through the opposite sliders.

#### to change-production

```

ask ideologists [ifelse happiness-today > happiness-yesterday
  [set production (production + (responsiveness-id-happy))
  ask patch-here
  [set pcolor (pcolor - 0.002)
  if pcolor < max-color [set pcolor max-color]]]
  [set production (production + (responsiveness-id-sad))
  ask patch-here
  [set pcolor (pcolor - 0.002)
  if pcolor < max-color [set pcolor max-color]]]]]

```

```

ask opportunists [ifelse happiness-today > happiness-yesterday
  [set production (production + (responsiveness-opp-happy))
    ask patch-here
    [set pcolor (pcolor + 0.002)
      if pcolor > min-color [set pcolor min-color]]]
  [set production (production + (responsiveness-opp-sad))
    ask patch-here
    [set pcolor (pcolor - 0.002)
      if pcolor < max-color [set pcolor max-color]]]]

```

After having produced, agents compute the new level of average supply; they update their productivity according to their contribution to production, and they check the productivity of the sector they belong to.

In our kibbutz we allow also mobility through the working areas; when, in a certain sector there happens to be an excess of productivity, the less productive workers are asked to move to a low productivity sector, in the following way:

```

to change-patch
  ask turtles with [updated-productivity < 20 and sector-number = 1]
  [if (productivity-agents-sector1 > required-productivity-to-01)
    [move-to patch 1 0 right random 360 forward random-float 0.45
      set sector-number 3]]
  ask turtles with [updated-productivity < 20 and sector-number = 2]
  [if (productivity-agents-sector2 > required-productivity-to-00)
    [move-to patch 1 1 right random 360 forward random-float 0.45
      set sector-number 4]]
  ask turtles with [updated-productivity < 20 and sector-number = 3]
  [if (productivity-agents-sector3 > required-productivity-to-10)
    [move-to patch 0 1 right random 360 forward random-float 0.45
      set sector-number 1]]
  ask turtles with [updated-productivity < 20 and sector-number = 4]
  [if (productivity-agents-sector4 > required-productivity-to-11)
    [move-to patch 0 0 right random 360 forward random-float 0.45
      set sector-number 2]]

```

One could argue that this is an unrealistic feature, since such a mechanism suffers from a selection problem; in this way, in fact, spatial distribution of productivity is biased.

Workers belonging to the milk sector can be **dismissed** by the kibbutz assembly, which acts as the central planner. This occurs if the milk sector doesn't meet the market requirement.

```

to dismiss
  if expell?
    [ask patch 1 1 [if productivity-agents-sector4 < required-productivity-to-
11
    [set pcolor black
ask turtles with [sector-number = 4]
[hide-turtle
  set productivity-agents-sector4 0
ask turtles with [sector-number = 1] [
  set happiness-yesterday 0
  set happiness-today 0
  set needs 0
  set initial-productivity 0
  set updated-productivity 0
  set production 0
  set productivity-agents-sector1 0
ask turtles with [sector-number = 2] [
  set happiness-yesterday 0
  set happiness-today 0
  set needs 0
  set initial-productivity 0
  set updated-productivity 0
  set production 0
  set productivity-agents-sector2 0
ask turtles with [sector-number = 3] [
  set happiness-yesterday 0
  set happiness-today 0
  set needs 0
  set initial-productivity 0
  set updated-productivity 0
  set production 0
  set productivity-agents-sector3 0]]]]]]]]
end

```

The expel function is not automatically active; it can be put to work switching on the **expel button** in the interface. The dairy products are the only ones to be exchanged in the market; for this reason the survival of this sector is crucial to the economy. Therefore, the milk production requirement is higher with respect to that of other sectors, as we have already pointed out. In further extensions of the model, one may add other dismissal criteria.

Agents are asked to draw current plots of average supply, happiness and productivity, in order to allow the user to see the evolution of the main variables and to make several kinds of comparisons.

## **Collapse of the system**

The economy in our model collapses either when the productivity of the milk sector falls below the required threshold which implies lack of monetary income, or when the average productivity of the whole economy falls below a minimum threshold for more than one cycle.

The code relative to the first source of failure is the following:

```
to collapse
  if average-supply <= 10
  [ tick-advance 1600
  ask patches [set pcolor black]
  ask turtles [wait 0.03
  set happiness-yesterday 0
  set happiness-today 0
  set needs 0
  set initial-productivity 0
  set updated-productivity 0
  set production 0
  set productivity-agents-sector1 0
  set productivity-agents-sector2 0
  set productivity-agents-sector3 0
  set productivity-agents-sector4 0]]

  if ticks >= 1700 [stop]
end
```

The other cause for collapse is indirect and it occurs through the realization of the dismissal in the milk sector.

The underlying reasons that cause indirect cooperation to fail may be: too high a number of opportunistic agents, free riding behaviour, decline in ideology (in our model a decrease in the parameters of the change-production function), or a distorted imitation process, in which the most successful behaviour appears to be that of the free riding type.

We address some of these issues in the experiment discussion.

## Questions for potentially interesting experiments

1) Does the system collapse if ideologists disappear?

We assume that ideologists can leave voluntarily the kibbutz, in order to see if ideology is the real driving force of the system; recall that ideology in our setting is indirectly determined by the different happiness-production relation among types.

This is implemented by setting the number of ideologist to the minimum, using the slider in the interface.

2) How does production evolve if we modify the happiness-production parameters?

We want to see in what way different values for individual elasticity affect the evolution of average supply. Changes may occur both following an increase or a decrease in the elasticity parameters, where by elasticity we intend those parameters that determine the responsiveness of the happiness-production function.

In order to model ideology more accurately we have created two different running models, called “Russia” and “Italy” that differ from one another in the way in which ideologists become happier and then more productive.

In the Russia model ideologists increase their level of happiness when the average supply of the milk sector reaches a level that they consider satisfactory, while in the Italy model ideologists become happier when average supply meets their demand, meaning that to satisfy their needs they first consider average welfare.

“Russia” and “Italy” can be exchanged using the chooser in the interface.

We run the two experiments above comparing all different pairs of parameter values in both models.

## Experiment results

In the following paragraph we describe all the experiments implemented with our model using different values for the relevant parameters: number of agents and happiness-production responsiveness (or elasticity).

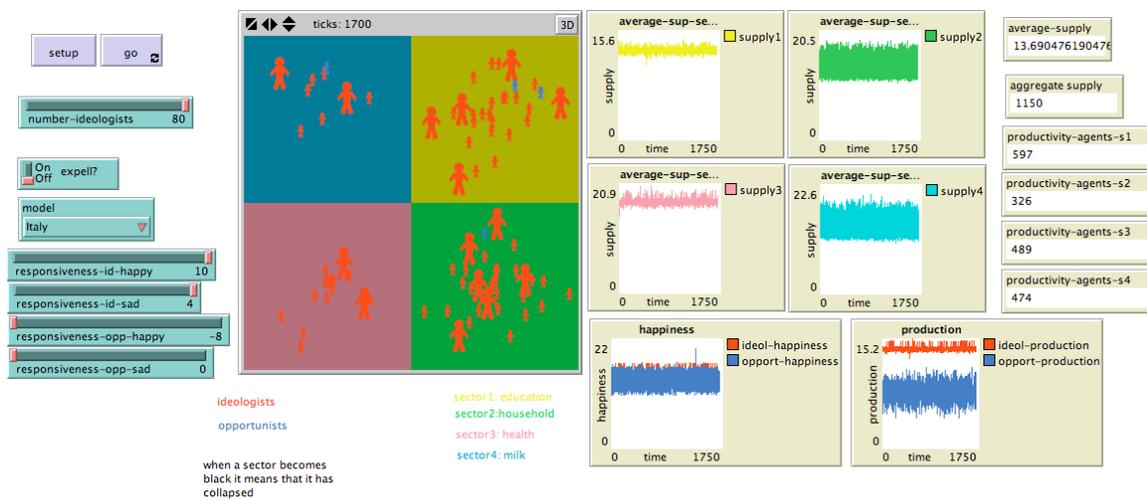
For each experiment we report the parameter values of reference, the result obtained by running the model, a graphical evidence of the results and some comments when significant.

Each experiment is implemented at least four times; in those cases where the results appeared to be highly variable across the experiments, the average result has been reported.

We include the table of experiments, which shows all possible combinations of parameter values.

