

UNIVERSITY OF TURIN

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# THE DEVELOPMENT OF ETHICAL BANKS: A SIMULATION MODEL

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# Introduction

My interest in ethical finance themes emerged from observing a small cooperative looking money. Although it had a socially and environmentally sustainable project, it failed in getting a loan. This was the starting point of the research; many questions raised: do the financial intermediaries pay attention in the externalities of financed activities? Economical organizations and firms have a strong impact on our environment and on our society: they have to be monitored. Is there any intermediary agreeing with this position? In giving a loan, are the social outcomes of an entity taken into account? At the moment, is there anyone interested in these items? What if banks (and other financial intermediaries) would take care of these aspects evaluating the credit worthiness? Which would be the results? Which types of economical organizations would be excluded from receiving a loan? Do this exclusion affect entire sectors of the economy? Which ones?

Banks are one of the main players in the economic system due to their intermediary role, this is why they are crucial when dealing with the economic development. Growing attention both for environmental and social sustainability, calls on the economical actors to have more ethical behaviors. Banks are moving towards this direction, but in a very slow way. This research analyzes the current situation of the ethical banking environment by focusing on the action adopted by banks to improve their concern on social-environmental sustainability. This overview introduces a second part of the work concentrated in exploring the possible evolutions of the actual banking environment. The future developments are inspected by computing an Agent Based Model (ABM) simulation. In particular the attention is directed on observing how

banks and their credit policies influence the actions adopted by the financed entities. The ultimate aim is monitoring how the impact of the firms sector on society and environment can vary following banks actions.

In this work we will not forget to consider some basic economical features. In fact ethical banks are competing with unethical (or traditional) ones by the loan interest rate proposed to firms. Firms can be as well distinguished between ethical and unethical, according to their social and environmental impact. Firms can be in need of money during their business activities and they choose to borrow money either from ethical banks or traditional ones, trading off between their ethical values and the interest rate proposed. Simultaneously, a bigger part of the population interact with banks, making deposits or withdrawing them. Information plays a key role here. Individuals influence each other ethical/ unethical values when interacting, and consequently their bank choice.

In particular, chapter 1 contextualizes the ethical banking sector in the current banking environment. It deals with the international networks of ethical banks: organizations created with the objective of support and sponsor the ethically oriented finance and the institutions sharing ethical finance principles. The European Federation of Ethical and Alternative Banks, the International Association of Investors in the Social Economy and the Global Alliance for Banking on Values are the mentioned organizations. The second chapter provides a definition of “ethical banking” and examines which are the principles upon which an ethical bank is created. This class of banks is characterized by transparency in money-collecting activities and integrated judgment procedures, inspecting not only creditworthiness of the activities requesting financing but also their social-environmental impact. Chapter 3 underlines the intermediary role of banks in the economic system; it describes which are the most frequent attitudes developed by banks about ethical items. We study two cases: Deutsche Bank and UBS. Chapter 4 is dedicated to an overview of the Italian Ethical Banking environment, where Banca Popolare Etica plays the main role. Consequently, the case of Banca Popolare Etica is analyzed in detail. Chapter 5 inspects its credit policy and its evaluation procedure: following the features of ethical banks, Banca Popolare Etica de-

velops a social-environmental analysis in order to monitor the impacts of the financed projects. Chapter 6 introduces the second part of my research: an Agent Based Model (ABM) simulation with NetLogo. This part explains what Agent Based Modeling is, listing its uses and its weaknesses. The successive chapter is dedicated to a brief introduction of NetLogo: it is an agent-based programming language and integrated modeling environment. In this section are explained its composition and its terminology. Chapter 8 describes the phase of the model projection, from the hypothesis to expected results. Chapter 9 reviews in detail the model implementation, reporting a general view of each model version. The last chapter reports the experiments and the research results. The experiments deal with possible scenarios, inspecting different levels of ethics. They are reproduced twice: first in a crowded world, where agents interact frequently. Then in a less populated one, where agents interactions are less frequent. Finally some conclusions will be suggested.

# Chapter 1

## Banks and ethics

The prolonged crisis with its on-going banking sector problems, liquidity and sovereign risks, unprecedented policy interventions and protracted low interest rates has altered the market environment in which financial firms and investors operate. Financial fraud and recent banking scandals (such as rogue trading, Libor fixing) have additionally undermined the already low confidence in the sector, and raised concerns about structural flows in the way banks operate and are being regulated and supervised. Misconduct is still widespread in the financial services industry. Restoring investors confidence is crucial to overcome this crisis, but remains difficult at the current juncture.

As reported by Wehinger<sup>1</sup> (2012) this was the backdrop for the discussion at the October 2012 OECD Financial Roundtable. The discussion was concentrated upon the causes and the consequences of the recent financial crisis. In particular, it focused on observing analyzing the challenging environment of banks. During the congress, it emerges that banks have already made improvements in the management of risk, “down-sizing and de-risking their balance-sheets”. Moreover, the activity of the regulatory institutions is increased; policy makers and supervisors took steps to improve regulatory interventions in order to support financial stability. They want to clarify which are the objectives that have to be quickly reached to re-establish the financial sector equilibrium.

Nonetheless, consumer representatives argued that regulators have not paid enough attention to the financial consumer protection. They explained that the crisis led to emerge three main objectives for the reform of the financial sector:

- the achievement of the financial stability and of the management of systematic risk;
- the reconstruction of financial institutions;
- the achievement, through the work of the financial sector, of the benefit of financial users and society as a whole.

The regulators are focusing on the first two points, while the third one has not received much attention. So, it was argued that reforming financial markets should be a combination of :

- a new model of regulation providing sanctions to the actions that caused market failure;
- cooperation of corporate governance and ethics;
- effective market forces.

As Wehinger<sup>1</sup>(2012) reports:

(...) The objective should be to create a system that penalizes detrimental behaviors and market inefficiencies and rewards good behavior and real competition and innovation. Little evidence was seen that the necessary improvement in governance and ethics or real competition would result without tougher regulation.

From this report emerge many ideas that lead to deep challenges in the banking environment. First of all is pointed out the idea of a link between the benefit of financial users and that of the society. The latter seems to be not just a consequence of the first, but an objective. The benefit for an individual deriving from the financial sector has to be converted in a benefit for the

society. So, the financial users and the society have to be considered as a whole and the financial sector has to work for their benefit.

Moreover it emerges the necessity of enhancing corporate governance and ethics. Too many scandals and market failures occurred; it seems necessary to overcome the misconduct characterizing the financial sector recently. Banks have to introduce ethics in their corporate governance. A more ethical approach in developing their actions seems to be essential; it can restore consumer confidence and trust in the financial markets. Wehinger<sup>1</sup> writes:

(...) Enhancing financial consumer protection is an essential part of the process to restore trust in the financial markets and bring back consumer confidence for retail financial products. However, it can only go so far to protect consumers from, and perhaps prevent, unethical behavior that are required for financial providers to become more consumer centric - and more ethical - must come from the providers themselves. This is why improving the reputation of financial service providers through appropriate consumers-focused values, ethics and standards will in the end complement, not hinder, any future regulatory interventions.

The necessity of a more ethical behavior of banks is underlined also by Fried<sup>2</sup> (2012) article *Banks need to compete on good behavior*, where we read:

(...) Allegations of mis-selling, Libor rigging and money laundering have drained trust in the financial sector even further.

(...) If we want banks to change the way they see themselves and serve society, then we need this Commission to provide an open but balanced examination of the behavior of companies and individuals.

The commission introduced on these lines is the Commission of Banking Standards, instituted by the UK Parliament. In autumn 2012 its work was focused on the analysis of the financial crisis causes and on the necessary interventions to re-establish the stability of the financial sector. What Fried foretold in his

article was a critical intervention of the Commission on an important issue: human behavior.

As we can read<sup>2</sup>:

(...) It is now for the commission to make serious recommendations to help banks define (and in some cases rediscover) their values; and to hold bank boards accountable as custodians of a healthy bank culture.

(...) If the commission succeeds, future culture (applied to banks) will not be defined by pay or moneymaking capacity but by good human behavior and it will be rooted in the legitimate expectations of a bank's clients, shareholders, regulators and employees – not to mention the needs of society.

As we can extrapolate from these pages, after the financial crisis we often read the word “ethics” into economical essays. The bank sector is developing a process of sensitization at ethical principles. A part of the society (such as consumer representatives, as we reported previously) is requiring more ethically oriented behavior of banks. It is considered the first step to overcome the mistrust characterizing the financial sector. Consumers lose their confidence with banks. What they need is a new image of banks, that introduces first of all an ethical behavior.

Nevertheless the approach of “banks” and “ethics” is not an innovation. From many years social demands are changing, and the knowledge of the effects that banks can have through their lending policies is increasing. Banks are suffering the pressures from general public, NGOs, governments, regulator institutions to go beyond conventional business management. It results that several banks are approaching to an ethically oriented finance. In particular, they are approaching to the so called “impact investing”.

“Impact investing” refers to a kind of socially responsible investing that has the aim of producing, along time, positive social and environmental impacts as well as a little financial return. Impact investors are active into companies, organizations and funds both in the social and in the environmental field. Moreover, impact investing deals with different asset classes, such as private

equity, debt and fixed income. So, the main objective of impact investors is to produce social and environmental challenges through their employment of capital. Criteria to evaluate the social and environmental impacts become a component of the investment process.

Banks developing impact investing are financial intermediaries for which analyzing the social and environmental impacts of activities constitutes the main priority. Moreover, this analysis is made available to their depositors, guaranteeing transparency. This kind of banks are defined “ethical banks”. They receive those investors and depositors sensible to social items more than to financial ones.

In the world an important growth of ethically oriented intermediaries has been recorded. It proves that it is possible increase the agreement between intermediaries customers about responsible investments; “responsible” means investments with positive impacts on the society and the environment.

Financial-ethical institutions are represented mainly by three international networks:

- the European Federation of Ethical and Alternatives Banks (FEBEA), that works in the European context;
- the Global Alliance for Banking on Values (GABV), active in the international context;
- the International Association of Investors in the Social Economy (IN-AISE), that represents also other financial intermediaries.

## 1.1 The European Federation of Ethical and Alternatives Banks

FEBEA is a non profit organization created in Brussels in 2001 from a set of European ethical banks. Nowadays its members are: 11 banks, 6 savings and loan cooperatives, 5 investment companies and 3 foundations. Among the creators there is also the Italian “Banca Popolare Etica”. “All the members

share the principles of transparency and social environmental utility”, as we can read in the FEBEA website. First of all, FEBEA aims to be a place where sharing and exchanging experiences. In addition, it wants to develop financial tools able to support existing European initiatives and help the growth of new ones in the field of ethical oriented finance. In the third article of FEBEA Articles of Association we can read its purposes<sup>3</sup>:

The purpose of the non-profit association is to develop ethical and solidarity finance in Europe through dissemination of information and the participation of citizens. To this end it aims at:

- supporting the exchange of information and experience and the co-operation between national networks and practitioners of the social economy and finance in Europe or European Free Trade Area;
- representing its members vis-à-vis the EU institutions and other financial and political organizations;
- creating the financial and banking instruments necessary to the fulfillment of this purpose.

The association may implement all actions that correspond directly or indirectly to its purpose. It may notably lend its support or take an interest in any activity similar to its purpose.

Up to now, the main financial tools created by FEBEA are a guaranteed fund (“Solidarity Guarantee”), an investment fund (“Solidarity Choice”) and a financing company (“SEFEA”).

Moreover, ordinarily members exchange good practice and organize meetings amongst their social economy networks.

## 1.2 The Global Alliance for Banking on Values

GABV is a foundation made up from the world’s lending sustainable banks. It is an independent network of banks; through finance, they aim to support sustainable development for people, communities and the environment. It

owns an established charter<sup>4</sup> where essential features of the foundation are described.

First, the charter states the required characteristics of its members; they are:

(...) Innovative banking institutions whose primary focus is on:

- Delivering social finance products and basic financial services while
- Financing community based development initiatives and social entrepreneurs thereby
- Fostering sustainable and environmentally sound enterprises and fulfilling human development potential including poverty alleviation while
- Generating a triple bottom line for People, Planet and Profit.

Members include microfinance banks in emerging markets, credit unions, community banks and sustainable banks. There are also two more requirements for members:

- they have to be independent and licensed banks with a focus on retail customers;
- they need a minimum balance sheet of \$50 million.

The main creed of the organization is that all people on the planet are economically interdependent and responsible for current and future generations. Consequently, the objective becomes improving the quality of life for everyone.

GABV tries to reach these goals through a set of defined activities to be developed with the cooperation of many partners. The activities are grouped into five areas:

- Advocacy and engagement: GABV supports public debate about banking to expand ethical finance principles; it provides comments on many current items, participates in public events and collaborates with local and global governmental entities;

- **Developing Human Capital:** GABV is creating networks across its members to promote knowledge sharing, product development and human development. Researching and cataloging existing training programs and identifying opportunities, GABV wants to elaborate a long-term human capital development plan. This plan will include explications to share expertise, build skills and deliver training;
- **Expanding Its Network:** GABS aims to expand its network of members, working in three directions. First, identifying existing banks that share ethical principles; then, collaborating with banks that are converting their business in a more ethical one; and finally investing in new banks created upon analogous principles;
- **Measuring Impact:** GABS plans to develop a common measure to quantify success from the point of view both of financial returns and social impacts. The research regarding these items will aim to establish how and to what extent GABS members currently quantify their impact on society and the environment. So the research will focus on measuring how sustainable banking impacts in human lives;
- **Raising Financial capital:** since financial capital is required to support and invest in sustainable activities, it is necessary an investigation of the existing capital structure of the members. It is then useful determining a market investment criteria for sustainable banking and developing new plans; create a separated class of ethical financial assets for institutional investors is an example.

### **1.3 The International Association of Investors in the Social Economy**

INAISE was born in 1889 and it is a network of socially and environmentally oriented financial institutions. It works in European and non-European countries. Using INAISE, investors can exchange experiences, diffuse information and ideas about ethical principles.

The members of INAISE are banks, co-operative financial institutions, non-profit associations, foundations, venture-capital and guarantee-funds, all sharing the principles sponsored by the organization. But INAISE members do not just have to sustain ethical principles; they need to develop also a different investment approach compared with traditional financial institutions. First, they have to guarantee transparency and attention with costumers. Investors can see which are the activities financed with their money; in this way they become conscious and involved in the investment process. Moreover, as investors they can be also a font of information and advices, besides accepting probably more flexible terms and conditions.

INAISE members sponsor and promote the following sectors:

- Environmental and sustainable development, such as renewable energy, organic agriculture, clean-technologies;
- Social economy; co-operatives, community enterprises, employee participation are examples;
- Health-care, that means clinics and hospitals, programs for disabled, health centers;
- Social development, that includes social housing, social services, community transports, charities;
- Education and training, such as school buildings, trading courses and organizational developments ;
- North-South, that refers to: fair trade and small business like crafts, farming and small-scale industries;
- Culture and arts: artists, local radio, films.

Referring to the aims of the organization, we can report the fourth article of its Statute<sup>5</sup> (1989) :

1. The object of INAISE is to further the development of finance organizations involved in the social economy. INAISE is a non-profit-making association.

2. This objective shall be pursued by the:

- Provision and sharing of information on investment and banking policies and practices in each country in which a member is based as well as at a European and International level;

- Education and training of personnel of the members and others on Social Investments practices;

- Publication of information to members and others about the activities of INAISE and its members as well as on any subject directly or indirectly related to its objects. INAISE may use all available media for this purpose and circulate information by any technical means at its disposal;

- Provision of information to its members and others on matters which affect the investment policies and practices of its members and others.

# Chapter 2

## Introducing *ethical banks*

All the organization previously described refer often to ethical banks, sustainable banks and ethically financial institutions. As we have introduced, they are characterized by paying a lot of attention to how use their money. They finance only activities with positive impacts on the society and on the environment. This approach goes in the opposite direction with respect to the one of the commercial banks. The latest are more concentrated on the financial capability of the financed activities. But there are many other features characterizing ethical banks.

A detailed definition of ethical banks is provided by FEBEA on its website<sup>6</sup>. It contains explanations of each aspect of banks activity:

### 2.1 The role of ethical banks

“The role of an ethical bank is to work for the common good”; it has to receive depositors and investors funds and use them to finance social, environmental and cultural projects. Ethical banks based its activity in supporting “social inclusion, sustainable development, development of social economy and social entrepreneurship. Moreover it follows the task of increase public consciousness and information about the need of having other objectives besides the mere financial profit.

## 2.2 The origin and the destination of money

Ethical banks own funds coming from the deposits of its customers. It does not accept non-declared money or funds coming from illegal activities, armament industries or high polluting industries.