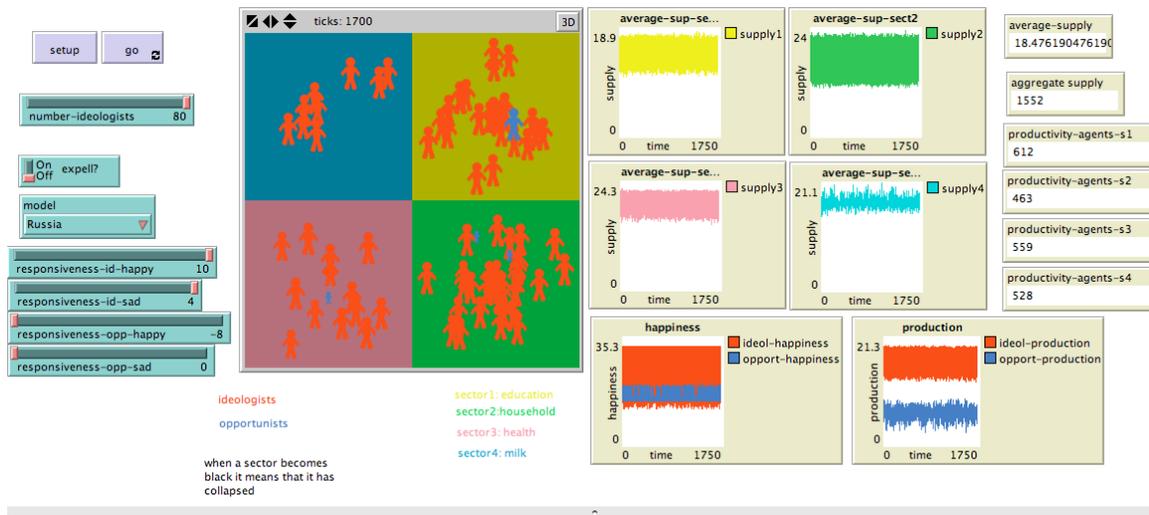
elasticities (Russia and Italy)						
composition of the population (Russia and Italy)		high	medium	low	high/low	low/high
	ideologists	id-h	id-med	id-l	id-h/l	id-l/h
	opportunists	op-h	op-med	op-l	op-h/l	op-l/h
	medium number	m-h	m-med	m-l	m-h/l	m-l/h

id-h I) prevalence of ideologists, high elasticity in absolute value (meaning a that ideologists have a high level of idealism and that opportunists have a high level of opportunism), Italy model.



Result: the model doesn't collapse spontaneously; from the image above we can see that ideologists result to be both happier than opportunists and more productive as well; production is compatible with the sector requirements, and ideologists produce more than opportunists.

id-h R) prevalence of ideologists, high elasticity, Russia model.

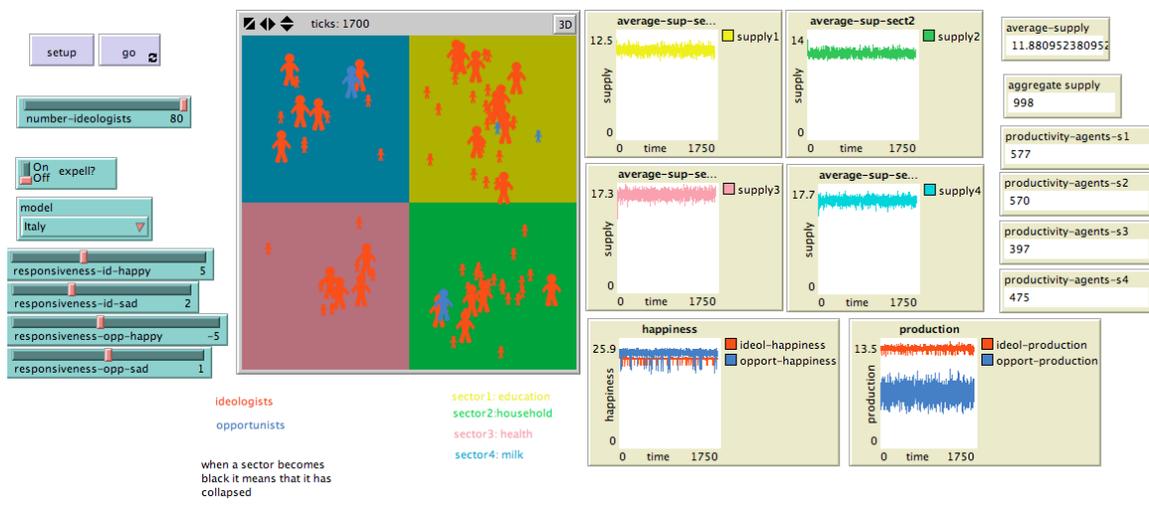


Result: as in the complementary experiment with the Italy model when the system runs with the prevalence of highly ideological agents, the economy keeps stable.

Ideologists have a highly variable happiness, partly overlapping with the opportunists' happiness level while they appear to be much more productive than the latter ones.

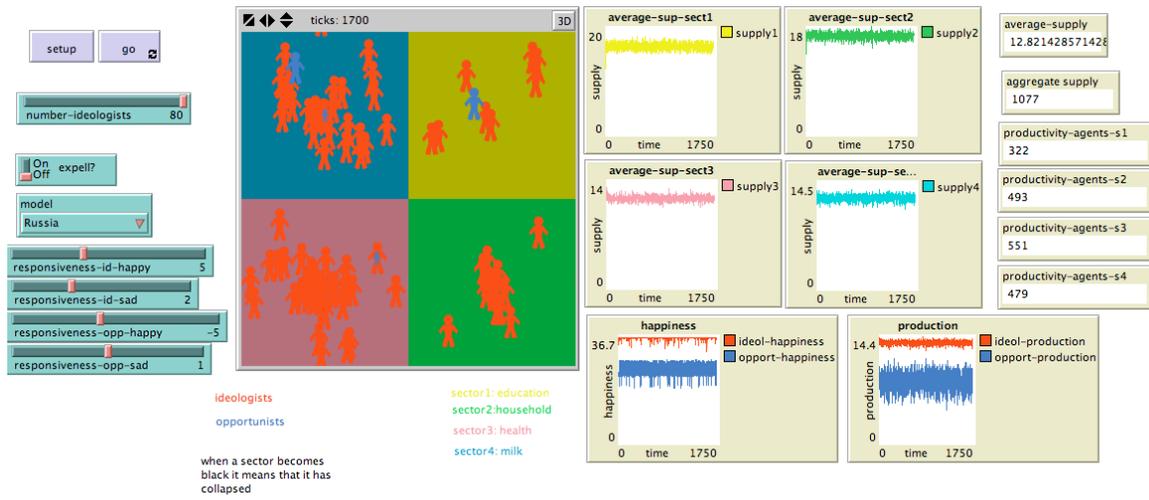
The average supply is higher than in the Italy model "ceteris paribus", since it depends on a higher happiness and therefore higher individual productivity.

id-med I) prevalence of ideologists, medium values for elasticity, Italy model.



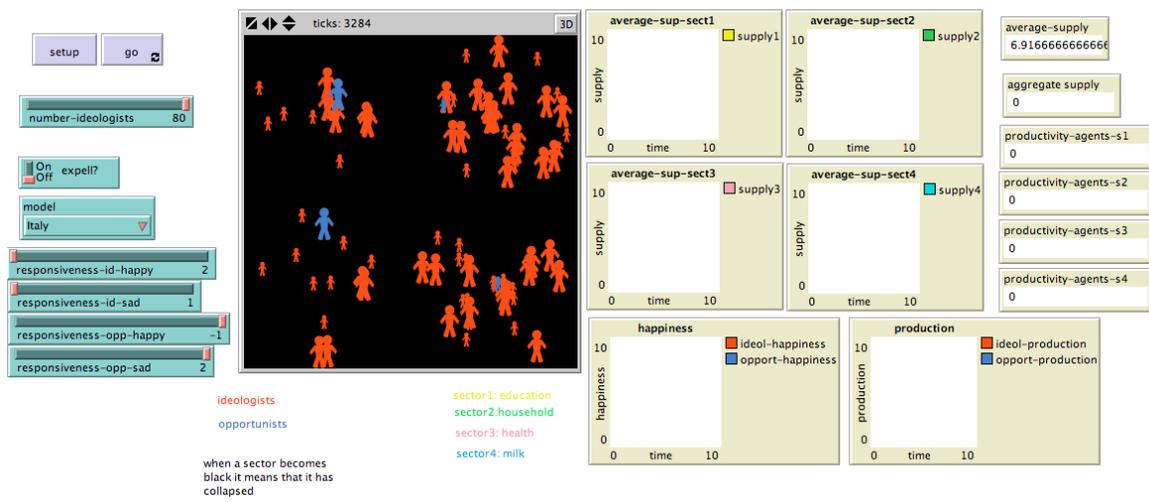
Result: the model doesn't collapse. In this case opportunists are happier than ideologists and less productive as intuitive; this causes the level of average supply to be lower than the high elasticity case.

id-med R) prevalence of ideologists, medium values for elasticity, Russia model



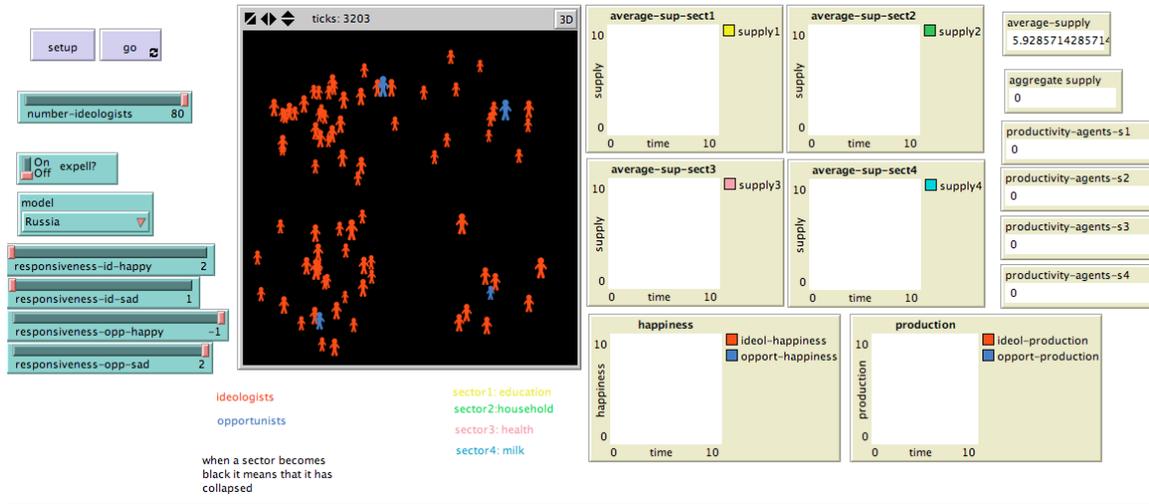
Result: with respect to the same experiment run in the “Italy” mode the result appear to be quiet similar. The system keeps running, average supply is slightly higher; ideologists are happier than in the Italy model and therefore more productive, while opportunists show parameters similar to the previous case.

id-l I) prevalence of ideologists, low elasticity in absolute value (low responsiveness of production to happiness for both types of agents), Italy model.



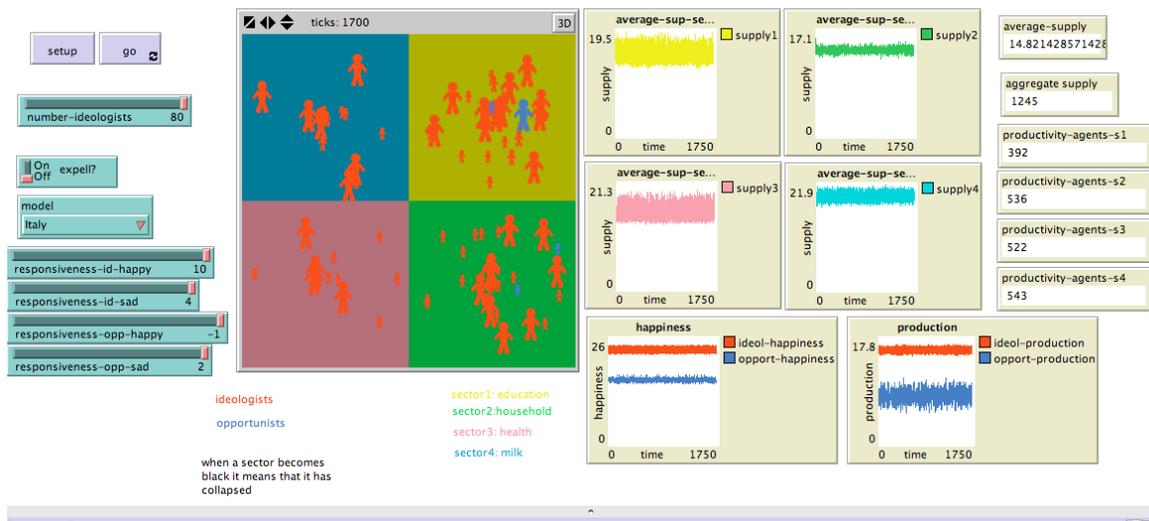
Result: the collapse of the economy occurs after some time; in the image this can be seen through the four sectors turning black, and the plots disappearing.

id-l R) prevalence of ideologists, low elasticity, Russia model



Result: the economy collapses immediately.

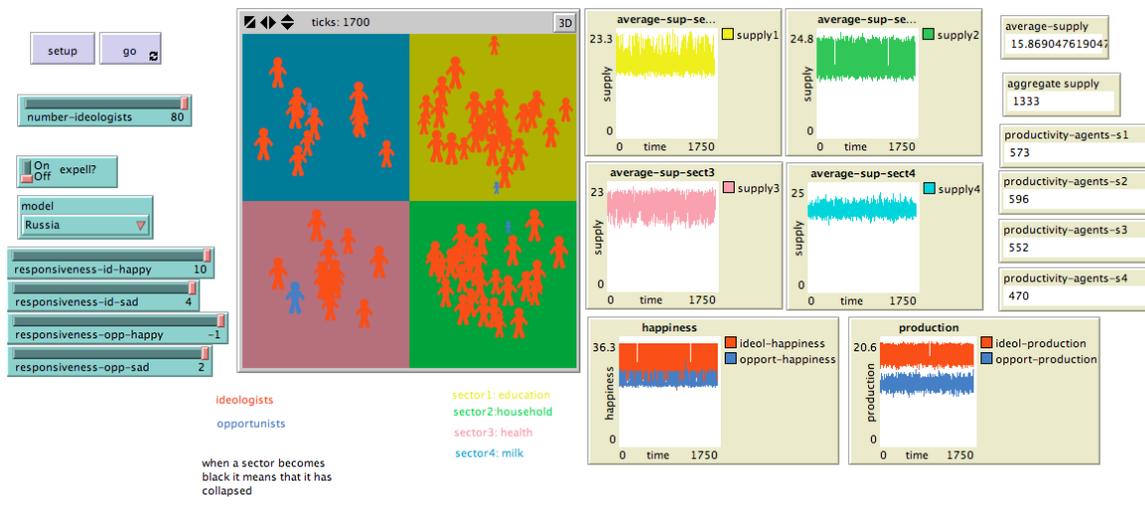
id-h/l I) prevalence of ideologists, high elasticity for ideologists and low elasticity for opportunists, Italy model.



Result: the model doesn't collapse. As intuition would suggest, a system where most of the agents are highly ideological, and only a few of them are "mild" opportunists, the balance is in

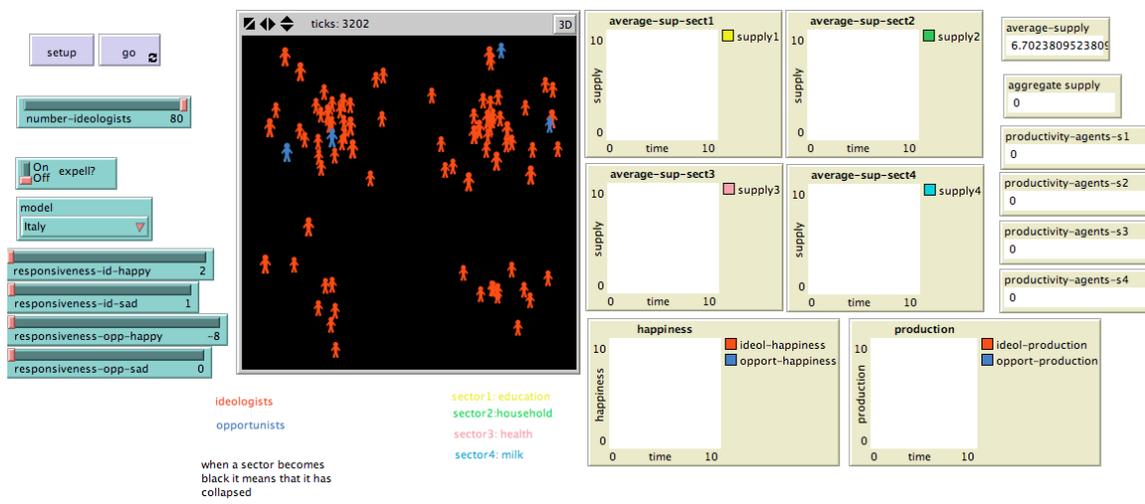
favour of the former ones, which keep the economy up.  
 Ideologists are both happier and more productive than opportunists.