The objective of an ethical bank is to support activities for human, social and economical promotion; so it analyzes deeply the impact that may have the activity it will finance both on the society and on the environment. It gives a high value to activities dedicated to the weaker groups of the population and to the most degraded areas. For instance ethical banks give priority to who is favoring social integration and employment and to initiatives for self-employment of women and youth. Consequently, activities belonging to “controversial sectors” are not financed. For instance, these are activities dealing with alcohol, tobacco, gambling, nuclear energy, exploitation of animals or human rights violation.

The attention to who finance go through the elaboration of a new method of evaluation. Entities requesting financing are subjected to two levels of analysis. At the assessment of the financial worthiness is added an impact assessment. This second part of the evaluation procedure aims to estimate the social-environmental impact of the project; it is developed following some established criteria of evaluation and it is proper of ethical banks. To get the demanded funds, a project has to obtain a positive evaluation in both fields. “In an ethical bank at least 90% of financing distributed to companies/institutions/organizations meets both economic and social-environmental criteria.”

This double-level evaluation leads the set of all financed activities to be characterized by a very low risk level.

## 2.3 Criteria and values for the use of money

The basic value upon which an ethical bank bases its management of money is the transparency. The ethical bank guarantees to its customers transparency on both the investments and the management of internal activities. Ethical banks publish the lists of their investments; some of them also give customers

the possibility of deciding the destination of their savings.

The banks business model is characterized by traditional banking activities: receiving deposits and granting of loans. To finance activities this type of banks does not consider only financial guarantees. Also personal or social guarantees are very important. The latter can be provided by the local network to which belongs the activity.

Usually, ethical banks can distribute as funds only 15% of their regulatory capital.

Furthermore, this class of banks prefers activities with a “long-term” temporal horizon, and supports the real economy. So it does not speculate on short-term operations, and does not use derivatives or other financial tools for credit objectives. The main profit is due to interests on loans.

## 2.4 Conditions for bank management

To ensure the activity and the sustainability of an ethical bank it is necessary a fair profit. The profit is usually reinvested in social projects of the bank. It may also occur that the bank establish a limit to the remuneration of its capital. Anyway the spirit of an ethical bank consists in putting “credit at the service of people”, and there is not an exclusive research for profit.

For the management of the bank is required a participation of its employees, shareholders or members. This participation is realized by codified procedures or statutory instruments. The participation is also guaranteed by a consolidated and branched network that the bank creates on the territory, at a national level and at a local one. In this way the bank obtains also a full knowledge of its clients and of their projects.

Finally, an ethical bank ensures a positive spirit among its employees establishing a maximum ratio between the highest and the lowest salary in the company. It is a maximum of 7 to 1. with this rule the bank guarantee transparency and justice in salary management.

# Chapter 3

## Reasons for being ethical

Banks are one of the major players in the economic system due to their intermediary role. It is for this reason that they are essential in realizing an economic development, sustainable from an environmental point of view. Banks are moving towards this direction, but in a very slow way. Anyway, the first step of European banks has been realized in the 1990s; it consisted in developing new products such as environmental friendly investment funds. But elaborate financial tools is not enough to realize a positive impact on the society. First of all, banks have to being aware that the environment can bring risks. The financed activities may be dangerous from the environmental point of view. So it is necessary being able to price these risks.

### 3.1 The intermediary role of banks

Figure 3.1 shows the typical cyclical process of a macroeconomic system. The arrows represent cash flows. Households consume goods produced by companies, import goods from the international markets, pay taxes to the government and converge their savings to financial markets. Companies produce goods and export them into the international markets, invest and receive investments. The government receives taxes, pays subsidies and invest. International markets are the point where goods (imported and exported) are traded. Financial markets are implied in all the described dynamics, as the image highlights

through the shaded area. Financial transactions of households, companies, government and international markets flow through financial markets.

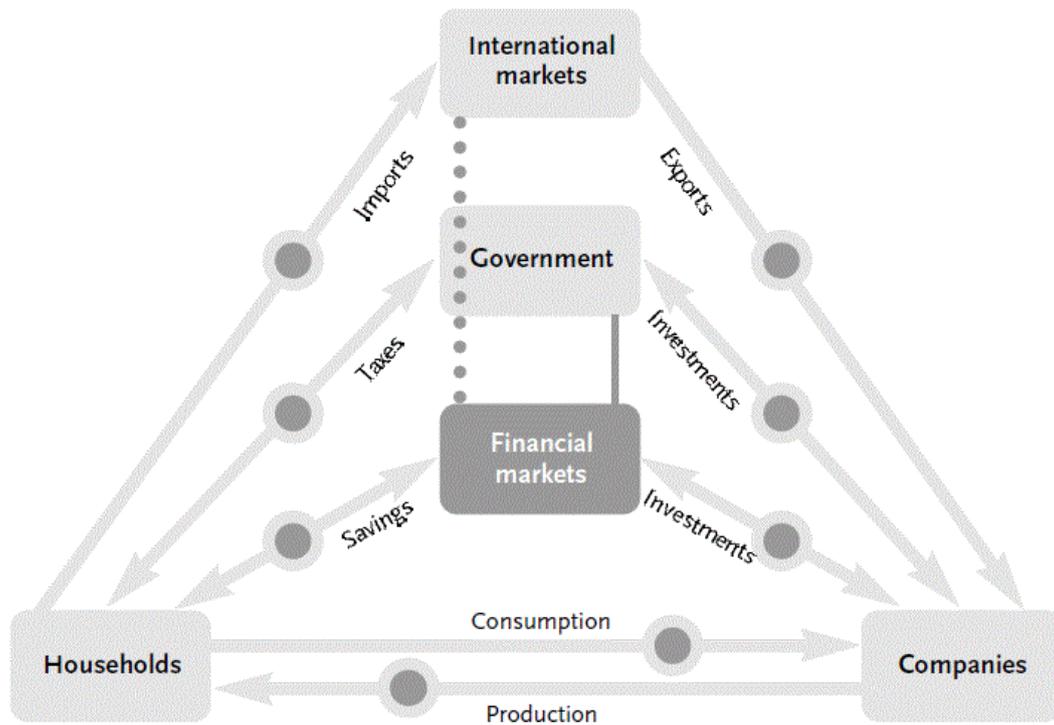


Figure 3.1: *The role of the financial markets in an economic system. Jeucken (1988)*

The intermediary role in the economy is realized by different functions. First of all, banks act as intermediary putting together people with a surplus of money and people with money need. Moreover, banks mediate the time horizons of the parties; it may occur that the creditor has a short-term surplus, while the debtor has a longer-term need. It can be also the case that creditors and debtors are far from a geographical point of view. So banks create contacts between market players even if they are separated by high distances. Banks play a central role also from the point of view of risk management. They have a deep knowledge of financial markets, obviously higher compared to persons with a money surplus that want to invest it. Banks have capability of study risks and they develop different approaches manage them. Due to large scale, banks have also the possibility of spreading the risk. Through this knowledge of

the risk, banks can reduce the information asymmetry between market parties. So these intermediaries can influence the speed and the direction of economic growth.

In particular, thanks to the risk management function, they can contribute to a sustainable development of the society. The starting point consists in developing consciousness that environment can bring risks and opportunities. Then, they have to price this risk and make it effective differentiating tariffs. So debtors with a higher environmental risk will pay higher interests. This procedure is an efficient way to foster environmental sustainability, but especially at the beginning may produce a loss of profitability. The question is if the bank will accept the results of the procedure.

Jeucken and Bouma<sup>6</sup> (1999) state that intuitively banks have a hindering role in the achievement of sustainable development. First, investments that aim to reach environmental sustainability often need long-term payback periods, while banks prefer short-term investments. Then, these types of investments guarantee a low rate of return, while financial markets usually ask for a higher as possible rate of return. So it seems the case that sustainable investments do not find investors in the current financial market.

In an economic system, households and companies do not take into account the environmental externalities of their investments, since any price is attributed to that kind of risk. So prices upon which they make their economic decisions do not include the price for environmental sustainability. So there will always exist an investment with a higher rate of return compared to those that take in account environmental sustainability. For instance, a company that does not pay attention to social and environmental externalities will guarantee a higher rate of return compared to a company that is sensible upon these themes. A bank will award the first one with a low cost of capital or request for collateral. But in a long-term horizon the second company would have been a better investment in terms of social and environmental outcome. But Jeucken and Bouma conclude that banks are not hindering the achievement of sustainability; they can even help it. For this purpose, the higher rate of return has to be overcome by strict legislation and driving forces that push towards this aim. One of the main driving forces are government policies, that

work at an internal level. Driving forces coming from the external economic environment are customers, competitors, NGOs and an increasing part of the society sensible to those items.

Moving towards sustainability can have two advantages for banks. The first is related to the exposure to risk; banks can decrease their exposure to risk analyzing the activities of their customers. If the continuity of a customer is threatened by new legislation, then the bank itself will also be affected. The second advantage regards the development of new products, environment friendly, that satisfies the demand of the investors. In facts, among investors, is increasing the attention for new business with positive externalities, lower risk and interesting rate of returns.

## 3.2 Actions taken by banks

In the current economic world, banks are reacting to environmental and economic sustainability items in different ways and at many levels. In order to describe the different reactions, Jeucken and Bouma<sup>6</sup> (1999) develop a model that identifies four stages or attitudes. Theoretically each bank goes through each stage to reach the final one, that represents the best attitude. But it can be the case that the bank overpasses one of the intermediary steps. The four stages are: defensive banking, preventative banking, offensive banking and sustainable banking; they are showed by Figure 3.2 .

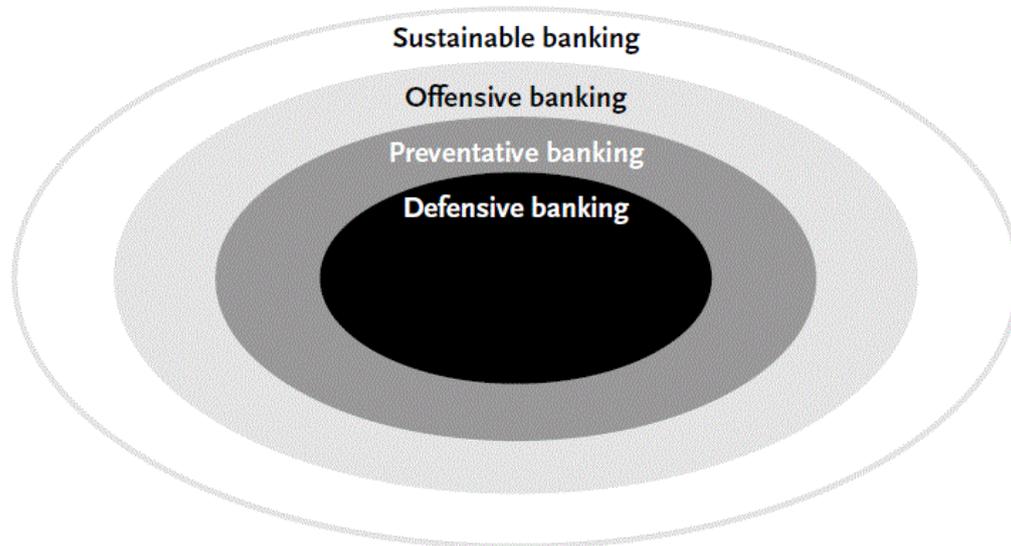


Figure 3.2: *A typology of banking and sustainable development. Jeucken (1998)*

As the figure shows, each outer layer contains the previous ones; this means that sustainable banking will contain all the features of offensive banking, preventative banking and defensive banking. Initially, banks move from the inner layer toward the external ones.

The inner layer is *defensive banking*. At this stage the bank is non-active in fostering sustainability; it may even hinder actions in this direction taken by government, because they can damage interests and profitability of customers. This attitude is also developed at an internal level. The bank does not consider actions that may be opportunities for cost saving, such as energy efficiency. Fortunately, nowadays this stage is proper of a few banks, but it describes the attitude of many departments within banks, as those related to investment banking.

The successive stage is *preventative banking*. From the internal point of view, banks take into account actions to reduce costs and to reach eco-efficiency. This stage can be inevitable due to the actions of external driving forces such as government and NGOs, that push toward more attention to sustainability. But the preventative attitude differs from the previous stage mainly for what concern internal actions. Banks at this stage only consider

internal processes such as environmental management and credit risk assessment.

The *offensive banking* considers also the external activities in addition to the internal ones. But the external actions are concentrated on creating new environmentally friendly products, such as environmental investment funds and finance specific activities. This attitude can be considered innovative: banks are looking for win-win solutions. The problem is that those solutions do not lead to sustainability until environmental costs are not completely integrated into the price system. At the beginning of this stage we can identify an example in Deutsche Bank, that we will analyze successively.

The outer stage is *sustainable banking*. First of all this attitude requires that the investors have the same vision of the bank. Banks at this stage do not look for the highest rate of return, but for the highest sustainable rate of return. Moreover, they accept investments with long payback periods and high risk. So banks do not consider only financial risk but also social-environmental risk. For this purpose they develop procedures to test the social-environmental impacts of companies requesting financing. Unfortunately, few banks reach this stage. One of the main reasons is that those ideas are not so diffused in the society. In Italy, Banca Popolare Etica can be considered an example of the development of a sustainable banking attitude.

### 3.2.1 Deutsche Bank: an example of preventative banking

Deutsche Bank is developing an offensive sustainable banking attitude. It deals with ethical items, as we can read in the *Code of Business conduct and ethics*<sup>7</sup> (2014) in its website:

Our values, and the beliefs which lie behind them, support our goal of long-term cultural change, an essential element of Deutsche Bank's strategy and crucial to helping restore the bond of trust with society. These Values and Beliefs are at the core of all we do and are designed to ensure that we conduct ourselves in a manner

that is consistent with the highest ethical standards. They define the type of institution that Deutsche Bank aspires to be and must be visible in the way we conduct ourselves.

Deutsche Bank adds two codes to this one; they are named *Code of Ethics for Senior Financial Officers* and *Complaints in Accounting and Auditing Matters*.

The actions of Deutsche Bank referred to sustainability are concentrated on internal management. The *Code of Business conduct and ethics* provides mainly ethical guide-lines for employees. It pays also a lot of attention on the clients, giving importance to preventing and managing conflicts of interest, protecting client information and managing clients complaints.

Deutsche Bank also deals with the reduction of credit risk by integrating environmental issues in the credit risk assessment process. The *Code*<sup>7</sup> reports:

(...) We are committed to long-term thinking and to an entrepreneurial spirit that properly balances risks and returns. We also recognize that our strategy requires consistent adherence over a long period and may not be easily achieved in the short term. Deutsche Bank is committed to generating sustainable value for our clients, employees, shareholders and society by responsibly balancing risks and returns and by putting long-term success over short-term gain. We do so by ensuring we have appropriate oversight, controls and governance in place.

(...) Sustainability is at the heart of our corporate responsibility principles. We believe that being economically successful and internationally competitive generates value for our shareholders, clients and society at large. We consider the environmental and social impact of our actions and apply high environmental and social standards to our business to support a sustainable future.

Although the nature of this initiative is “preventative”, the bank is also offensively oriented, understanding the necessity of developing innovative and sustainable financial tools. In 2011 83 million Euros were dedicated to “Global Social Responsibility Investments”, distributed in the sectors showed by figure 3.3 :

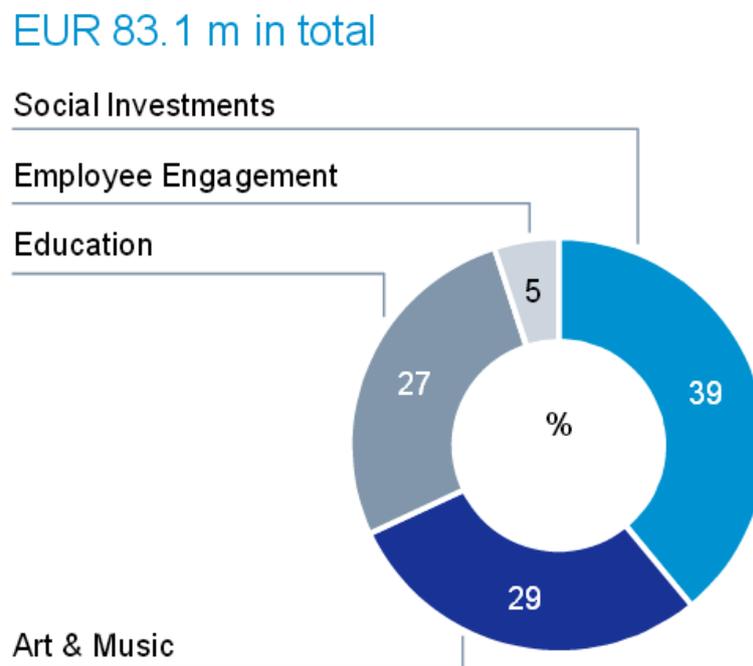


Figure 3.3: *Global social responsibility investments. Deutsche Bank (2011)*

Anyway, the evolution to become a sustainable banking is long. Big efforts are been made in this direction, but up to now they regard only a small part of the Deutsche Bank business.