id-h/l R) prevalence of ideologists, high elasticity for ideologists and low elasticity for opportunists, Russia model



Result: the model does not collapse, showing similar results as in the Italy case with same parameter values, except for a higher variability in ideologists' happiness and production level.

id-l/h I) prevalence of ideologists, low elasticity for ideologists and high elasticity for opportunists, Italy model



Result: even in a system populated mainly by ideologists, if these show a low responsiveness while the opportunistic agents have an extremely negative level of elasticity, the system collapses immediately.  
 Ideologists have a low level of happiness and low level of productivity.

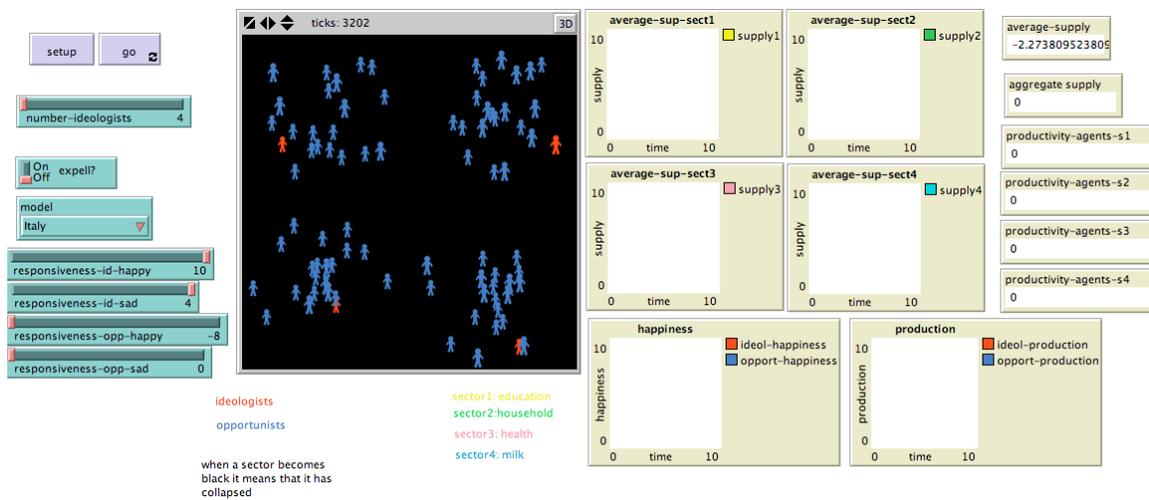
id-l/h R) prevalence of ideologists, low elasticity for ideologists and high elasticity for opportunists, Russia model



Result: the result in this case appears to be highly significant, especially compared to the same experiment applied to the Italy model. In fact this economy, with many “weak” ideologists and few “strong” opportunists, collapses but only after a while.

This can be explained by the fact that in the Russia model the agents (as if there was a central planner) look only at the milk sector and at the relative market requirement, so that the economy survives longer although with a lower level of individual welfare.

op-h I) prevalence of opportunists, high elasticity, Italy model



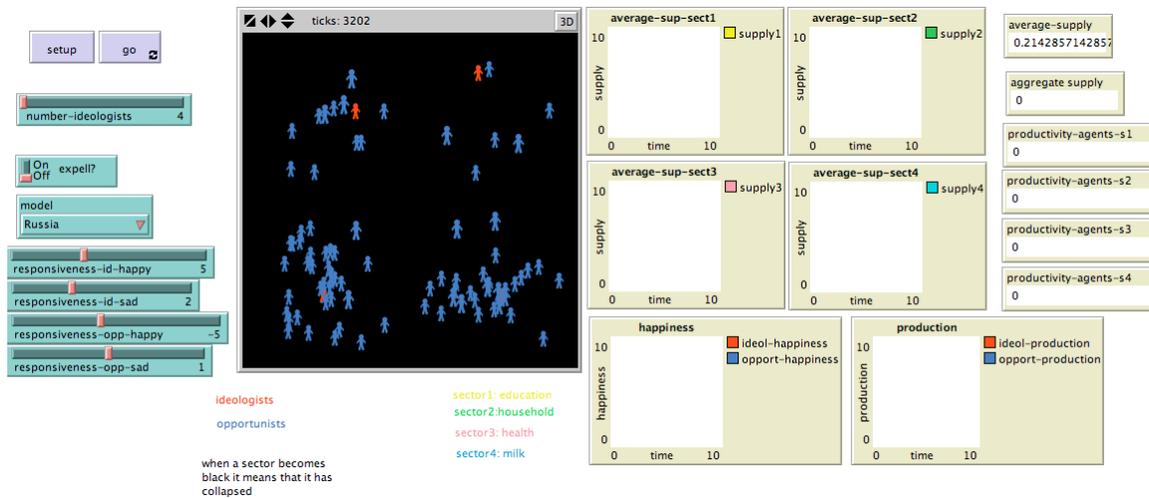
Results: immediate collapse of the system

op-h R) prevalence of opportunists, high elasticity, Russia model

Result: same as in the case above; this depends on the fact that the few ideologists in the system, in spite of their high level of responsiveness to happiness, are not able to sustain the productivity requirements due to the presence of a great number of highly opportunistic agents.

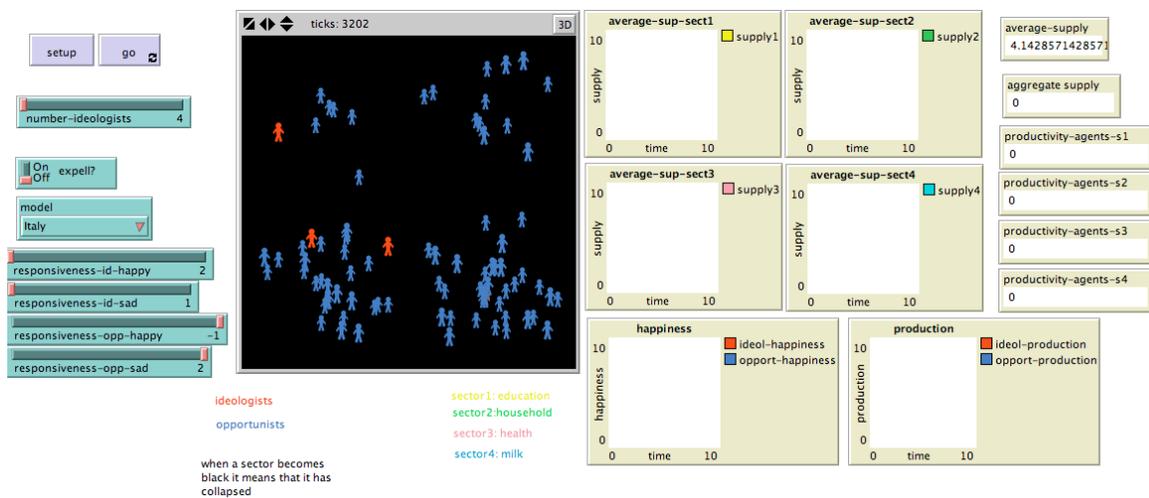
op-med I) prevalence of opportunists, medium values for elasticity, Italy model

op-med R) prevalence of opportunists, medium values for elasticity, Russia model



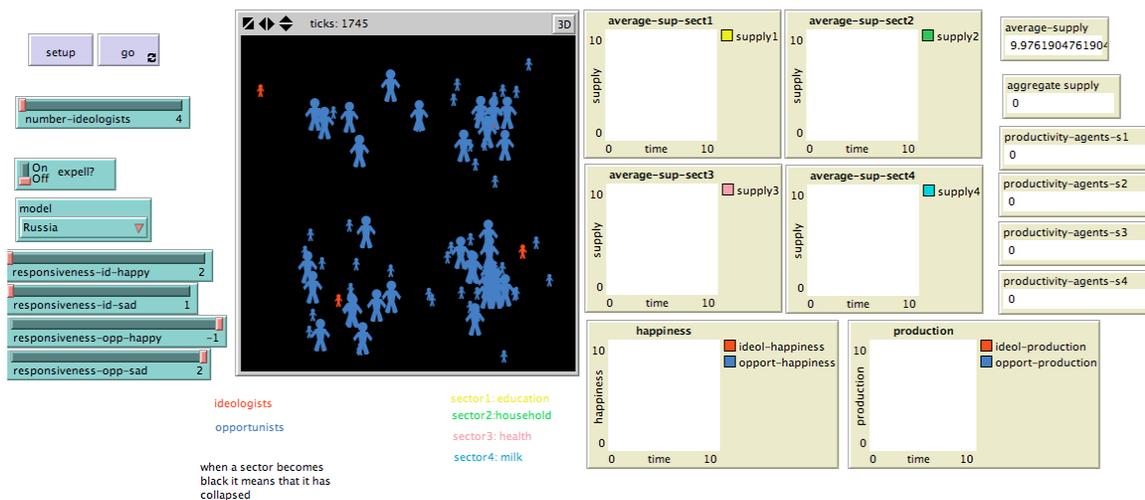
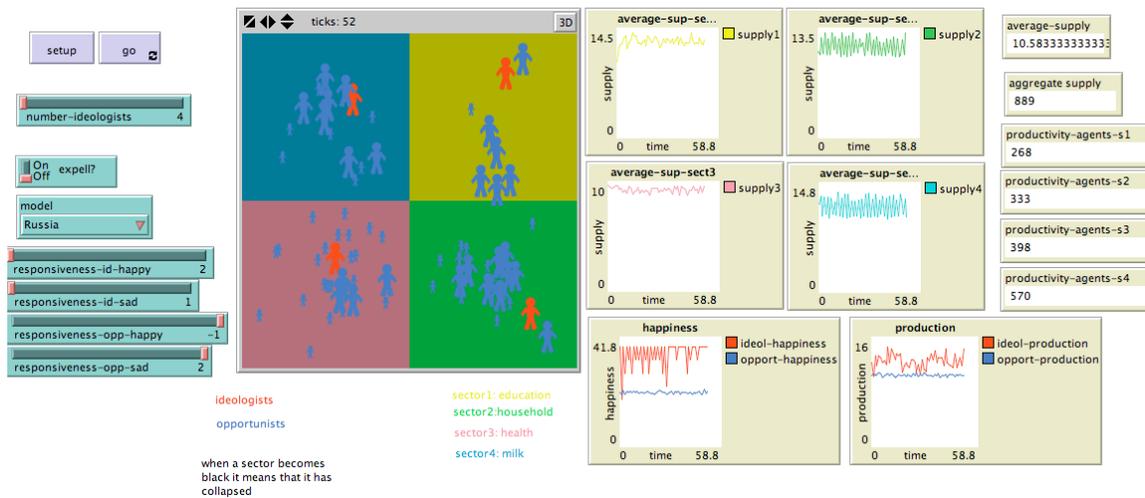
Result: the two experiments show the same result, i.e. the collapse is immediate in both cases.

op-l I) prevalence of opportunists, low elasticity, Italy model



Results: the system collapses immediately.

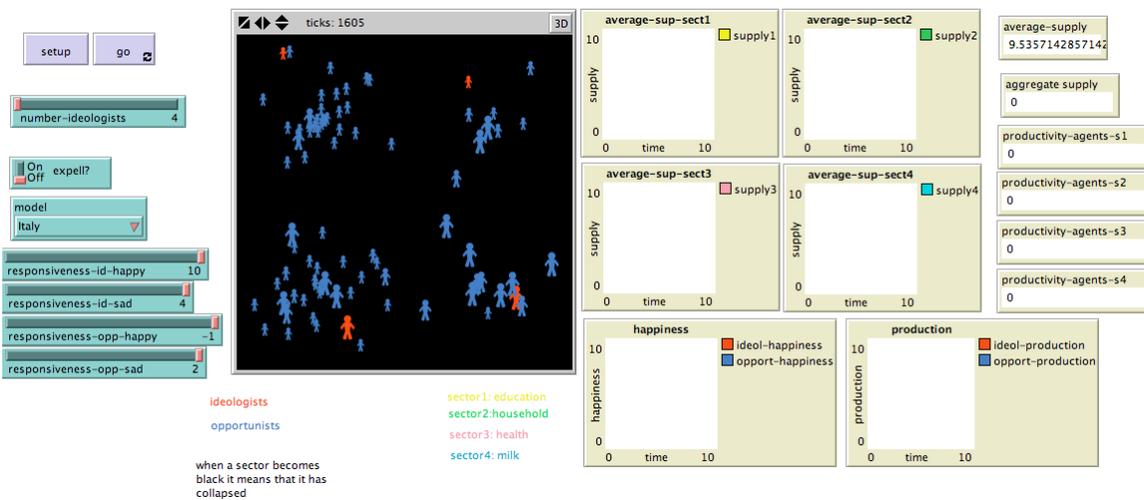
op-l R) prevalence of opportunists, low elasticity, Russia



Results: the system doesn't collapse immediately as expected, but only after a while.

The underlying reason may be that the few ideologists are very happy, while opportunists have a low elasticity to happiness, which makes them more productive than usual. Since agents here look only at the milk productivity requirement, the few ideologists are able to sustain the economy for a longer period of time with respect to the Italy model run with the same parameter values.

op-h/l I) prevalence of opportunists, high elasticity for ideologists and low elasticity for opportunists, Italy model.

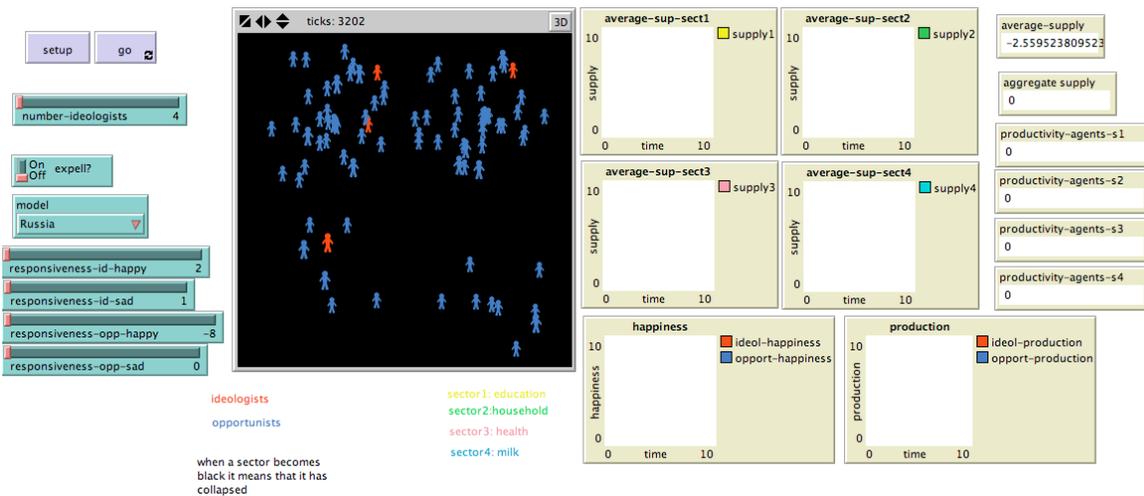


op-h/l R) prevalence of opportunists, high elasticity for ideologists and low elasticity for opportunists, Russia model

Result: in both cases above the collapse is immediate, in spite of the high elasticity of ideologists.