### 3.2.2 An example of offensive banking: UBS

From many years UBS developed a preventative attitude to banking activity. In February 1999 it implemented the “Global Environmental Risk Policy” for investment banking activities, and it was the first such initiative by a major bank. Although the nature of this initiative was preventative, UBS has consolidated also an offensive attitude. As we explained previously, offensive banking means be able to consider external activities in addition to internal ones. Banks with this attitude are also developing and marketing environmentally friendly products. In this context, UBS developed “Eco-Performance Portfolios”. These consist in funds invested in international equities, “with the emphasis on environmental and social criteria”. An informative prospective of

such Fund, published by UBS<sup>8</sup> (2010), reports the Fund description:

- Actively managed equity fund based on compelling stock selection;
- diversified equity portfolio investing in selected companies worldwide, primarily large caps;
- investments in companies that generate above-average environmental, social and economic performance and also offer interesting growth potential;
- diversified across sectors and countries offering broad coverage of the global market.

Anyway, also in this case only a part of the business is dedicated to sustainable banking. In order to become a sustainable banking, the entire business has to evolve following an attitude of sustainability. The bank will not look for the highest financial rate of return, but it will seek for the highest sustainable rate of return.

## Chapter 4

# The Italian Ethical Banking sector: an overview

The first experience of ethical finance in Italy is represented by the constitutions of a financial cooperative: the MAG (“mutua autogestione”, literally “mutual self-management”), that was born in Verona in the 1978.

In the 80’s the model of the MAG spreads around Italy, and new cooperatives born in Milano, Torino, Reggio Emilia, Venezia, Roma and Firenze.

In 1993, an action of the set of laws regarding the banking sector (Testo Unico Bancario), established that only banks can collect money among depositors and it is forbidden to other financial institutions. Consequently, the cooperatives such as MAG, can collect money only from their members. After that cooperatives created an ethical bank, that was born in 1999 in Padova with the name “Banca Popolare Etica”. We will examine in depth its case in the successive chapter.

In the last 15 years the ethical banking sector has increased its components. New ethical banks are born, such as *Banca Simefica*; moreover existing Banking Groups have developed ethical branches. *Banca Prossima* of the *Intesa San Paolo* group is was born in 2008 and *Universo non-profit* of *Unicredit* group was born in 2009.

## 4.1 The case of *Mag 4*

Mag 4 is a financial cooperative that was born in Turin in 1987. It operates in the ethical finance field, focusing its activity on principles such as the co-operation and the self-management, in alternative to the traditional economic system. The main objective of the Mag 4 is financing activities sharing its same principles. We read in its website<sup>9</sup>:

It wants give support to enterprises who operate in no-profit sector that are based on values such as co-management of the enterprise, the no-speculative reinvestment of profits, the democratic organization, the inclusion of disadvantaged, transparency, democracy, respect for the environment and participation.

It pays a lot of attention to the relationship with members, guaranteeing information transparency and members participation:

Mag4 raises money to make investments in a fair circuit, not speculative and transparent. With the subscribing to shares in share capital, shareholders will be able to control the use of their savings through transparent information on funded projects and on the progress of activities. They may also participate to the social life of the cooperative taking part in the meetings and contribute to the cultural promotion of MAG and solidarity economy.

The main receivers of funds are cooperatives, associations and mutual aid societies that develop activities dealing with solidarity, social integration, fair trade, youth education, environmental protection, and all those activities that do not have negative impacts on people or on the environment.

## 4.2 The case of *Banca Prossima*

Banca Prossima is the bank of the Intesa Sanpaolo Group dedicated exclusively to the non-profit and religious sector. The bank meets the needs of companies

of the third sector in order to improve the quality of banking services and to participate in the growth of the sustainable economy.

As written in its statute<sup>10</sup>, Banca Prossima:

(...) has as its goal the creation of social value and the widening of access to credit. (...)To this end, the company provides particularly banking services to secular and religious organizations which work, without profit, developing common good services as well as other public and private entities who set activities and initiatives that create social value acting in the non-profit sector.

The bank wants to meet the company and associations penalized by the conventional criteria of banking evaluation. It uses an innovative rating model that considers the special characteristics of nonprofit organizations.

The bank created also a fund for the development of the social enterprise in which it pays every year at least half of our profits. This Fund enables Banca Prossima to provide credit to the most interesting but economically difficult projects.

## Chapter 5

# The case of Banca Popolare Etica

Banca Popolare Etica is the most important example of ethical banking in the Italian panorama. As we can read in *The economist*<sup>11</sup> (2013):

Ethical banks are nothing new, but Banca Etica takes its name seriously. Its annual report calls for a citizens' revolt against casino finance, the use of tax havens and speculation in commodities. Executive pay is not allowed to exceed six times the lowest wage at the bank. And it does not want to get involved with anything having to do with pornography, oil or arms.

(...) Such ideas may explain why Banca Etica is small: it has only 17 branches, around 230 staff and loans of less than €1 billion (\$1.3 billion), and made a profit of €1.6m in 2012. The firm provides mainly credit to the non-profit sector and green businesses. It was, for instance, the first Italian bank to lend to co-operatives of young people who farm land confiscated from the Mafia.

This institution is born with the objective of create an ethical bank from all points of view. The main ideas of the bank are reported in the Banca Etica's website<sup>12</sup>:

The idea behind *Banca Etica* consists in creating a place where savers, driven by the common desire of a more transparent and

responsible management of financial resources, may meet socio-economic initiatives, inspired by the values of a sustainable social and human development.

The bank manages savings raised from private citizens, as singles or families, organizations, companies and institutions in general, and invests them in initiatives pursuing both social and economic objectives, operating in full respect of human dignity and the environment.

In such context *Banca Etica* sets out to educate both savers and borrowers by enhancing the awareness of the formers about their saving's destination, and encouraging the latter to develop their management and entrepreneurial abilities.

## 5.1 The principles inspiring the Bank

Banca Popolare Etica operates following a set of ethical principles listed in the “Manifesto della Finanza Etica”. It is a document written by the Bank with the objective of state which are the ethical principles grouped in the definition of “ethical finance”.

In particular, as the bank states in the fifth article of its Articles of Association<sup>13</sup>, the ethical principles inspiring the bank are the following:

- ethically oriented finance is aware of non-economic consequences of economic actions;
- access to finance is a human right;
- efficiency and soberness are components of ethical responsibility;
- profit produced by the ownership and exchange of money must come from activities oriented towards common well-being and shall have to be equally distributed among all subjects which contribute to its realization;
- maximum transparency of all operations is one of the main conditions of all ethical finance activities;

- the active involvement of shareholders and savers in the company's decision making process must be encouraged.

## 5.2 The application of the ethical principles

The application of the principles of ethical finance is observable mainly in two aspects; first of all in the importance of having correct and clearly procedures that respect laws and that form part of a cautious and health administration; then in the relation between the bank and the financed customers. This relationship goes through the social and environmental analysis, that the bank uses to establish the principles of ethical finance.

Most of all, the credit policy is based on choosing the activities to be financed. This is realized with two types of criteria: a negative criterion, that lists a group of activities that the bank cannot finance, and a positive criterion, that lists some sectors that the bank has to facilitate financing customers.

The list of activities that the bank cannot finance contains, for instance:

- production and trading of arms;
- activities with apparent negative environmental impact;
- scientific field activities dealing with experiments upon weak individuals or animals;
- intensive breeding of animals that do not respect international standards of certification;
- activities producing ghettoization of minorities or special categories of the population;
- activities with direct relations with nations that do not respect human rights;
- activities dealing with the trade of sex;
- gambling.

A deep analysis of the sectors of employment permits to finance subjects that have the human, economic, social and environmental sustainable development as objective, coherently with the bank's mission. Since the beginning the bank granted financing to organizations operating within the third sector; these organizations had to:

- carry out civilly oriented economic projects;
- have the legal form of co-operative societies, associations or social-institutions;
- operate in an area chosen between social co-operation, international co-operation and environment.

Nowadays the range of investments sectors is increasing, including firms with a for-profit legal form of organization; the main sectors in this direction are those dealing with energetic efficiency, renewable energies and production and trading of biologic products.

So what differentiates Banca Popolare Etica from traditional banks is the careful evaluation of the social and environmental impacts of the activities to be financed. As reported in the website<sup>12</sup>:

Over and above the traditional economic evaluation procedures, the projects to be financed undergo an evaluation aimed at analyzing the consequences of the projects on common welfare and natural environment. In this respect, *Banca Etica* carries out a thorough analysis of the social and environmental responsibility.

To grant financing, *Banca Etica* gives primary importance to the following aspects: (i) the reliability of the project, which undergoes a thorough economic and practical feasibility analysis, and (ii) the relation of personal trust between the Bank's personnel and those who represent the organisation requesting the financing. Therefore, *Banca Etica's* evaluation is not based exclusively on the wealth asset and thus on the securities the client is able to ensure.

This field of analysis is added to the evaluation of the credit worthiness; the latter is the only aspect that traditional banks analyzes about the financed subjects.

The environmental analysis is also useful to influence the financed entities behavior. It is important to avoid that the financed activities have contacts with non ethical activities. Furthermore, it leads the financed entities to pay more attention to the aspects that will be taken in consideration with this type of inspection.

Aiming to set up a personal trust relation with the customers, the bank establish a deep contact with the financed entities; via this relation it can diffuse an ethical oriented finance and sustainable development ideas.

As previously explained, the evaluation procedure consists in a process of collection and analysis of data about all the borrowers; the objective is to discover the projects consequences on common welfare and natural environment. This investigation aims to integrate the economic-financial analysis, evidencing three main aspects of the borrower: the social value of the activity to be financed, the coherence with the principles of the bank and the ethic credibility of the organization.

In order to realize the social-environmental investigation, Banca Popolare Etica uses the shareholders' local groups that are located all around the territory. The local groups represent the meeting point between the shareholders and the bank. Through them shareholders participate in the bank's social and cultural activity. These groups have a deep knowledge of the local activities oriented to environmental sustainability.

The system of territorial organization is a peculiarity of *Banca Etica*; it allows the bank to establish a direct relation with the territory maintaining a simply commercial structure. Another peculiarity of the bank is the "social evaluator"; he is a person instructed to develop a special activity: he collects data related to the organization requesting the financing. He is specially instructed to develop this specific activity.

The process of inspection involves the entire bank at different levels: from the central office to the local groups, through special professional persons, created ad-hoc.

### 5.3 The internal executives bodies

*Banca Etica* applies Ethical principles also to the internal organization structure. To this aim it created many institutional bodies that cooperate to guarantee an ethical equilibrium. We can list four institutions:

- The *Shareholders assembly*: it is the “sovereign body of the Bank”. It deliberates in both ordinary and extraordinary sessions. All the shareholders can participate to the assembly, and it is guaranteed the equality principle: each member has the right of a vote, independently from the owned amount of shares. The assembly aims to be also a meeting place, as we can read in the website description<sup>12</sup>:

(...) The Assembly is to be considered as a place where people, who have ethical finance at heart and who strongly believe in its principles, can meet, exchange experiences and opinions;

- The *Board of Directors*: is the management institution of *Banca Etica*. Its members are democratically elected among the shareholders by the Assembly. In some cases it can also form a sub-institution: the *Executive Committee*, that has to develop special activities on the basis of the powers of attorney rendered by the Board. It permits to the Bank to guarantee a more careful and slender administration of peculiar items;
- The *Board of Auditors*: its main task is supervise the bank’s management, “to ensure that it carries out its functions in compliance with statutory constraints, legal rules and company resolutions”.
- The *Proviviri Committee*: literally “Committee of Guarantors”; it is constructed to resolve potential conflicts which can arise among the shareholders or between the Bank and its customers. The conflicts can be related to the application of the Statutory articles or to any other institutional bodies deliberation.

## 5.4 The social analysis

The process of inspection was changing continuously in the past years, in order to improve the model of analysis. The more recent methodology enhance three steps:

- the social-environmental questionnaire (QSA), that is filled by the organization requesting the financing;
- the social analysis of the balance sheet (ASB), realized by a credit supervisor;
- the social-environmental analysis (VSA), realized by the social evaluator.

### 5.4.1 The social-environmental questionnaire

The questionnaire is the first step of the entire process of social-environmental inspection; it contains a list of questions that aims to collect information and to create a first profile of the organization. The questions are based upon essential aspects of social and environmental consciousness. The questionnaire is destined to all new customers, such as organizations or individual firms; on the contrary some customers such as public agencies are dispensed to fill it.

As soon as the customer fills it, he becomes responsible for his declarations; this is very important, because this part of the process aims both to collect information and to establish a communication line with the customer. Moreover, the bank has constructed the questions to evoke to the customer a reflection about the proper social responsibility.

There exist different versions of the questionnaire, depending on the typology of the customers requesting the financing; there are specific questionnaires for associations, cooperatives, foundations, enterprises and individual firms. Also enterprises with experience and start-up have proper ones; for the latter there is a simplified questionnaire.

The questionnaire is made up by sets of questions; they are grouped according to the area of inspection: mission, governance and relationships with shareholders, environmental responsibility, non-discrimination, transparency

of all the operations, customers protection, safety and healthiness on the labor place, contracts and timetable, system of social responsibility.

Questions about the mission of the organization ask for business objectives, in order to measure the level of transparency of the declared mission and to verify if it is coherent with that one stated at the beginning of the activity. In case of associations foundations, cooperatives and NGO the bank investigates also the social objectives.

The area dedicated to the governance and to the relationship with shareholders inspects about the organization structure of for-profit organizations and about the application of democratic principles in the management of non-profit organizations.

The questionnaire gives great importance to the environmental responsibility: it verifies the sensibility on this theme and the daily obligation for the environmental sustainability. There are questions about the energetic consumes of the organizations (particularly regarding the energetic efficiency), about the waste sorting realized and about environmental certifications.

The area that deals with non-discrimination focuses on the sensibility to the integration of immigrates and underprivileged persons; it collects data about the composition of the workers from the genre standpoint. Furthermore it inspects specific actions realized to improve the labor conditions of weaker people.

From the transparency point of view the questionnaire aims to establish and confirm management's transparency through the communication with stakeholders and customers. It verifies which and how many methods are used to spread information: the organization has to establish a dialogue with the stakeholders; customers have to be constantly informed about the features and the safety of products. In this direction the bank investigates the implementation of procedures inspecting the customers satisfaction.

Central themes are also the workers labor-place, the contract and the timetable. The objective of the bank is to guarantee that the attention paid by the organization on these themes overcomes the simply respect of law. So questions verify in detail every aspect of the relationship between organization and workers, particularly in case of cooperatives and for-profit organizations.

They are questioning workers safety certifications, the frequency of accidents, the contract typologies and the quantity of overtime hours.

Questions about social responsibility management focus on the balance-sheet items and are directed to cooperatives and for-profit organizations. They investigate the redaction of the balance-sheet, its publication and the transparency of financial documents information.

Finally, the questionnaire creates the basis for the successive step of the inspection, because it emphasizes the critic points that the social evaluator will have to analyze more carefully.

### **5.4.2 The social analysis of the balance sheet**

In this part of the process specialists analyze the balance-sheet values in order to verify if the administration acts responsibly or if there are some critical elements from both the financial and the social point of view. For instance they look for indicators of a correct fiscal behavior that respects the legal form adopted by the organization. If analysts identify some critic value they have to inform the social evaluator. He will inspect these items during his process of analysis.

### **5.4.3 The social-environmental analysis**

The social-environmental questionnaire is the basis for this step of the analysis process. The social evaluator that realizes the analysis belongs to the area in which the organization operates. He has to verify possible critical elements arising from the questionnaire, analyzing the answers and the non-answers to every question. During this process a manual containing the description of every area of investigation helps the social evaluator. He researches new information about the organization and he can ask for more documents. Usually he visits the main offices to realize a meeting directly with the responsible agents. At the end of this process the social evaluator writes a final report where includes the description of his research, a personal judgment about each area of investigation (that is expressed by a value in a range from 1 to 5) and

a summary where he reports in detail the results of the analysis. In the report he has to highlight the social and environmental impact and it has to include the judgment of the Territorial Organization of the associates.