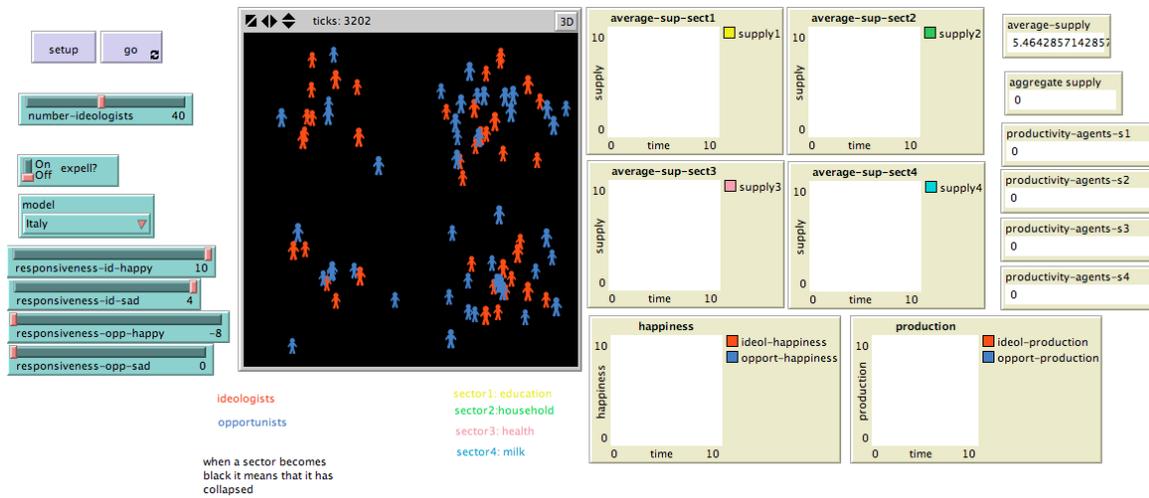
op-l/h I) prevalence of opportunists, low elasticity for ideologists and high elasticity for opportunists, Italy model

op-l/h R) prevalence of opportunists, low elasticity for ideologists and high elasticity for opportunists, Russia model



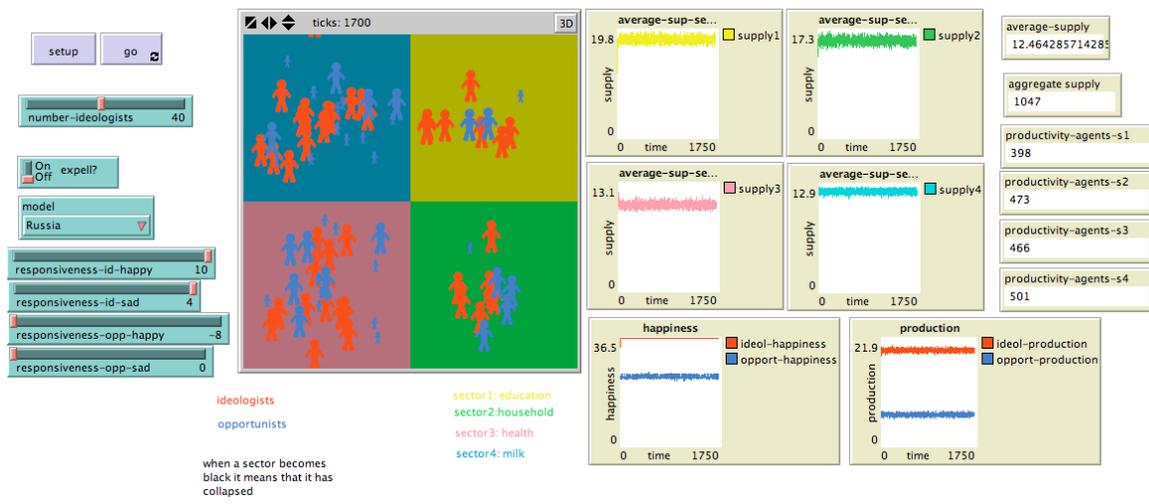
Result: immediate collapse in both models.

m-h I) medium number of ideologists and opportunists, high elasticity, Italy model



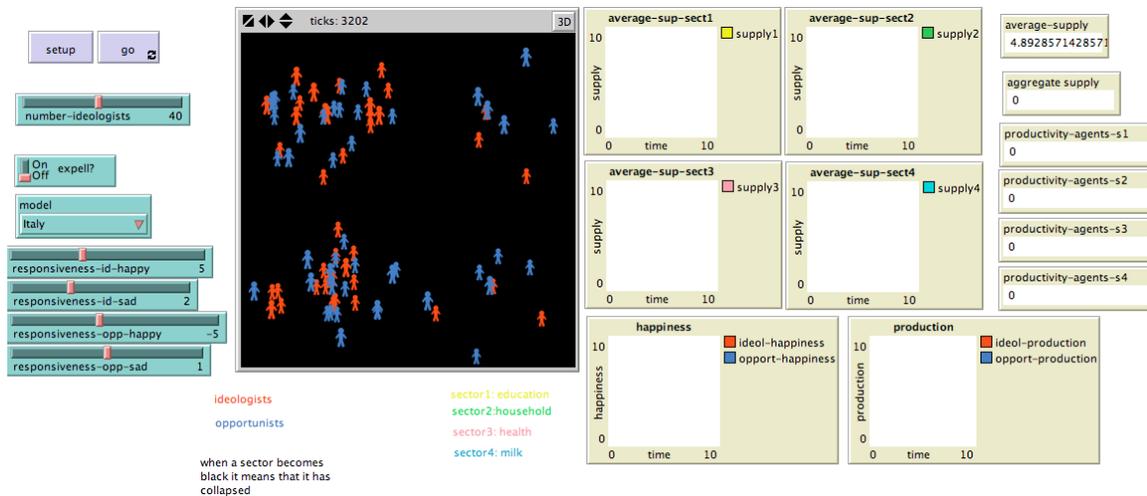
Result: the model collapses immediately, probably due to a low level of ideologists' happiness.

m-h R) medium number of ideologists and opportunists, high elasticity, Russia model



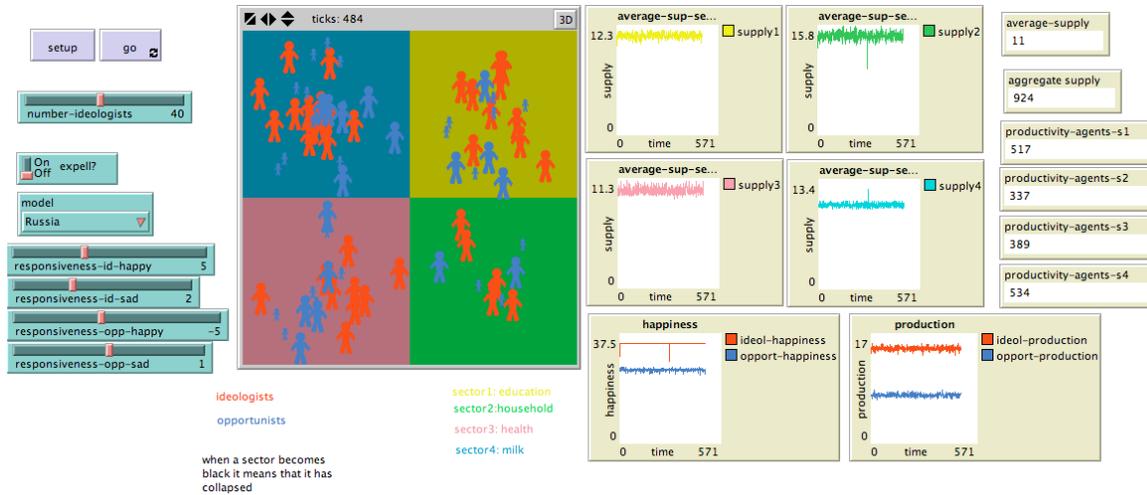
Results: the model doesn't collapse. The productivity of ideologists is very high, and so is their happiness level; this allows them to sustain average supply to a satisfactory level, differently from the Italy model.

m-med I) medium number of ideologists and opportunists, medium values for elasticity, Italy model



Result: the model collapses immediately

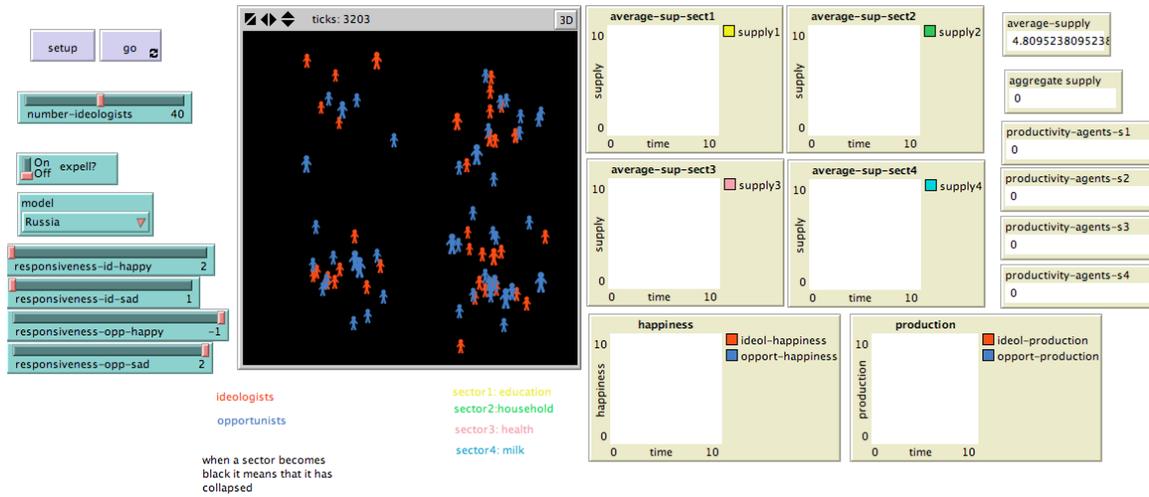
m-med R) medium number of ideologists and opportunists, medium values for elasticity, Russia model



Result: in this case we obtain very close results to those emerged in the high elasticity case, with a medium number of ideologists. Also now, the Italy model collapses while the Russia model keeps running.

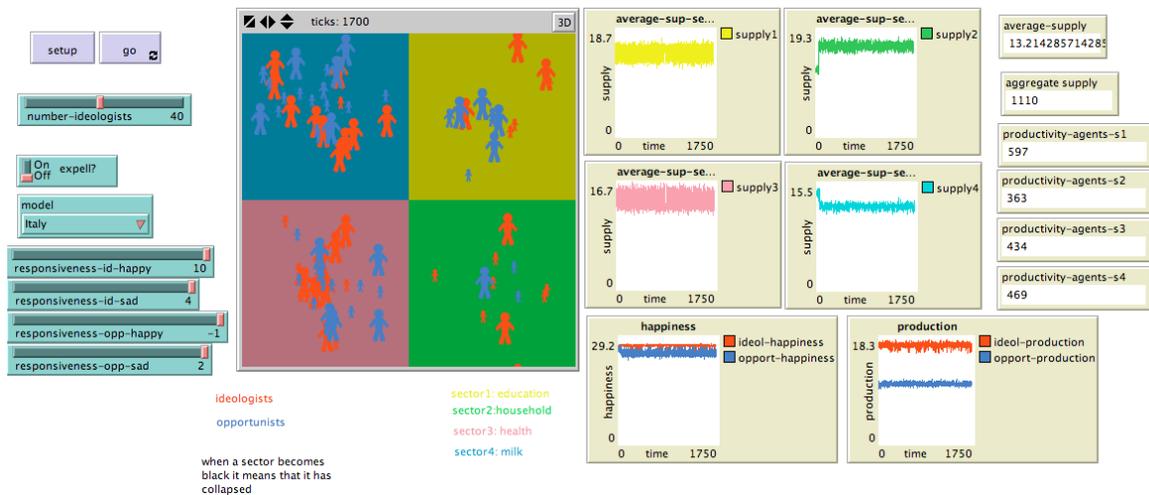
m-l I) medium number of ideologists and opportunists, low elasticity, Italy model

m-l R) medium number of ideologists and opportunists, low elasticity, Russia model



Results: with low elasticity parameters both models collapse, due to low responsiveness of ideologists.

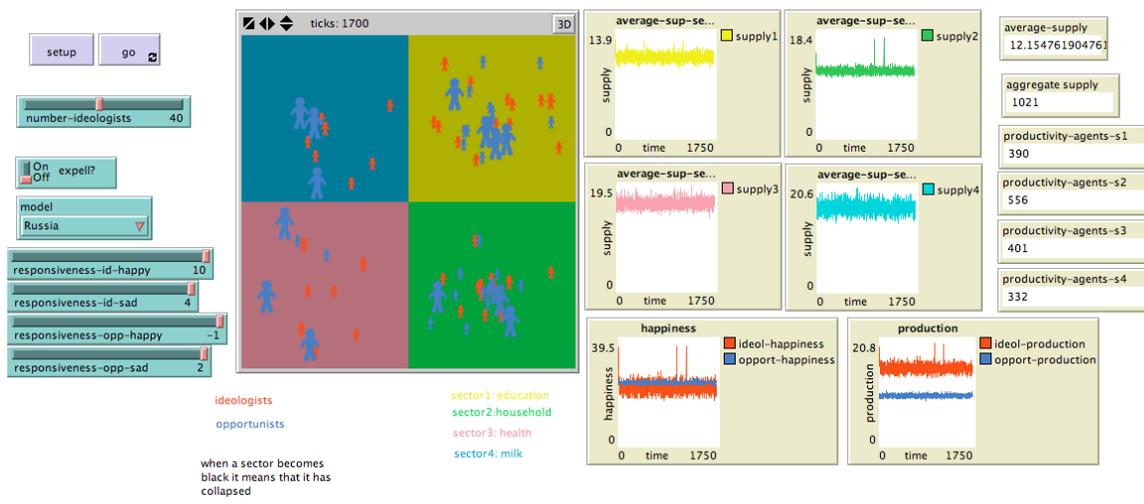
m-h/l I) medium number of ideologists and opportunists, high elasticity for ideologists and low elasticity for opportunists, Italy model



Result: the model doesn't collapse. When the reaction of ideologists to an increase in happiness is significantly high, while the level of opportunism is low, the former ones are able to sustain economic growth. Ideologists are much more productive than opportunists.

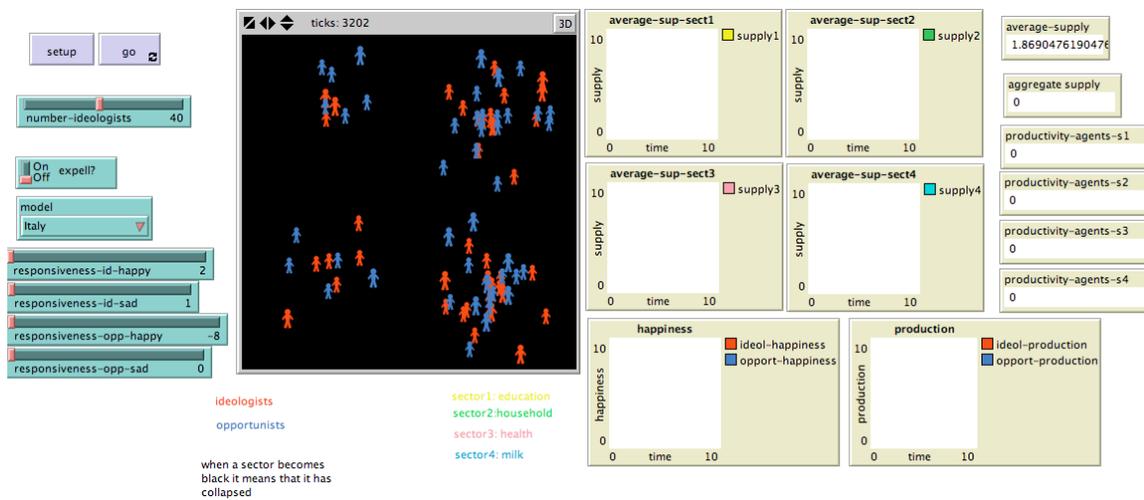
m-h/l R) medium number of ideologists and opportunists, high elasticity for ideologists and low

## elasticity for opportunists, Russia model



Result: all the relevant variables report similar values as in the Italy model using the same parameters. The model doesn't collapse, even if ideologists have high happiness variability.

m-l/h I) medium number of ideologists and opportunists, low elasticity for ideologists and high elasticity for opportunists, Italy model



m-l/h R) medium number of ideologists and opportunists, low elasticity for ideologists and high elasticity for opportunists, Russia model

Result: in both cases above the model collapses immediately, because of the high opportunism and low idealism of agents.

## Interpretation and comments on simulation results

To interpret the results of our simulation we follow two different lines that depend on the relevant control variables of the model as already pointed out in the table of the above section:

- 1) the composition of the kibbutz population for both country models
- 2) the happiness-production elasticity for both country models

In the first experiment we control for the population composition.

In each case we indicate the control variable with: (.)