There are two types of social-environmental analysis depending on the features and on the complexity of the organization requesting the financing:

- the standard social-environmental analysis is the one realized by the bank through the social evaluator activity;
- the advanced social-environmental analysis is used in order to evaluate more complex organizations. It is realized with a specific methodology and it is carried out by the Cultural Relations and Social Responsibility Office. In order to define a complex organization some features are taken in account, such as the dimension, the administration structure, the country in which it operates and the business developed by the organization. In case of complex organizations the bank does not accomplish the social-environmental questionnaire: it realizes only the other two steps of the inspection process. The social-environmental analysis has a period of validity of two years, and then it has to be renewed.

The result of the entire process of inspection completes the economical-financial analysis and provides an integrated analysis including both the valuations. It is possible to elaborate a total final judgment of credit worthiness with respect to both the organization and the project. (Figure 5.1)

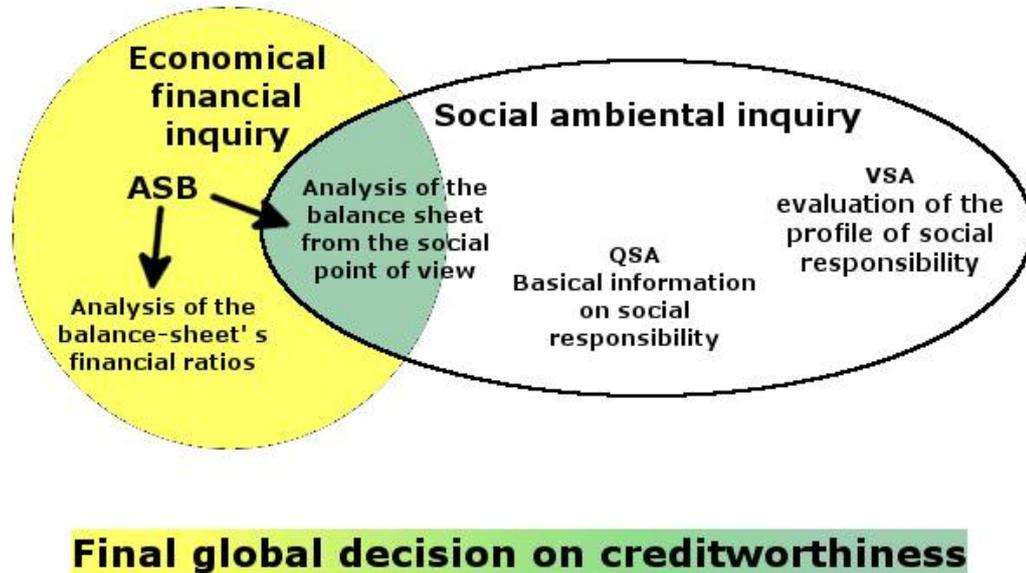


Figure 5.1: Final global decision on creditworthiness. Milano and Grillo

Up to now the two inquiries are realized into two steps and they are integrated only at the end of the process. Anyway, nowadays the bank is working on a new evaluating system, in order to reach the complete integration of the two inquiries among the process. This integration will be realized through two directions:

- the computerization of the social analysis procedure, so that it will be constantly connected with the financial verification procedure;
- the elaboration of a weighed system for social-environmental values.

The computerization of the procedure permits to customers to fulfill quickly the application of the questionnaire as soon as the line of credit-responsible inserts the request in the system; at the same time they are entered, data are available for the social evaluator. With this system every participant to the process can manage his part of data. Moreover, the line of credit-responsible will always be informed about the VSA, as the social evaluator about the credit situation.

Furthermore, the bank is creating a weighed system in order to uniform the elaboration of the questionnaire values. The weighing will be double: not only every area of the questionnaire will have a weigh (ex. Governance, transparency etc...), but also each set of questions forming the area. In this way the system preserves the subjective judgment of the social evaluator; at the same time it defines a limited range of possible values. The score that results from the VSA will be added to the balance-sheet inspection score and will form part of the final grade.

Initially, the VSA will weigh only 20% of the final score; this because in this moment the bank does not own a sufficient database able to realize the customers social analysis and to check its creditworthiness.

# Chapter 6

## Agent-Based Models

Computer simulations are a consolidated way of building models reproducing reality. For quite some time they have been considered a good alternative to the approach involving mathematical equations, as we read in Luna and Stefansson <sup>14</sup>(2000):

Computer Simulations of economic systems are slowly gaining ground within the profession. Economists have become aware of the limitations of the standard mathematical formalism. On the one hand, when dealing with real world phenomena, it is often impossible to reach a “closed form” solution to the problem of interest. One possible approach is to simplify the problem so that an elegant closed-form solution is synthesized. The implicit assumption is that the simplification process has spared all relevant elements and discarded only unnecessary ornaments. In case this a priori seems too strong, the empirically oriented researcher may want to employ a simulation to study the dynamical properties of the system. On the other hand, what Frank Hahn once dubbed “pure theory” is suffering from “exhaustion”, the purely deductive method seems to have reached a dead end. Hahn argues: (...) thriving subject will know at each stage of its development what the next crucial questions are. Pure theory is not exception. But is so happens that it is becoming ever more clear that almost none

of them can be answered by old procedures. Instead of theorem we shall need simulations.

Their argumentation shed light on the fact that mathematical models do not accommodate the intrinsic complexity of scientific models. In the rest of the essay introduction we will often refer to the “complexity” of models, because it is the main reason why simulation models developed. Because of this it is obviously important to provide a definition of complexity; to this end we refer to Anderson<sup>14</sup> (1972): “complexity arises when the individual agents of a system act and interact with each other and the number of agents is relevant”.

With computer simulation the limits of the mathematical tractability disappears. Now, also models with a high levels of complexity can be developed. They can include more features and dynamics of the real system. Mathematical models have limitations also regarding the capability to provide detailed analysis and description. Also this problem may be overcome with computer simulations.

Computer simulations has many other advantages. They have a flexibility proper of a computer code and it can be combined to an intrinsic computability. Moreover, with the construction of artificial worlds scientists have the possibility to transform simple inputs into unforeseeable outputs. Basic assemble hypotheses used to built the model may lead to unexpected and original results. These results can be easily observed; they can increase the intuition of the observer and may suggest new interpretations of real world phenomena.

Agent-Based models are a subclass of computers simulations; in this case variables are used not only to describe the whole system, but also to model its individual agents. To better understand the features, we go through the definition of Railsback and Grimm<sup>16</sup> (2012):

ABMs are thus models where individuals or agents are described as unique and autonomous entities that usually interact with each other and their environment locally. Agents may be organisms, humans, businesses, institutions, and any other entity that pursues a certain goal. Being unique implies that agents usually are different from each other in such characteristics as size, location, resource

reserve, and history. Interacting locally means that agents usually do not interact with all other agents but only with their neighbors (in geographic space or in some other kind of “space” such as a network. Being autonomous implies that agents act independently of each other and pursue their own objectives.

## 6.1 Main characteristics of Agent-Based Models

First of all, computer simulations are not equation-based: they are agent-based as reality. The only thing that can be equation-based is the process of making decisions. The decision-maker can act following some equations.

With agent-based models we can reproduce real systems and “play” with them; we generate agents, put them in a virtual environment, then let the virtual world run and observe what we can learn from it. With this procedure we can reach unforeseeable results starting from an established set of hypotheses and dynamics of interaction. These results increase our knowledge of the real system we are modeling. This interpretation is supported also by Axelrod and Testfatsion<sup>17</sup> (2005); here agent-based modeling is considered a third via of approaching scientific analysis, together with deduction and induction. In particular, it is seen as an intermediary way, that lies between them. Deduction means starting from sets of assumptions and deriving theorems. With induction scientists look for empirical data to support the elaborated theorems. Exactly as deduction, simulation starts from a set of assumptions; then, the model generates a list of data that can be analyzed, as in the induction procedure. But the result is totally different: we do not start from a meticulous studied set of assumptions: they are experimental. So the model does not lead to a theorem with a high range of validity. Simulation models just increase the knowledge of systems through controlled experiments.

ABMs are also “across-levels” models: they study at least two levels simultaneously. Considering the agents acting in an environment, it means studying the emergent dynamics of the environment through the analysis of the behavior of each individual agent. Traditionally, some scientists have based their

studies of a system just on the analysis of the whole system changes. On the contrary, other scientists concentrated their research only on the agents: how each agent react varying the external conditions. As Railsback and Grimm<sup>16</sup> (2012) report, ABMs work differently:

(...) We use them to both look at what happens to the system because of what its individuals do and what happens to the individuals because of what the system does.

In this way we can deal with problems concerning emergence: systems dynamics that emerge depending on how the individual components of a system interact with each other and their world. Hence, with ABMs we can investigate how the behavior of the system and its components arises and develops.

ABMs differ also from traditional models for being “unsimplified” in alternatives ways: they often include processes with a high level of complexity. This aspect do not allow these processes to be included in simpler models.

## 6.2 Uses and weaknesses

Referring to Axtell<sup>18</sup> (2000), we can list three different uses of agent modeling techniques:

- the first and the simplest is their use in a way similar to traditional simulations. It occurs when the formulated equations describe completely a social process. In this case the equations are “explicitly soluble, either analytically and numerically”;
- the second use arises when “mathematical models can be written down but not completely solved”; in this case agent modeling techniques can significantly improve the results of the simulation; they can show dynamical properties or be a support to test the dependence of the results from the set of assumptions;
- the third use deals with those problems for which defining equations is not useful or possible. In this case the agent-based models represent the only way to perform an analysis.

Unfortunately, the ability of ABMs to deal with complex problems comes at cost: the use of agent modeling techniques has many weaknesses. As Terna<sup>19</sup> (2014) states, they arise from the following items:

- the difficulty of understanding them, without studying in detail the program language;
- the need of a complete check of the computer code in order to avoid unbiased results just related to code errors; obviously, anomalies are not generated always from an error. They can be important results, but it is always necessary check this possibility;
- the complexity of exploring all the possible set of hypotheses with the aim of providing the more exhaustive results. This because the elaboration of a ABM leads to the creation of a range of possibilities, impossible to be analyzed completely.

We identify also:

- the requirement of additional skills to use simulation modeling.

Considering the first item, the difficulty of communicating the results can be solved with the creation of a new common language. Quoting Luna and Stefansson<sup>14</sup> (2000) referring to agent-based modeling:

Unfortunately, too often the acceptability of the frame of analysis and the transmissibility of its results are spoiled by the difficulty to *read* the model and hence by the “unrepeatability” of the results reported. It is hence becoming pivotal to construct a common language, not dissimilar from French for diplomacy or more recently English. Simulation will have to be written **in** some Esperanto: it is obvious that the current Babel is against the emergence of a renewed enthusiastic effort in economic theory.

An important project in this direction is the creation of Swarm, developed by a team of researchers at the Santa Fe Institute in New Mexico. It was

created with the purpose of defining a complete common language for agent-based model development. In one of the papers written to present the project, the authors defined Swarm as a “multi-agent platform for the simulation of complex adaptive systems”. As we can read in Minar, N. et al<sup>20</sup> (1996):

In the Swarm System the basic unit of simulation is the *swarm*, a collection of agents executing a schedule of actions. Swarm supports hierarchical modeling approaches whereby agents can be composed of swarms of other agents in nested structures. Swarm provides object oriented libraries of reusable components for building models and analyzing, displaying, and controlling experiments on those models.

Swarm is an indispensable innovation in the field of agent-based modeling, but it does not reach completely the purposes that brought to its elaboration. The initial objective are not totally achieved. Terna<sup>19</sup> (2014) argues:

From the point of view of coding, considering modern languages such as Python, a large part of the Swarm library is now unnecessary. On the contrary, when considering the protocol aspect of the project, Swarm has been highly successful, being its basic structure intrinsically the basis of several recent tools.

In the direction of Swarm many others tools have been created. Repast, Ascape, JAS and SLAPP are examples. The Swarm language can also be found in other programs, such as Netlogo and Starlogo.

To deal with the second item of difficulty, Terna<sup>19</sup> (2014) proposes a check procedure. The problem we are discussing is about the possibility of succumbing to biased results of the simulation due to code errors. He advertizes the duplication of the code using two independent tools developed by two different scholars. Obviously, the results will never be the same, mainly because they depend on random numbers. But if the outcomes will be similar, then this check procedure can lead to a reasonable answer. We can be quite sure that the generated processes are not results of coding errors.

We can deal with the third weaknesses introduced, that is related to the impossibility of analyze the entire set of hypotheses, reporting the items proposed by Terna<sup>19</sup> (2014). First he proposes the use of neural networks to pick out behavioral rules from experience. The procedure consists into save rules generated in an automatic way employing reinforcement learning techniques. With neural networks we try to generate artificially rules that can reduce the vast set of behavioral hypotheses. An alternative way to analyze the wide set of hypotheses is use genetic algorithms to determine behavioral rules and monitor their changes.

We introduced in the list an additive item of difficulty: to use simulation modeling additional skills are necessary and this can represent a difficulty for users. These skills are not just related to a new “language” consisting of a set of concepts, essential to think about and describe models. They include also software skills that are necessary to implement models and analyze them. Producing useful software can be more complex for ABMs than for most other kinds of models. Moreover, also strategies for projecting and studying models are required. A model can reach too high levels of complexity: it is indispensable to adopt methods for analyzing it and to determine which entities should not be part of it.

# Chapter 7

## A brief introduction to NetLogo

NetLogo is an agent-based programming language and integrated modeling environment. It is useful for simulating natural and social phenomena. In particular, it is adapt for modeling complex systems developing over time. Users can define hundreds or thousands of agents, all acting independently. This gives the opportunity of studying the interactions between individual agents, and their interaction with the environment.

### 7.1 The NetLogo composition

NetLogo is made up by three sheets: the first contains the interface (Figure 7.1), the second the information and the latter the code.

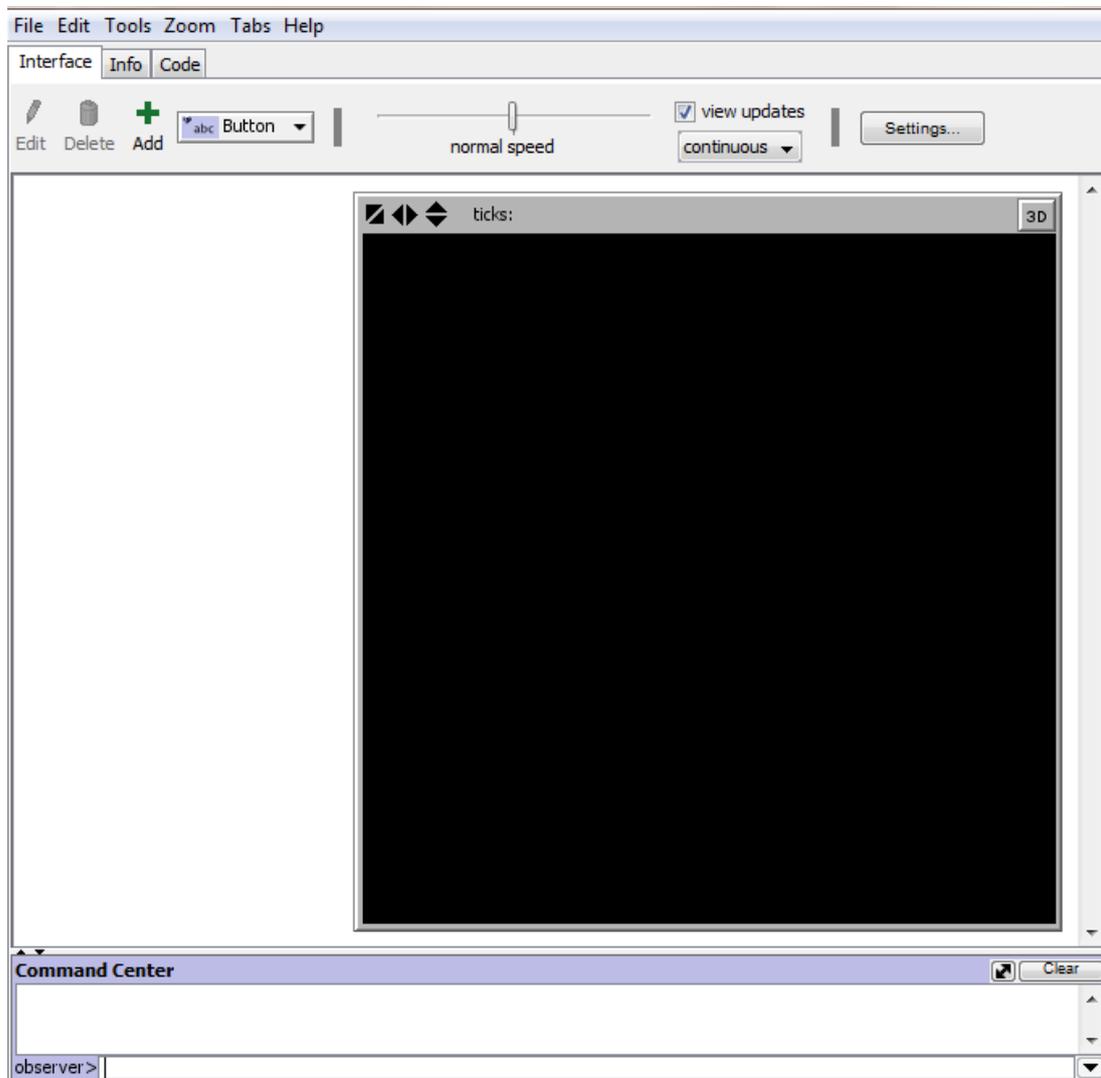


Figure 7.1: NetLogo Interface

In the interface page we can find:

- the *interface builder*: it is a drop-down menu and it allows the creation of buttons, sliders, switches and choosers useful to modify the actions of the agents; monitors, plots and notes to show the outputs of their interaction;
- the *worldview window*: graphically, it is the main component of the interface sheet. It represents the space where the user can observe agents

interacting. The modeler can use it to reproduce the feasibility of the movement: as in reality distances represent obstacles to interactions. Otherwise it can be used simply to improve the showed result. It is made up by a defined number of square cells, the *patches*, and it is two dimensional. They have own attributes (size, color, etc...) that the user can modify, together with their number;

- the *command center*: it is where the user can forward commands to turtles, patches or link agents giving them some instructions. It has two parts: the output area where NetLogo can respond by printing text, and the input line, marked with the “observer” label.
- the *settings-button*: it allows changes of the features of the worldview window. For what regards the world, the user can change the location of origin (center, corner, edge, custom) and the extreme values of the coordinates. Moreover, he has the possibility of “block” the world, both horizontally and vertically. In facts, as soon as created, the world wraps in both directions. About the view, there is the possibility of vary the patch size, the font size and the frame rate. This button controls also the presence of the tick-counter. The time flowing is represented by the increasing number of ticks; a tick is a unit of the measure describing time. The tick-counter allows to keep track of how many ticks have passed.
- the *speed-slider*: it is located upon the worldview window. Through this slider the user can vary the speed of creation of agents and their movements.

The “info-tab” sheet allows the user annotate all the information about the program. Fulfilling it, he can describe in detail his program, to make it understandable by other users. The page is made up by a list of sections: for each one is defined a subtitle and are provided some tips; they act as a hint for the author in describing the model. “What is it?”, “How it works”, “How to use it” are sections names examples.

The code sheet is built to contain the lines of code inserted by the author. The code appears written in many colors to differentiates the different com-

ponents; the keywords are green, the commands useful for the observer are blue, the values of the variables are orange, etc....After writing the program the user has to click on the check-button to confirm it. With this operation the program controls the logic integrity of the inserted code and marks the errors. It helps the user providing a brief description of the error, helping him to identify the mistakes and to correct them. At the bottom of the sheet there is also a procedures button: it reports the name of all the procedures created by the author in the underlying code.

## 7.2 The NetLogo terminology

In NetLogo there are four types of agents:

- mobile agents, defined as turtles, moving around the world;
- patches, that are the square cells composing the space;
- links: each one of them connects two turtles and represents relationship among turtles;
- the observer, that may be the author or just an user of the model; he controls the models and its displays.

Each of these categories of agents own personal variables and commands, that are defined in the NetLogo Dictionary. These built-in variables define agents general features, such as the color, the size or the location. They differs from the agents variables that the author defines building a model. The latter are “global” variables, which means that all agents can read and change their values.

NetLogo provides an important support for the user: the NetLogo Dictionary. Mainly, it contains the *primitives* related to every category of agents. A primitive is a built-in procedure or command for instruct agents about what to do. The dictionary is a useful tool because the user can constantly look through it to find primitives that already do what he wants command to the agents. Referring to the action they develop, the primitives can be *commands*

or *reporters*. A command tells to the agents to do something; a reporter compute a value and report it as output. The primitives can also be global, that means valid for each type of agents; or they can be related to a specific category of agents. In the Dictionary this is indicated by an icon of a turtle, patch, link or observer. In the latter case the primitives can be executed only by that kind of agents. If you are defining the setup of the patches, you can not use a primitive only turtle related. NetLogo returns you the error “using a turtle command in a patch context”. The NetLogo Dictionary lists all the primitives divided by groups, differentiating to who they are related.

Another useful tool provided by NetLogo is the Models library. You can go through it by the drop-down menu of the file button. This library contains many NetLogo models grouped by discipline. They simulate different phenomena, dealing with art, biology, computer science, etc.... The models are selected to be easily understood and to show NetLogo’s tools. The library includes also some code examples related to particular commands of the program. The aim is write some lines of code to provide examples about how use difficult items.

# Chapter 8

## Projecting the model

### 8.1 The Modeling Cycle

As Railsback and Grimm<sup>16</sup> (2012) argue, “being scientific always means iterating through the tasks of modeling several times”. When we project a model, we do not reach the perfect result at the first attempt. Sometimes the first project shows us that we are off the right path: what we are modeling does not investigate the processes we are interested for. Other times we are on the right direction but the model needs improvements: its first version is too simple. In this cases we repeat all the *steps* that brought to our result. We have to go through these tasks several times, in a systematic way, to get an acceptable result. The different tasks are reported in Figure 8.1. It shows the cycle path that we iterate each time we get an unfulfilled result. Iterating does not means that we start from the beginning every time. It may occurs that we assembled a good set of hypotheses but an unacceptable model structure.

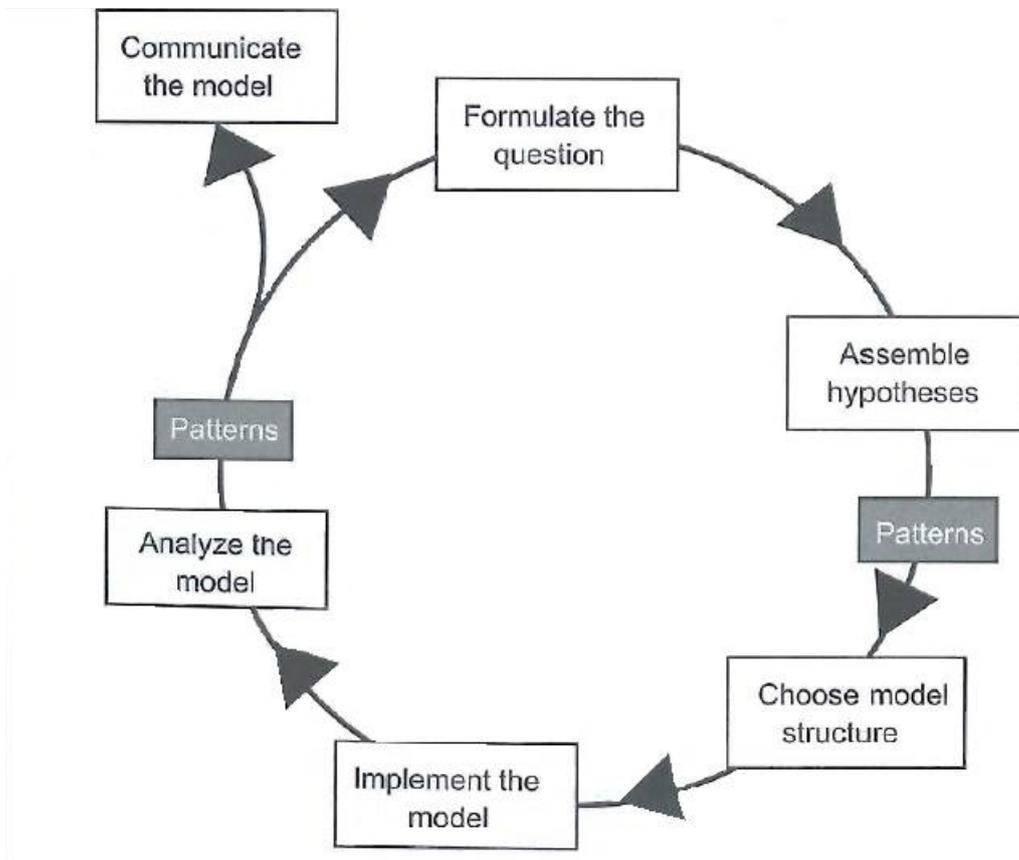


Figure 8.1: *The modeling cycle. Grimm and Railsback (2012)*

- *Formulate the question.* It is the first step we go through when we start projecting a model. Good questions are clear and productive; it costs a difficult effort formulating them, mainly because when we start we do not have a clear situation in mind. We ask to us which processes we want investigate and reproduce. It may occurs that we formulate a question, and developing the model we realize it is not the right one; maybe it is too simple or too complex. This task results very hard and can need several iterations.
- *Assemble hypotheses for essential processes and structures.* Once we formulated the questions we want to investigate, we proceed formulating hypotheses about the processes. We want design our model. First, we

have to reflect on which factors have a strong influence on the phenomena of interest. Are they independent or interacting? There exist other factors with a big influence on these ones? An advertised method is using diagrams and maps to avoid too much confusion. After clarifying which are the agents and the processes involved in the model, we determine how they interact. A big effort we have to do in this task is maintain the model very simple; we want increase the understanding gradually, while iterating through the cycle. As we explained before, the preliminary understanding of a system is not sufficient to determine which agents or processes play important roles, and which are less important.

- *Choose model structure.* When we speak about “model structure” we refer to the set of scales, variables, entities, processes and parameters involved in the model. We defined the main actors in the previous step. Now we have to model them and the environment in which they act. How is represented the space where agents move through? Which are the state variables of every agent? We define attributes, behavioral features, movement. We think about details. This phase of the research can result in an essay: a written formulation of the model.
- *Implement the model.* After assembling an acceptable set of hypotheses and defining a detailed model structure, we have to translate them in a program language. This is the most technical part, because we deal with computer programs and mathematical tools. We are transforming written dynamics into animated ones. Thanks to this work, we will have a clearer idea of how our initial model looks useful.
- *Analyze the model.* Reached an acceptable result we can start to analyze the model. The objective is test it and its dynamics. Maybe it will be necessary going through a process of model-tuning, to refine the code. Sometimes, even if the model works, it has problems in the outcomes. To overcome them, we need just to vary the values of some variables. This

revision aims to eliminate the defects that make appear the mechanisms not perfectly fluent. This phase can need a lot of time and never lead to a final consolidated output. The analysis of the model includes also learning about it; consequently we learn also about the real world and its phenomena. In fact, we do not just want to see what happens when we put some agents in the same environment and make them interact. We want to see what their behaviors and the outcomes of their interactions can clarify and predict about real systems.

## 8.2 Formulating the questions

Trying helping some friends in a project, we went through a discussion about the possibility of getting financed for small entities with not consolidated financial capabilities. We supported the discussion with the example of a small cooperative looking for money to realize a very interesting project. It was interesting both from the economical point of view and particularly from the social-environmental one. Observing the process of looking for a lender of money, it shed light on the difficulty of the research. This was the starting point of our studies. Many questions raised: do the financial intermediaries pay attention to the externalities of financed activities? Economical organizations and firms have a strong impact on our environment and on our society: they have to be monitored. Is there any intermediary agreeing with this position? In giving a loan, are the social outcomes of an entity taken into account? At the moment, is there anyone interested in these items? What if banks (and other financial intermediaries) take care of these aspects evaluating a firm? Which will be the results? Which types of economical organizations would be excluded from receiving a loan? Do this exclusion affect entire sectors of the economy? Which ones?

### 8.3 Assembling hypotheses

We support this phase of the research with a map (Figure 8.2) to clarify our ideas about the model and to avoid confusion; it shows the basic ideas of our model.

Three classes of agents made up the world: banks, depositors and firms. They interact with each other and make money and information move from an agent to another.

Depositors have a quantity of money and they choose in which bank deposit it depending on different features, such as the sensibility they have on social and environmental issues, the level of information and the desire of remuneration. For instance there are individuals very sensible about the use of money their bank do: their prefer to sponsor activities with a good impact on their zone or on the environment, while probably they do not want to finance activities with negative social externalities. It follows that they agree in receive a lower remuneration for their deposits, because they assign a value to the positive social-environmental impact. Probably, they look for a bank that satisfies some ethic requirements, even if it is not the most convenient financial solution. Other individuals does not mind about the impact of banks on society, and they do not know about the existence of banks with greater level of ethic. This kind of depositors will go to the closest bank to their house or their job, without searching any particular condition. Another group of individuals care most of all on the remuneration they could achieve depositing their money, looking for the higher one. They will choose the bank satisfying their finance expectations, without paying attention to the social externalities. Obviously these features do not define different separated groups of individuals: does not exist a closed group of very sensible people with a high level of information; they are randomly distributed among depositors. Moreover, individuals interact with each others: they exchange information, ideas and experiences influencing the people they meet.

Banks instead receive deposits and lend money. Obviously they need to get a sufficient quantity of deposits to survive. As I introduced before, in this “world” there are different types of banks: “ethical” banks and traditional

banks. The former are banks that, lending money, take in account not only the financial features of the counterpart but also the social and environmental externalities. So these institutions identify some optimal sectors of employment and some activities that can not be sponsored, like the production or trading of arms or those that violate human rights. The second ones are banks that do not pay attention to the social-environmental skills of counterparts: the financial situation is the only thing that matters. Probably these banks ensure a higher remuneration for deposits. In the banks sector there are also banks who are greenwashing: they advertise being environmentally friendly (“green”), even if it does not correspond to reality. Their aim is promoting a false perception, in order to attract individuals that are sensible about ethical items, but not well informed.

Firms are sponsored by banks and they are divided by sectors of production. Each of them will be financed with a percentage of the bank deposits. Firms with positive social-environmental impacts have the possibility to be financed even if they are not creditworthiness from the financial standpoint. In this case a problem of moral hazard may grow up: some firms may be greenwashing in order to get money. Also entrepreneurs influence each others; the influence can be positive or negative.

We have to notice that among agents of different classes there is information asymmetry, that produce misinforming and can produce market failure. The aim is analyze what happens when information asymmetry exists, and what happens when it disappears.

In order to justify how deposits are generated, I use the concept of “money multiplier”, assuming a circular process bearing between banks and customers. People deposit money in banks, which lend this money to firms. Firms use only a part of the received funds, and deposit the other part into banks. The process repeats continuously, and it produces new deposits, increasing the money offer.