**1(.)-h I)** In the Italy model, with a high elasticity level for both types of agents, varying the number of ideologists in the system we obtain the following result:

- prevalence of ideologists, the model doesn't collapse
- prevalence of opportunists, the model collapses
- medium number of ideologists, immediate collapse

**1(.)-h R)** In the Russia model, with a high elasticity for both types, varying the composition of the population, we obtain:

- prevalence of ideologists, the model doesn't collapse
- prevalence of opportunists, immediate collapse
- medium number of ideologists, the model doesn't collapse

Comparing results 1(.)-h I) 1(.)-h R), both models appear to be sensitive to the variation of the population composition, for a high elasticity level. In particular, we note that the two models differ when elasticity is high and the number of ideologists and opportunists is the same: in this case, the Italy model collapses immediately, while the Russia model survives.

The underlying reason may be that in the Russia model ideologist are happier, since they only take into account market success of the milk sector while ignoring the average welfare. Since their production responsiveness to happiness is high, they are able to sustain the economy.

**1(.)-l I)** In the Italy model, with low elasticity for both types, varying the number of ideologists in the system, we obtain the following result:

- prevalence of ideologists, the system collapses almost immediately
- prevalence of opportunists, immediate collapse
- medium number of ideologists, immediate collapse

**1(.)-l R)** In the Russia model, with a low elasticity for both types, varying the composition of the population, we obtain:

- prevalence of ideologists, the model collapses immediately
- prevalence of opportunists, the system collapses, but only after a while
- medium number of ideologists, the model collapses immediately

Comparing 1(.)-l I) and 1(.)-l R), we can see that except the case for a medium composition of the population, the two models are the same, since the Italy model survives longer with a high number of ideologists, while the Russia model survives longer with a low number of ideologists. This is probably due to the different change-production function of agents between the two countries. The Italy model needs a high number of ideologists to keep up average supply, while

in the Russia model even few very happy ideologists can carry on production for a longer period of time.

**1(.)-med I** In the Italy model, with medium elasticity for both types, varying the number of ideologists in the system, we obtain the following result:

- prevalence of ideologists, the system doesn't collapse
- prevalence of opportunists, immediate collapse
- medium number of ideologists, immediate collapse

**1(.)-med R** In the Russia model, with a medium elasticity for both types, varying the composition of the population, we obtain:

- prevalence of ideologists, the model doesn't collapse
- prevalence of opportunists, the system collapses
- medium number of ideologists, the model doesn't collapse

Comparing 1(.)-med I) 1(.)-med R), both models appear to be sensitive to the number of opportunistic agents in the system when the elasticity has an average value.

In both cases the predominant presence of ideologists sustains the economy, while the prevalence of opportunists causes the system to collapse immediately. The only relevant difference occurs when the two types of agents are equally present in the economy. In this case the Russia model, once more, appears to be stronger.

**1(.)-h/l I** In the Italy model, with high elasticity for ideologists (high idealism), and low elasticity for opportunists (low opportunism), varying the number of ideologists in the system, we obtain the following result:

- prevalence of ideologists, the system doesn't collapse
- prevalence of opportunists, the system collapses after a while
- medium number of ideologists, no collapse

**1(.)-h/l R** In the Russia model, with a high elasticity for ideologists, and low elasticity for opportunists, varying the composition of the population, we obtain:

- prevalence of ideologists, the model doesn't collapse
- prevalence of opportunists, the system collapses immediately
- medium number of ideologists, the model doesn't collapse

In the two models a high level of idealism is able to sustain the system both when the number of ideologists is high, and when there is a medium number of ideologists.

**1(.)-l/h I** In the Italy model, with low elasticity for ideologists (low idealism), and high elasticity for opportunists (high opportunism), varying the number of ideologists in the system, we obtain the following result:

- prevalence of ideologists, the system collapses immediately
- prevalence of opportunists, the system collapses immediately
- medium number of ideologists, the system collapses immediately

**1(.)-l/h R** In the Russia model, with a low elasticity for ideologists, and high elasticity for opportunists, varying the composition of the population, we obtain:

- prevalence of ideologists, the model collapses but only after a while

- prevalence of opportunists, the system collapses immediately
- medium number of ideologists, the model collapses immediately

Comparing 1(.)-l/h I) 1(.)-l/h R) with low idealism and high opportunism once more the Russia model appears to be slightly stronger, even if not significantly.

While the collapse is intuitive and straight forward for a low and medium number of ideologists, we surprisingly note that even in an economy populated mainly by ideologists, if there ideology is weak, the system doesn't survive.

In the second experiment we control for the happiness-production parameters.

**2id-(.) I)** In the Italy model, with the prevalence of ideologists, while varying the elasticity parameters in the system, we obtain the following result:

- high elasticity, the system doesn't collapse
- low elasticity, the system collapses almost immediately
- medium elasticity, the system doesn't collapse
- high elasticity for ideologists, low elasticity for opportunists, the system doesn't collapse
- low elasticity for ideologists, high for opportunists, the system collapses immediately

**2id-(.) R)** In the Russia model, with the prevalence of ideologists, while varying the elasticity parameters in the system, we obtain the following result:

- high elasticity, the system doesn't collapse
- low elasticity, the system collapses immediately
- medium elasticity, the system doesn't collapse
- high elasticity for ideologists, low elasticity for opportunists, the system doesn't collapse
- low elasticity for ideologists, high for opportunists, the system collapses after a while

Both models 2id-(.) I) 2id-(.) R) display similar results. None of the economies collapses when the level of ideology is very high, and the level of elasticity is medium. When the elasticity instead is low for ideologists, the system collapses immediately or after a short while in both countries.

**2op-(.) I)** In the Italy model, with the prevalence of opportunists, while varying the elasticity parameters in the system, we obtain the following result:

- high elasticity, the system collapses immediately
- low elasticity, the system collapses immediately
- medium elasticity, the system collapses immediately
- high elasticity for ideologists, low elasticity for opportunists, the system collapses after a while
- low elasticity for ideologists, high for opportunists, the system collapses immediately

**2op-(.) R)** In the Russia model, with the prevalence of opportunists, while varying the elasticity parameters in the system, we obtain the following result:

- high elasticity, the system collapses immediately
- low elasticity, the system collapses after a while
- medium elasticity, the system collapses immediately
- high elasticity for ideologists, low elasticity for opportunists, the system collapses immediately
- low elasticity for ideologists, high for opportunists, the system collapses right away

The results displayed in 2op-(.) I) 2op-(.) R) are quiet similar, in the fact that a kibbutz populated mainly by opportunists seems to have no chance of survival in the long run.

Note that in the case of Italy, when ideologist show high responsiveness and opportunists low responsiveness, the former ones are able to offset the negative externalities provoked by weak opportunists.

**2m-(.) I)** In the Italy model, with an equal composition of the population among types, while varying the elasticity parameters in the system, we obtain the following result:

- high elasticity, the system collapses immediately
- low elasticity, the system collapses immediately
- medium elasticity, the system collapses immediately
- high elasticity for ideologists, low elasticity for opportunists, the system doesn't collapse
- low elasticity for ideologists, high for opportunists, the system collapses immediately

**2m-(.) R)** In the Russia model, with an equal composition of the population among types, while varying the elasticity parameters in the system, we obtain the following result:

- high elasticity, the system doesn't collapse
- low elasticity, the system collapses immediately
- medium elasticity, the system doesn't collapse
- high elasticity for ideologists, low elasticity for opportunists, the system doesn't collapses
- low elasticity for ideologists, high for opportunists, the system collapses right away

In 2m-(.) I) 2m-(.) R) the results are highly variable for different values of elasticity. Because we keep fixed an average number of both types of agents, the comparison between the reactiveness of the models to elasticity is more straight forward.

The Russia model doesn't collapse both when elasticity takes high and medium values. Once again a system that considers only market requirement proves to be stronger.

## **Final remarks**

The model was meant to address the issue of privatisation regarding Israeli kibbutzim.

After several decades of success, the particular social- economic organisation of the kibbutz in its original form, is presently in decline. Through the analysis of indirect cooperation we aimed to simulate the causal relation between free riding opportunism and the collapse of the kibbutz economy.

After having performed repeated experiments, using different values for relevant parameters (i.e. productivity, happiness) a main pattern emerged: the system has no spontaneous tendency to collapse in a situation in which cooperative individuals prevail and vice-versa, it is more likely to fail if a kibbutz is mainly composed of opportunistic agents. However, also elasticity parameters seem to have a significant impact on the functioning of the system: a high level of ideology of cooperative agents, even if not predominant in the overall population, can frequently offset opportunistic behaviour.