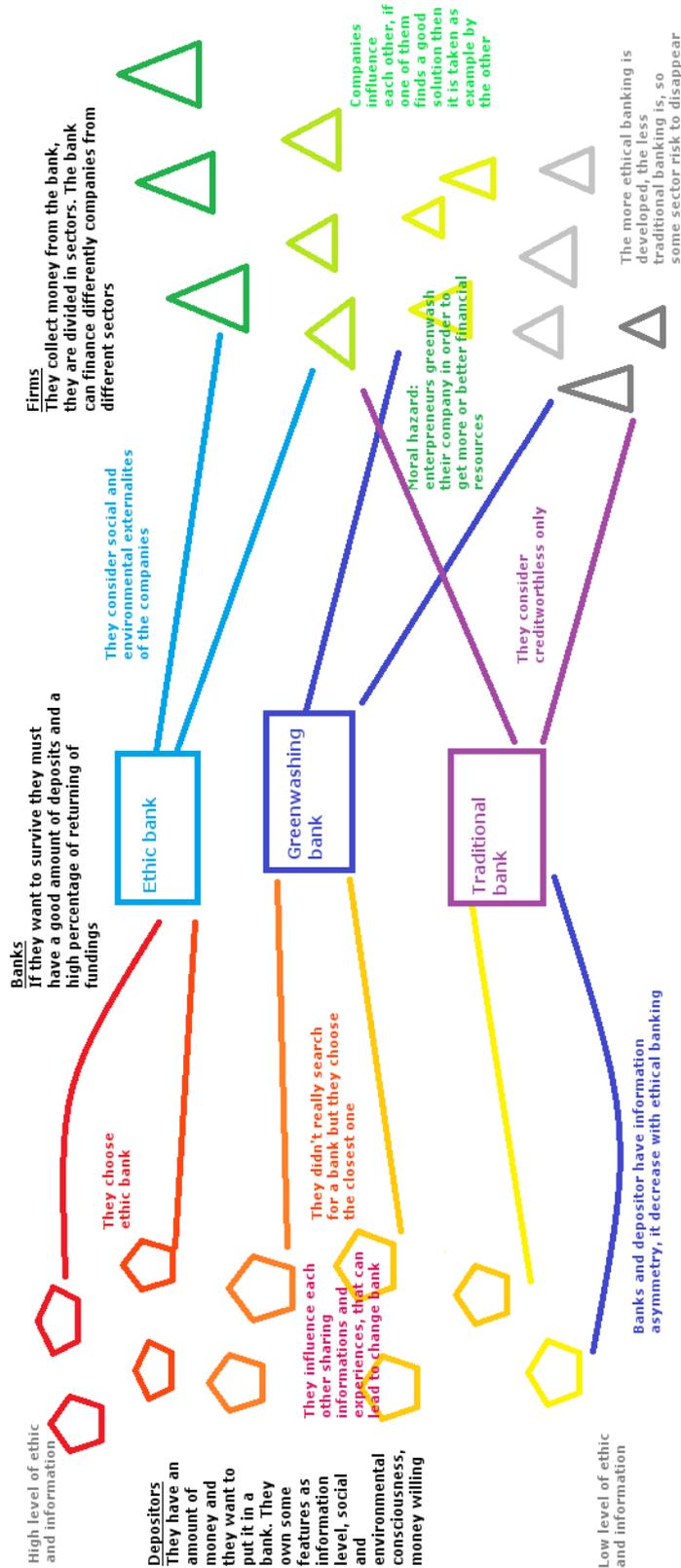


Figure 8.2: Hypothesis scheme

## 8.4 Choose the model structure

The model was born with the idea of inspecting the theme of ethically oriented finance and ethically oriented financial organizations. At the beginning the approach used consisted into analyzing the set of banks and other intermediaries of Italy, with the aim of identifying which of them were ethically oriented. The successive step was comparing ethically oriented intermediaries with traditional banks. In principle the comparison focused on the relation between banks and financeable-financed customers. We analyzed the attention paid by banks on the social-environmental externalities of their customers. Which customers are financed by ethical banks? The procedures used by ethical banks to decide if finance or not a customer are different from those of traditional banks? Do these procedures lead ethical banks to concentrate their loans to specific sectors? Initially, the model was based on the answers to these questions. So the model started enclosing two types of banks (ethic and not) and firms belonging to different sectors. One of the main purposes was inspect the reactions of traditional banks to the development of ethical ones. Obviously, reactions depend on the success reached by ethical banks: if it is limited maybe the feedback is negligible. But if the success is prosperous, then the dynamics of reactions are worth of attention. The explication of these dynamics is one of the main objectives of the model. Nevertheless, it encloses a priori an attribute to traditional banks: the greenwashing action. The assumption at the basis is that some traditional banks promote a false image of themselves referred to the attention for social and environmental externalities. This artificial image is realized in order to attract customers interested in ethic items.

In a second moment, to reproduce faithfully the reality, also depositors are added to the model. Who chooses to deposit money in ethical banks? Why? Is it because people are developing an ethical consciousness? The model deals with these items. In particular, it represents the choice as the result of the combination of two persons attributes: the level of information and the level of ethics. People with a high level of information and a high sensitivity to ethic themes will choose ethical banks. People with low interest to ethic will choose traditional banks, assuming that they are more attracted by the interest rate on

their deposits. Obviously the reality is not so well defined and consequently neither the classification proposed in the model. Moreover, in this context, interactions between people become extremely important. Depositants meet, observe and speak with each others. As a result, information circulates quickly among them and makes depositors increase their information level and vary the ethical one. So they consolidate their choices or they change their decisions.

## 8.5 The objectives of the model

The principal purpose of the model is exploring the evolution of a scenario where the main actors are banks, customers asking loans and depositors. In particular, it focuses on ethical banks, to discover what happens if they raise a sufficient number to be a real alternative to traditional ones. How does the world change if the number of ethical banks increases substantially? The traditional banks will increase their level of ethics? What about the organizations to be financed? Maybe, at the beginning they belong to a restricted range of activities. So it will be interesting to discover if ethical banks play an important role to develop these sectors. How react firms of other sectors to the expansion of ethical banks? Clearly, to be financed by an ethically oriented bank, there are social and environmental preconditions to satisfy. But different reactions may occur between borrowers; on one hand they can decide to pay more attention to social-environmental externalities, probably making significant changes in the procedures of production. This alternative is positive for the environment but can be difficult and expensive for the firm. On the other hand they can try to greenwash themselves; this option will permit them to satisfy the requirements of ethical banks and maybe it is simpler than really improve the organization. Anyway the second solution is damaging in the long term horizon.

Another interesting analysis is to discover how different actors are linked. How much are these links deep? Which is the result of the interaction between different classes of agents? Applying the question to the ethic part of the scenario the model can inspect for instance which are the dynamics consequent

to the success of an ethic firm. The ethic firm asks to be financed by an ethical bank, in order to obtain a loan with more advantageous financial conditions. If the firm realizes good results, then it can easily give back money, fulfilling the terms of the loan. Also the bank granting financing will realize a good financial result, increasing its borrowing capacity. Thanks to this, it can pay to the depositors a higher interest rate, making them happy. In this way the ethical inclination of the society reinforce itself. So does the good result of an ethical bank translate in a global success?

Information goes through the links between agents and it has a central role in the development of an ethical financial society. Different types of information are spread and the model aims to understand how it circulates among agents. How much it influences decisions? Which current of information prevails? The model aims to answer to these sets of questions, highlighting trends and economical behavior of agents.

### 8.5.1 The best scenario

The best result expected by the model is the scenario where the ethic world sustains itself and the choice to be ethically oriented becomes more strength. At the beginning some persons (those with higher levels of ethics and information) choose ethical banks to deposit money. Ethical banks realize complex procedures to grant financing. They analyze organizations not only from the economic-financial point of view, but also from the social-environmental one. So if firms have positive externalities will be easier to obtain loan with favorable conditions. On the contrary, firms that do not pay attention to their social-environmental impact will not obtain the loan. In principle, borrowers belong to specific sectors that permit them to have a good environmental impact. Granting financing, ethical banks help to develop these sectors, creating good advantages to the society. Firms have financial success and give back money to banks, translating their good results into banks good results. Banks can pay an interest rate to depositors and satisfy them with positive results. Lenders will continue to deposit their money into ethical banks and spread positive information about the performance to other people. More depositors

are attracted and a higher quantity of money arrives to ethical banks; they start to grow and with them the “ethical world”. Traditional banks observe the success and decide to increase their level of ethics. They acquire the procedures of social-environmental analysis of the customers, forcing all firms to pay attention to their externalities. At the same time organizations asking loans observe the advantages to be more ethical and improve effective changes to reach positive results. The entire society, little by little, orients to a more ethical financial behavior.

### 8.5.2 The expected scenario

In the expected scenario the model will not provide a total success of ethical banks. At the beginning it assumes that only a part of the population chooses ethical banks; the other part chooses the bank which pays the highest interest rate or the bank nearest to home. Even with a success of ethical banks it will be not so simple and effective convert other depositors to ethical banks; some of them look for a high interest rate on their deposits, while often ethical banks pay a low interest rate. Moreover, if the number of depositors interested in ethical banks increases, is not predicted that traditional banks decide of orienting themselves to an ethical finance. An alternative is the greenwashing: they promote a social-environmental sensibility even if they do not have it . In this way traditional banks try to attract those depositors with an increasing interest in ethical finance, but with a low level of information on these items.

The second set of hypothesis regards the lending action of banks. It is assumed that ethical banks grant financing to organizations that satisfy social-environmental preconditions. Firms obtaining ethical banks loans maybe would not obtain loans from traditional banks, because only their credit worthiness would be evaluated. So the social-environmental analysis developed by ethical banks can be a real advantage in order to grant financing and may lead firms without positive social-environmental externalities do greenwashing (while in the best scenario it is hypothesized that firms try to improve changes to obtain a good evaluation). The result of the greenwashing action is a global failure of ethical principles, so that it becomes difficult to attract new depositors to

ethical banks.

In a first moment there can be an expansion of ethical banks, but then this growth will be sometimes stopped by negative results. In case of missed implementation of ethical principles, lenders can return to traditional banks, which pay a higher interest. The alternative to this scenario is a continue growth of ethical banks, but in a very slowly way. On one hand the influence of ethical depositors and the circulation of information about more ethical alternative to traditional finance may attract an increasing number of lenders. On the other hand the greenwashing actions made by traditional banks and the higher interest rates continue to attract persons not so informed and convinced of ethical alternatives.

### **8.5.3 The worst scenario**

The worst scenario provides an insufficient development of ethical banks. Their quantity of depositors does not grow; they receive money from persons who have a high level of ethics and information. But these people are not able to spread enough information about the bank, and a few other persons agree on receive a lower interest in order to follow ethic principles. In general, in the society the possibility of financing social-environmental positive activities does not compensate the decrease of interest rate. So ethical banks are not able to be influential on the development of specific sectors, which will have a limited growth. Traditional banks do not submit these sets of firms to a social-environmental analysis, but they only evaluate their financial capability of giving back money. Only firms with yet solid financial conditions will obtain loans from banks. Moreover, the social-environmental analysis may lead to grant financing to firms with low credit worthiness, that will be not able to return money; ethical banks become weaker and if they do not collect enough money, they will not survive.

### 8.5.4 Extending the model

The model can be extended introducing the theme of Islamic finance, that nowadays is gaining popularity in western Europe. This for the increasing number of Muslims in this area and because it can be viewed as another face of ethical finance. Islamic banks can be included in the world as a set of banks different from traditional or ethic ones. They can be a real alternative to ethical banks, because they follow similar financial principles. In fact, they borrow money guaranteeing facilitated financial conditions. Moreover, they do not grant financing to those sectors of activities which are considered far from religious teaching. The main purpose of their inclusion is observing their interaction with the other agents in the model. Are they going to steal customers from ethical banks or from traditional ones? Can they sustain with their activities some sectors, improving their development? Can they grow and survive without financing specific set of activities? These items are relevant if we consider the complex financial contest in which they are inserted.

# Chapter 9

## Implementing the model

### 9.1 The core of the model: version 0

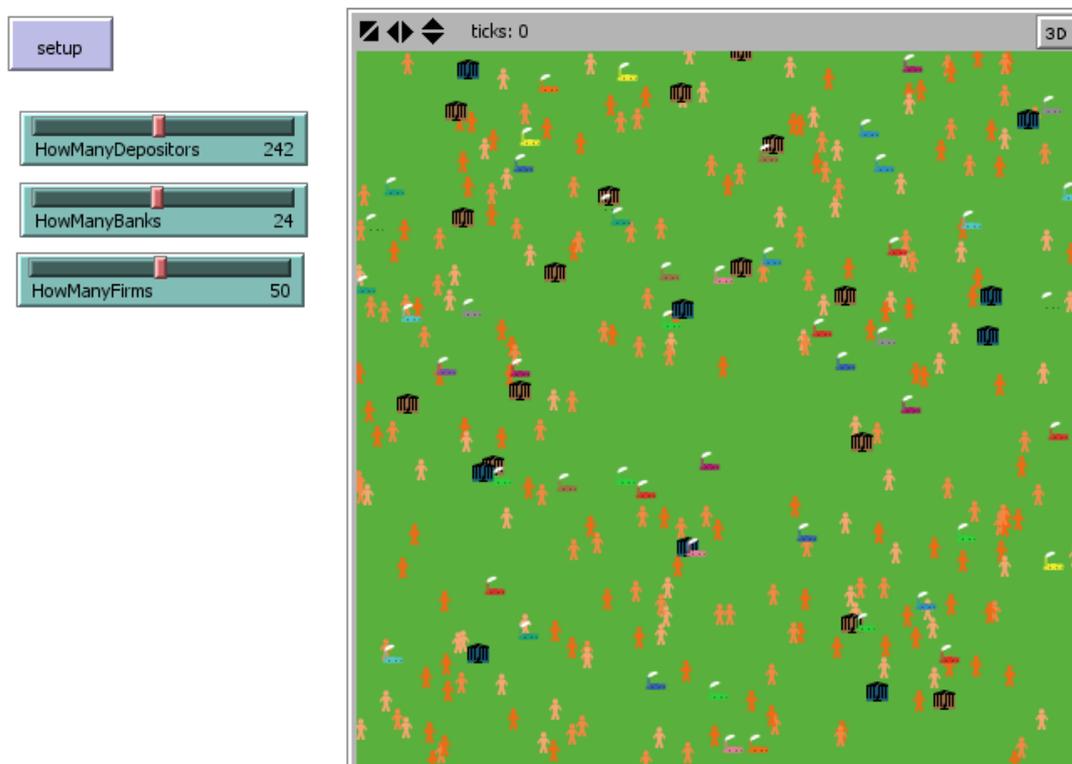


Figure 9.1: Version 0 Interface

The first version of the model are few lines of code that gather together the basic inputs of the project. It is a coarse version upon which we will develop the whole project. The main objective here is to show the basic ideas and assumptions of the model. We start defining the core of the setup procedure. In the model there are three different breeds: depositors, banks and firms.

```
breed [depositors depositor]
breed [banks bank]
breed [firms firm]
```

### 9.1.1 The setup

The setup procedure contains two setup commands that will be developed afterward: one for the creation of patches and the other for the creation of turtles:

```
to setup
  clear-all
  setup-patches
  setup-turtles
  reset-ticks
end
```

The first command of this procedure is “clear-all” and allows the user to reset the entire process (ticks, turtles, patches, plots, etc.) every time he presses the button “setup” in the interface page.

We use the command “setup-patches” to paint the patches of green, creating a green-world:

```
to setup-patches
  ask patches [set pcolor green]
end
```

Then we define the command “setup-turtles” to give “realistic” shape to the three groups of agents, in order to make the model more representative of the real world;

```

to setup-turtles
  create-depositors howManyDepositors
    [set shape "person"
      set color orange + random 3
      setxy random-xcor random-ycor
      set infoLevel random-float 10
      set ethicLevel random-float 10
      set money random-float 1000]
  create-banks howManyBanks
    [set shape "building_institution"
      set color brown
      setxy random-xcor random-ycor
      set seTest random 2
      if seTest = 1 [ set color 93] ] ; is a way to
      distinguish ethic banks
  create-firms howManyFirms
    [set shape "factory"
      setxy random-xcor random-ycor
      set moneyNeed random-float 5000
    ]
end

```

Depositors assume the shape of “person” and the orange color; banks are created as “building institutions” of color brown; firms are shaped as “factories”. All agents are created randomly around the world (setxy random-xcor random-ycor). The number of components of each breed is regulated by a slider in the interface page. The sliders allow the user to vary the initial situation in terms of numbers of agents. In this way will be easier perform analysis of different scenarios. In this version of the model we define the range related to the number of depositors from 0 to 500, the one related to the number of banks from 0 to 50, while firms can vary from 0 to 100; each one of them can vary in steps of 1. We assume these numbers trying to respect real proportions of agents and, at the same time, to predispose them for their analysis.

At the beginning we define also the main features of the agents. Each breed owns some attributes, that are specified in the “setup-turtles” command of the “setup” procedure:

```
depositors-own[infoLevel ethicLevel money]
banks-own[seTest]
firms-own[moneyNeed]
```

Depositors own “ethic-level”, “info-level” and “money” as attributes. Ethic-level means the level of ethic of the customer of a bank. It is a measure of the attention and of the propensity to ethical principles. We attribute to this variable a random value in a range from 0 to 10. We think that the ethical level is linked with the information owned by the depositor. If he has a good knowledge of the banks environment and of the banks varieties, there is a higher possibility he will develop an interest to ethical principles. For this reason we create the variable info-level, that corresponds to the level of information of depositors. It is evaluated with the same procedure of the previous one: it is a random value from 0 to 10. So, each depositor will own two values from 0 to 10, that will be combined to determine which type of bank he will choose (traditional or ethical).

Persons own an initial quantity of money, defined randomly from 0 to 1000. We want to give an initial amount to each customer and increase it every tick. The initial amount can be read as a bequest or an amount of money stored by the individual, that leads him to look for a bank. Obviously this amount varies from an individual to another: it is created randomly. Choosing 1000 as extreme value is totally random. We thought about a value not too great, in order to have the possibility to increase it easily. The only need was to have a value lower than the initial value of firms, at least partially; this for the assumption that a firm works with higher amounts of money with compared to a single depositor. In facts, also firms are created with an initial amount of money, that varies from 0 to 5000. So the major part of firms will have a higher quantity of money with respect to depositors. There will be only a few firms with an amount lower to some depositors (for sure not those ones with an initial amount greater than 1000).

Banks owns the attribute “seTest” that means “social-environmental test”. One of the main features that differentiates ethical banks from traditional ones, is that the former have a particular procedure to test firms requesting financing; it consists in performing a test also from the point of view of the social and environmental externalities. In the model, we assign to this attribute a random value from 0 to 2. The procedure “random” of Netlogo works reporting a random integer, greater or equal to 0, but strictly less of the number imposed. So, if we assign “2” as value, the procedure will assign to the attribute “seTest” a value equal to 0 or to 1. In this way we create a Boolean variable, useful to specify two types of banks. Farther on in the code, we will use it to differentiate ethic banks (that will be those with value equal to 1) from traditional banks (those with value equal to 0).

## 9.2 Introducing the movement: version 1

The second version of the model contains some important news, particularly from the behavioral point of view. In facts, after defining of the basis “setup” procedure, we add here a “go” procedure, with the aim of making agents move and taking decisions. Only with the movement of turtles and with their interactions, processes develop and can be observed. Moreover, this version differs from the former for the definition of new more detailed features about agents. Observing the code, there are new attributes to depositors and banks but not relevant changes regarding firms. In this part we focus on the trades between banks and depositors and that is why the firms are defined as previously seen.

In the first lines of the code we add two attributes:

```
depositors-own[infoLevel ethicLevel money deposits]
banks-own[seTest InMoney]
firms-own[moneyNeed]
```

In the zero-version, we assumed a starting amount of money (from bequests or previously saved) for each depositor, that lead them to look for a bank. But the deposit to the bank will be not equivalent to the entire amount owned by the agent, just a fraction of it. Moreover the amount of money for each

depositor changes every tick, in order to simulate salary income and consumption expenditure. Obviously, an individual will not store in the bank the entire salary; a part will be used for consumption and another part saved. Only the latter will be deposited in the bank. Considering these items, it is necessary to distinguish in the model the amount of money that depositors own in his “pockets” (money) from the part saved in the bank (deposits). We integrate also the create-depositors procedure, described in version 0, with the attribute (deposits) just explained, and we give it the initial value of zero:

```
create-depositors HowManyDepositors
  [set shape "person"
    set color orange + random 3
    setxy random-pxcor random-ycor
    set InfoLevel random-float 10
    set EthicLevel random-float 10
    set money random-float 1000
    set deposits 0]
```

So, through the setup-procedure every depositor will be created with a variable “deposits”, whose initial value will be 0.

We add also the variable “in Money” to banks. It corresponds to the amount of money that a bank owns. This means the money that it receives from customers through deposits and the money that the bank receives as interests paid on the lend sums by the financed firms. Also this variable is evaluated 0 in the setup-procedure: every bank initially does not have money. Moreover, we differentiate ethical and traditional banks using labels. “Label” in Netlogo is a built-in turtle variable, that may contain a value of any type. It makes appear turtles in the view with the given value “attached” to them as text. In this case banks will appear in the worldview with the label of “ethical bank” or “traditional bank”. We create banks randomly among the world, with the requirement that will not be more than one bank in the same patch. So, we add to the banks-creation procedure this if-cycle:

```
ask banks [if any? other banks-here [move-to one-of patches]]
```

The if-cycle procedure requires two components: a reporter, that must be a Boolean variable (it can report a true-false value), and a command. The command runs only if the reporter reports the true value. In our case the reporter is “any? other banks-here” and the command is “move-to one-of patches”. If a bank is created in the same patch of another bank, we ask to the bank of moving to another patch.

The go-procedure

We introduce the movement defining a “go” command; in this version it is related only to depositors:

```
to go
  ask depositors [ifelse InfoLevel > 7 and EthicLevel > 7
    [move-to one-of banks with [label = "ethic_ bank"]]

    [ifelse EthicLevel < 5
      [move-to one-of banks with [label = "traditional_
        bank"]]

      [move-to min-one-of banks [distance myself]]]

  set money money + 100

  if banks-here != nobody [let MyDeposit * 0.1
    set money money - MyDeposit
    set deposits deposits + MyDeposit
    ask banks-here [set InMoney
      InMoney + MyDeposit]]]

  tick
end
```

We start defining which is the condition that makes a depositor choosing an ethical bank. For this purpose we use two “if-else” cycle; in Netlogo, the if-else procedure requires three components: a “reporter”, that must report a Boolean (true or false) value; a first command, that runs if the reporter reports

the true value; a second command, that runs if the reporter reports the false value.

The first “if-else” cycle states that if both the level of information and the level of ethic of the depositor assume a value greater than 7, he has to move to an ethical bank. The assumption underlying this step is that an individual with high propensity to ethical principles and with a high level of information about ethical banks supply will choose an ethical bank. If the individual has not these required values has to follow the alternative command. The second command of the if-else cycle is another if-else cycle; it specifies that if the ethic-level of the depositor is lower than 5 (it corresponds to a very low value), he will move to a traditional bank. In this case the level of information is not significant. As we explained in the introduction to the model, a depositor with a low level of ethic will be not interested in the social-environmental externalities of the firm financed by the bank. Maybe he will take care of the return of the investment and not of its risk. The second command of this if-else cycle ask depositors to go to the nearest bank. If a depositor has neither a high level of ethic nor a low one, then he has not special requirements about his bank. He will look neither for an ethical bank nor for the bank that guarantees the highest interest rate. He will just choose the nearest to home bank or the nearest to his workplace. In the go-procedure we describe this command using the “min-one-of” construction, that reports the lowest value for the given reporter (in this case it is the distance).

Moreover, in the go-procedure we ask to each depositor of increasing his quantity of money by 100, every step. It is a constant amount, equal for all the depositors, independently from their initial quantity of money. Once they move to a bank (banks-here != nobody), we realize the next passage defining a local variable: “my Deposit”. In this way we can sum/subtract the value of the variable, both to/from the values of the depositors variables and of the banks variables. It corresponds to an amount equal to the 10% of the money of the depositor. Then, this amount is subtracted from the total amount of money of the customer: if he deposits this sum it will be any more available for the depositor, but it will be transferred to the bank. So, the variable “in Money” of the bank is increased by this value. At the same time, also the variable

“deposits” owned by the depositors is increased by the value of “my Deposit”; every tick the customer increases the total amount of deposits in a bank of the sums that are deposited as the go-procedure runs.

The go-procedure ends with the command “tick”. It has the function of running the tick-counter by one.

Summarizing, in this version the code describes three breeds, as in the version 0; in particular it focuses on depositors, defining for them a new feature: “deposits”, to record the amount of money individuals deposit in banks. Depositors have their own attributes (defined randomly among the population), which bring them to choose a bank. Every tick they deposit in the bank a part of their money, defined as “my Deposit”, that will be subtracted from their “money” and add to their “deposits”. In this way money is transferred from depositors to banks, and the “in Money” of banks is increased of “my Deposit”.

### 9.3 The array-extension: version 2

In the second version we continue to work with depositors, trying to create a more sophisticated structure for their interactions with banks. We introduced the variable “deposits” to record the total amount of money each individual transfers to his own bank account. As in reality, it may happen that an individual becomes a customer of more banks simultaneously; also in our model this opportunity is provided. In fact we want to monitor which are the open positions of an individual with all the banks. The first idea was to use a matrix with each row corresponding to an individual, and each column corresponding to a bank. Of course, at every tick the matrix has to be updated with the values of the new cycle.

		Banks			
		1	2	3	4
Depositors	1	0	50	0	0
	2	0	0	30	150
	3	100	0	50	0
	4	0	100	200	0
	5	50	25	65	0

Table 9.1: Banks-depositors matrix

As the matrix reported shows (Table 9.1), Depositor 1 has a deposit in his Bank 2 account. If, after a tick he will increase his sum deposited of 50 , the value in the first row-second column will be 100 (Table 9.2).

		Banks			
		1	2	3	4
Depositors	1	0	100	0	0
	2	0	0	30	150
	3	100	0	50	0
	4	0	100	200	0
	5	50	25	65	0

Table 9.2: Banks-depositors evolved matrix

Analyzing the possibility offered by Netlogo, we have decided to simplify our model just using the array-extension instead of a matrix. An array is a data-structure useful when there is a collection of values whose size is fixed. It has also a mutable structure: it is easy alter any item in an array if you know its position. This structure applied to our model allow to create an array for each depositor. Each array contains the information regarding depositor savings decisions. In particular it is possible to check the amount saved in each single bank: the value of any item is the sum deposited in the corresponding bank by the individual. Every time a deposit is done, the item related to this bank will be updated.

To create the array, first we have to add it as variable owned by depositors:

```
depositors-own[infoLevel ethicLevel ethical money deposits arr]
```

```
depositors-own[infoLevel ethicLevel ethical money deposits arr]
```

Temporarily we call it “arr”, to show it clearly and to use it easily. Then, we define it in the create-depositors procedure:

array:from-list is an array’s primitive used to create a new array containing the same items in the same order as the input list. For instance, if we define an array as follow:

```
create-depositors howManyDepositors
  [set shape "person"
    set color orange + random 3
    setxy random-xcor random-ycor
    set infoLevel random-float 10
    set ethiclevel random-float 10
    set money random-float 1000
    set ethical nobody
    set deposits 0
    set arr array:from-list n-values howManyBanks [0]
```

```
let a array:from-list n-values 5 (0)
```

what we obtain if we print “a” is:

In the code, we use this primitive to set “arr” (the depositors array) as an array with so many components as the number of banks. In fact, the input list is the list of banks, whose number of components is decided by the user through the slider. Moreover, we set every item of the list with value 0: initially there are no deposits in the bank accounts of depositors. At the end of the setup procedure, what is observable inspecting a depositor is:

```
{{array: 0 0 0 0 0}}
```

who	32
color	26
heading	356
xcor	-11.154174031341746
ycor	9.152155257839851
shape	"person"
label	" "
label-color	9.9
breed	depositors
hidden?	false
size	1
pen-size	1
pen-mode	"up"
infolevel	9.840317252555122
ethiclevel	4.099207560514397
ethical	nobody
money	173.18805966083684
deposits	0
arr	{{array: 0 0 0 0 0 0 0 0 0 0}}

Figure 9.2: Version 2-Turtle 32's features

The last line in the table (Figure 9.2) shows that the depositor 32 owns a variable “arr” that corresponds to an array of ten items (the user has set up ten banks in the world). All the components have value of 0, because the depositor 32 has done any deposit until this moment.

We integrate also the go procedure with two lines of code related to the array, in order to update it every tick:

```
if banks-here != nobody [let MyDeposit money * 0.1
  set money money - MyDeposit
  set deposits + MyDeposit
  ask banks-here [set InMoney InMoney +
    MyDeposit]
  let a first [who] of banks-here

  array:set arr a (array:item arr a +
    Mydeposit)
]
```

Here we use the array primitive `array:item`, that works reporting the item in the given array with the given index. First, we define “a” as the ID-number

of the agent-bank; it will correspond to the  $a$ -th item of the array. Then, at the  $a$ -th component of the array we add the variable “my Deposit”. As explained before, “my Deposit” is a local variable created to identify the amount of money deposited by the individual at each tick. After running the go-procedure, if we inspect depositor 32 we obtain:

who	32
color	27
heading	16
xcor	9.137057762262991
ycor	7.627523795338462
shape	"person"
label	" "
label-color	9,9
breed	depositors
hidden?	false
size	1
pen-size	1
pen-mode	"up"
infolevel	1.9090107706136428
ethiclevel	6.1860273807742585
ethical	false
money	103.10338572322696
deposits	11.455931747025218
arr	{array: 11.455931747025218 0 0 0}

Figure 9.3: Version 2- Turtle 32’s features after running the go-procedure

The first component of the array is changed from 0 to 11,45 (Figure 9.3). This means that at the first tick Depositor 32 has deposited this amount in the bank with ID-number 1. At the moment Depositor 32 has not done other deposits in other banks. In fact the sum deposited in bank 1 is equal to the amount of the variable “deposits”, that records the total amount of deposits of Depositor 32.

## 9.4 Focusing on firms: version 3

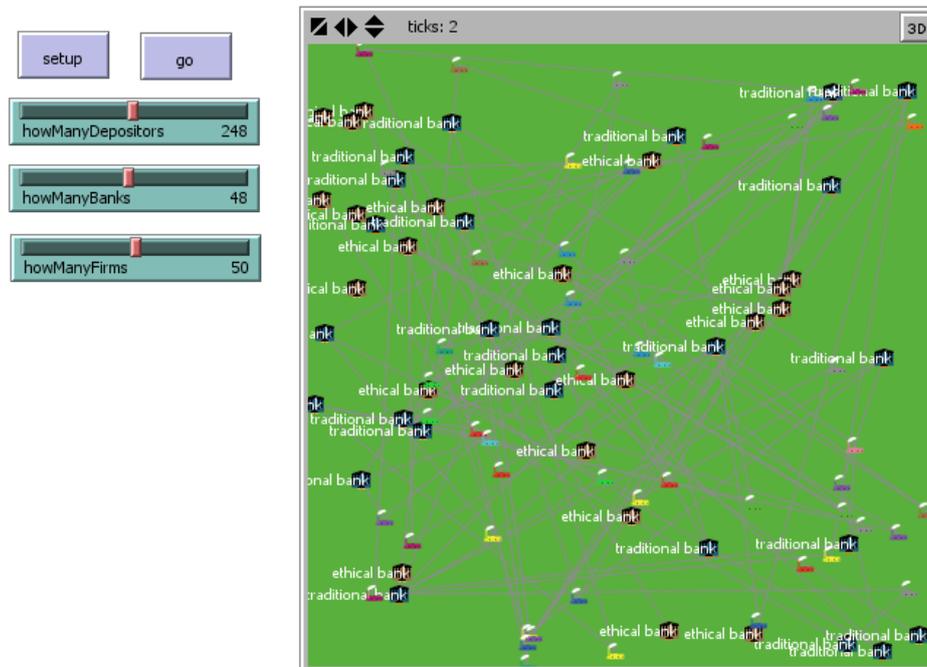


Figure 9.4: Version 3 interface after few Ticks

This version of the model is dedicated to develop the interactions between banks and firms. We start defining two variables for firms:

```
firms-own[moneyNeed se-index fin-index]
```

The variable “fin-index” is the abbreviation of “financial-index”, while “se-index” corresponds to “social-environmental index”. We introduce these variables to simulate the evaluation procedure that banks realize before releasing funds to a firm. Normally, traditional banks analysis of firms requesting financing is concentrated on the economic-financial features. The main point of interest is verifying if the firm will be able to give back money. In this case there is no attention on the firm impact on the society and on the environment. In order to reproduce this process of analysis we introduce the variable “fin-index” that works returning a financial-score to each firm. As we show onward, the score is a value generated randomly from 0 to 10.

Ethical banks develop a different procedure to release funds to firms. Entities are evaluated not only from the financial point of view; great importance is given to firms social and environmental externalities. If a firm has a low financial value, but may potentially be important for the society, it can obtain money. For this reason we define also a social-environmental index, that combined with the financial one, will permit banks to evaluate entities requesting financing. It will be generated randomly in a range of values defined from 0 to 10:

```
create-firms howManyFirms
  [set shape "factory"
    setxy random-xcor random-ycor
    set moneyNeed random-float 5000
    set se-index random-float 10
    set fin-index random-float 10]
```

### 9.4.1 The go-procedure

```
ask firms [let ethic-score se-index - 5 + (fin-index / 2)
  ifelse ethic-score < fin-index
    [create-link-with one-of banks with [label = "tradition_
      bank"]]
    if fin-index < 4 [let int-rate 0.08]
    if fin-index > 4 and fin-index < 8 [let int-rate 0.06]
    if fin-index > 8 [let int-rate 0.04 ]]

  [create-link-with one-of banks with [label = "ethical_
    bank"]]
    if ethic-score < 4 [let int-rate 0.08]
    if ethic-score > 4 and ethic-score < 8 [let int-rate
      0.06]
    if ethic-score > 8 [let int-rate 0.04 ] ] ]
```

First, we define a local variable: “ethic-score”. It reports the result of an ethical bank evaluation of firms. To compute it we combine the se-index and the fin-index previously defined. The integration of the two indexes reproduces faithfully the evaluation process of an ethical bank.

To compute an average of two scores we define the ethic-score as a function of the two indexes. It is not just the weighted average of them: in this case all the firms will obtain an ethical score greater than the financial index; only ethical banks will have customers.

Table 9.3: Possible outcomes of the variable "ethic-score".

		indsa										
		0	1	2	3	4	5	6	7	8	9	10
indfin	0	-5	-4	-3	-2	-1	0	1	2	3	4	5
	1	-4.5	-3.5	-2.5	-1.5	-0.5	0.5	1.5	2.5	3.5	4.5	5.5
	2	-4	-3	-2	-1	0	1	2	3	4	5	6
	3	-3.5	-2.5	-1.5	-0.5	0.5	1.5	2.5	3.5	4.5	5.5	6.5
	4	-3	-2	-1	0	1	2	3	4	5	6	7
	5	-2.5	-1.5	-0.5	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
	6	-2	-1	0	1	2	3	4	5	6	7	8
	7	-1.5	-0.5	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5
	8	-1	0	1	2	3	4	5	6	7	8	9
	9	-0.5	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5
	10	0	1	2	3	4	5	6	7	8	9	10

So, we have to weigh differently the two values. Table 9.3 shows all the possible results obtainable combining the values of the two indexes, following our formula. The yellow portion of the table corresponds to the combination of values that leads the firm choose an ethical bank. As we can see, a firm must have at least a value of 5 in the social-environmental index to be accepted by an ethical bank, while even a not so high value of the financial index is sufficient.

Then we introduce an if-else cycle, which reporter is given by the inequality “ethic-score < fin-index”. If it is true, then the firm will ask funds to a traditional bank. If it is false the firm will request financing to an ethical bank.

Obviously, the interest each bank ask to pay on the lend sums is proportional to the financial index of the firm. If the financial value is lower than 4 (quite low), then the entity will have to pay a higher interest (8%). If the capability of giving back money is high (financial index greater than 8) the firm will pay a lower interest (4%). In the other cases the interest to be paid will be of 6%. Ethical banks follow an analogue procedure.

The interaction between firms and banks is realized through “links”. Using the command “create-link-with”, we create an undirected link between the caller and an agent. In our case the caller is a firm while the agent is “one-of” the banks of the chosen type.

## 9.5 Version 4

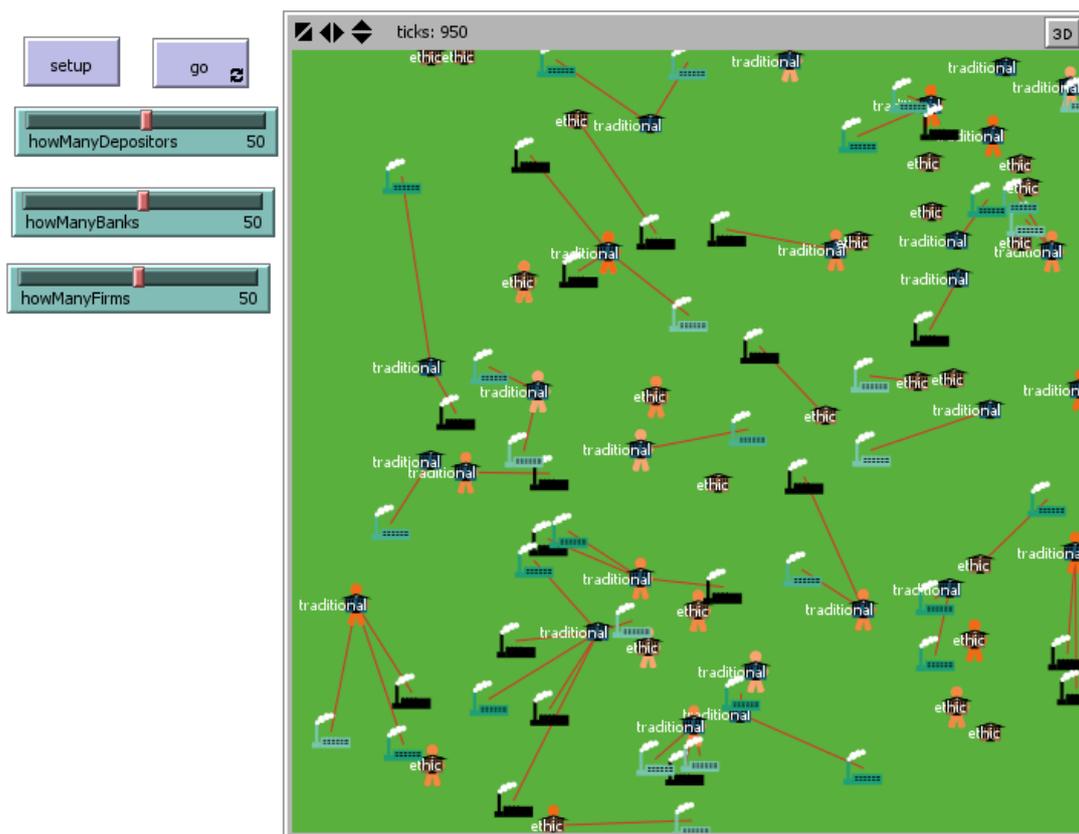


Figure 9.5: Version 4 interface after 950 ticks

As we can observe from the interface picture, there are changes regarding the visible features of turtles. First, we increase the size of them; if in the setup procedure you do not specify any size for turtles, NetLogo creates them with size 1. Now we increase it to 2, for both depositors and firms. We also switch the firms color from random to a defined color. We use the command “color 75+random 3”: firms are generated of a color that is chosen randomly from a hue of green. Regarding to the banks we change the labels: they switch from “traditional banks” and “ethical banks” to just “traditional” and “ethical”. The result is a clearer and more effective view of the agents.

Then, we concentrate on improving the interaction structure between banks and firms. Firms acquire three more attributes: “firmMoney”, “debt” and “int-rate”:

“firmMoney” refers to the amount of money owned by a firm. It is generated randomly in an interval from 0 to 3500 by the create-firm procedure.

```
firms-own[moneyNeed ind-sa ind-fin firmMoney debt int-rate]
```

“Debt” is an attribute to identify the quantity of money a firm has to reimburse to the bank. It includes also the interests that the firm has to pay on the borrowed sum. At the beginning we do not specify a value for debt: at the end of the setup procedure it results equal to 0.

“int-rate” is a variable that represents the interest rate that firms pay on the borrowed sum. This variable varies depending on the credit or the social worthiness of firms. We defined it in version 3 using the command “let”. In NetLogo the command “let” have to be followed by a variable name and by the value we want attribute to it. So “let” creates a new local variable and gives it the defined value. Now we want “int-rate” to be more than a local variable. So we define it in the attributes of firms at the beginning of the code. Then, in the go-procedure we specify it using the command “set”.

### 9.5.1 The go-procedure

In this version we integrate the go-procedure only in the part referred to firms. First, we simplify the code. Only few line of code are used to define firms movement:

We use a if-else cycle: if the quantity of money owned by the firm is sufficient, the firm can follow the “firm-act” procedure. Otherwise the firm stop work: it fails. It do not start anymore the “firm-act” procedure and it becomes black. Switching the color, we can monitory the failed firms number from the worldview window.

```
ask firms
[
  ifelse debt < 2 * moneyNeed
  [firmact]
  [set color black ]]
```

Separately, we define the “firm-act” procedure, recalled by the go-procedure:

```
to firmact
```

```
  ; creating link with bank and firm
  let ethic-score ind-sa - 5 + (fin-index / 2)
  ifelse ethic-score < fin-index

    [create-link-with min-one-of banks with [label =
      "traditional"] [distance myself]
    [set color red]
    if fin-index < 4 [set int-rate 0.08]
    if fin-index > 4 and fin-index < 8 [set int-rate 0.06]
    if fin-index > 8 [set int-rate 0.04 ]]

    [create-link-with min-one-of banks with [label =
      "ethic"] [distance myself]
    [set color red]
    if ethic-score < 4 [set int-rate 0.08]
    if ethic-score > 4 and ethic-score < 8 [set int-rate
      0.06]
    if ethic-score > 8 [set int-rate 0.04 ]]
```

```

; moving money

if firmMoney < (moneyNeed / 2)
  [set firmMoney firmMoney + moneyNeed
   set debt debt + moneyNeed
   let b moneyNeed
   ask my-links [ ask other-end [set InMoney Inmoney - b]] ]
if debt > 0

  [set debt debt * (int-rate + 1)
   let payBack firmMoney / 20
   set debt debt - payBack
   set firmMoney firmMoney - payBack
   ask my-links [ ask other-end [ set Inmoney Inmoney +
     payBack] ]]

set firmMoney firmMoney - random (moneyNeed / 200) + random
  (fin-index / 20) + random (moneyNeed / 200)
end

```

The first part is similar to version 3; it differs only for few details regarding the “int-rate” attribute (described before). In this version we add a second part, that is introduced by a line of comments: “moving money”. The aim of these lines of code is describe the cash-flows of firms. When a firm requests financing? How many interests are paid on the borrowed money? The firm money increases or not at every tick?

We introduce an if-cycle: if the quantity of money the firm own is less than a half of the amount the firm need, the firm requests financing. In this case the if-cycle runs; the amount of money defined as “moneyNeed” is transferred from the bank to the firm. So the variable “firmMoney” (that specifies the money owned by the firm) is increased by the amount “moneyNeed”. It is also added to the variable “debt”, because the debt of the firm increases by the borrowed sum. Then, defining “moneyNeed” as a local variable, “b”, we

proceed to subtract it from the bank money. To develop this passage we use a `links` command; we ask to the caller of the link (in this case it is the firm) of asking to the agent linked with it (that in this case is a bank) to increase its amount of money by “`moneyNeed`”.

If the firm has an amount of debt, then we have to define a debt procedure in detail. Obviously, the firm pays some interests on the borrowed sum. So we have to consider them when we speak about debt. The amount of interest is computed multiplying the debt with the interest rate value increased by one. Then we add it to the debt. From now until the end of the procedure, when we write `debt`, we are taking into account the latter definition. We proceed to define a local variable: “`payBack`”. It refers to the amount of money a firm reimburses to the bank. We assume that every tick the firm pays back an amount of money equal to  $1/20$  of the firm money. Obviously, the reimburse is proportional to the firm debt. This amount is subtracted to the debt: paying back a part of it, its value decreases. Then this local variable is subtracted by the “`firmMoney`”, while it is added to the “`inMoney`” of the bank. To realize the latter passage we use the `links-structure` previously defined. We have a caller of the link, the firm, and we make it ask to the agent at the other end of the link, the bank, to increase its amount of money. We are transferring money from the firm to the bank.

With the last row of the code we specify how the variable “`firmMoney`” varies every tick, independently from the debt of the firm. We try to change it in a random way, to reproduce the firm income. This is a coarse mechanism to reach this aim; in a future version we will improve it. “`MoneyNeed`” can be considered as a measure of the financial size of the firm. We change “`firmMoney`” by a random amount of money that depends on it; a bigger firm will work with an higher amount of money. The absolute value of its gain/loss will be greater compared to that of a smaller firm. In the formula we take into account also “`fin-index`” to make the firm money varying also depending on the financial stability of the firm. A firm more financially stable will have a higher income. We add and subtract the same function depending on “`moneyNeed`” to express a random result. This value is contained in an interval whose extreme values are:  $[-(moneyNeed/20); +(moneyNeed/20)]$

## 9.6 Refining the model: version 5

In this version we are refining the model. The basic objective of the project consists into focusing on the interactions of ethical and traditional banks with costumer; we will introduce sliders to vary their level of ethics and of information to observe the outcome scenario. But now the structure of interaction of the three agents is not well defined. We are simplifying the code and creating a balanced world nearer to reality.

### 9.6.1 The setup procedure

We start modifying the creation of banks; in the previous versions they were created following the number decided by the user. In fact, with the slider in the interface page the user could vary the quantity of banks in an established interval. Here we impose to have always at least two banks in the world: an ethical bank and a traditional one. The slider interval of variation becomes  $[2; 100]$ . The set of banks depending on the slider are “random banks”:

The two fixed banks are created separately, with the same features of the others banks. This separated procedure guarantees always the creation of an ethical bank and of a traditional one.

```
let howManyRandomBanks howManyBanks - 2
```

We introduce also two sliders to control the levels of ethic and information of depositors. They are the basis of the future development of the model:

Before, both of the levels were a value created randomly in an interval of values  $[0; 10]$ . Now we reduce the superior extreme value of this interval to 5; we sum to it a quantity imposed through the slider. In this way the user can influence the ethics of customers, even if only partially. If the sliders fix the value of 0 for both the levels, then in the world the level of ethic among depositors will be very low. If the ethic level slider is located on 3, then all the depositors will have a level a level of ethic of at least 3.

```
set infoLevel random-float 5 + infoDepositors  
set ethicLevel random-float 5 + ethicDepositors
```

The last alteration regards the “firmMoney” variable. Its interval of variation is now [0; 2000].

## 9.6.2 The go-procedure

First, we modify the movement of depositors:

Before, the money of the depositors was increasing every step. Now it is not the case. We increase it of a random quantity from 0 to 25 and then we subtract to it 10. In this way, if the number created randomly is less than 10, the total amount added to depositors money will be negative. It is not sure that a depositor increases his amount of money every tick. The meaning of increasing the depositors amount of money is to reproduce a wage. But it may occurs that the wage amount is not sufficient to face the expenses of the period. The balance of that period will be negative: the depositor will decrease his money amount.

```
set money money + random 25 - 10

if banks-here != nobody [if money > 100

    [let MyDeposit money * 0.1
     set money money - MyDeposit
     set deposits deposits + MyDeposit
     ask banks-here [set InMoney InMoney + MyDeposit]
     let a first [who] of banks-here
     array:set depositVector a (array:item depositVector
                               a + MyDeposit)]

        if money < 25

            [let a first [who] of banks-here
             if array:item depositVector a > 0
             [let MyWithdraw array:item depositVector a * 0.9
              set money money + MyWithdraw
```

```

set deposits deposits - MyWithdraw
ask banks-here [set InMoney InMoney - MyWithdraw]
array:set depositVector a (array:item depositVector
    a - MyWithdraw)
]]
]]

```

Moreover we assumed that individuals deposit a quantity of their money every tick. But this passage does not reproduce faithfully the reality. If an individual has not money, or if he has few, he will not make deposits in the bank. On the contrary, he maybe will withdraw some money from his banks account. To this aim we create a procedure similar to those for deposit money using the array structure. If an individual has a quantity of money greater than 100, he will deposit part of his money; if he has a quantity of money lower than 25 he will withdraw money. 25 is considered a very low quantity: in this case the depositor can deposit anything and maybe he need liquidity. If the quantity of money is from 25 to 100, the individual will not move money from his banks-account. The procedure to deposit money was introduced in the previous versions. The procedure to withdraw money is analogous. Obviously it has a necessary condition: the amount of money in the bank-account needs to be positive. An individual has to have deposits to withdraw them. We define also a local variable: “myWithdraw”. It corresponds to the amount of money the individual moves from the bank account to his pockets. This amount is added to the depositor’s liquidity (money) and it is subtracted from his deposits. Simultaneously, the bank account is decreased of the cashed amount. The last passage consists into modify the array and integrate it also with the withdrawn sums. The result is that every depositor owns an array: it records every movement in the banks-accounts of the individual. If a depositor deposits an amount of 100 in Bank 3, then his array increase the third value of 100. Assuming that after some ticks he needs money and withdraws his deposits in Bank 3, the third value of his array will decrease of 100.

The go-procedure ends with new lines of code:

In the previous version we asked to firms with a reasonable level of debt to

act. The acceptable level of debt was indicated as lower than the double of the money need of the firm. If the amount of money that a firm needs to work is too high with respect to its leverage capability, then it crash. It becomes black and it does not start the procedure “firmact”. Here we add the creation of new firms. As time goes on, some firms fail and new firms born. To generate firms we define a local variable: “pCreateFirm”. It is a number generated randomly from 0 to 100. Through an if-cycle we establish that if the generated number is greater than 98, then it is followed the procedure “createFirm” and a firm is created. Every tick there is the 2% of probability that a new firm borns. It means also that a new firm is created about every 100 ticks. Then, if we want to increase the number of firms we just have to change the number 98 with a lower one.

```
ask firms [ifelse debt < 2 * moneyNeed
           [firmact]
           [set color black]]

; creating new firm

let pCreatefirm random 100
if pCreateFirm > 98 [createFirm]

ask banks [if inMoney < -10000 [die]]
```

Obviously, also banks can fail. So we introduce a command, asking banks to die if their amount of money (inMoney) is lower than -10000. We decided for a quantity lower than 0, to lead to banks a margin.

The procedure “createFirm” leads to generate a firm identically to those made by the setup procedure:

```
to createFirm

create-firms 1
  [set shape "factory"
   set size 2
```

```

set color 75 + random 3
setxy random-xcor random-ycor
set moneyNeed random 5000
set ind-sa random-float 10
set ind-fin random-float 10
set firmMoney random 2000]

end

```

In this version is not specified what happens if a firm fails and it does not reimburse the debt to the bank. Banks seem to be not affected by firms failures. We have to improve this passage in the next version.

When a firm fails it stops its activity and it becomes black. When a bank crash it dies: it disappears from the worldview window. This because the aim is to observe the general dynamics of the financial world evolution. It seems more reasonable focusing on the number of firms generated and failed, and not on that referred to banks. Maybe this procedure will suffer changes in the next versions.

```

; moving money
if firmMoney < (moneyNeed / 2) [
  set firmMoney firmMoney + moneyNeed
  set debt debt + moneyNeed
  let b moneyNeed
  ask my-links [ ask other-end [set InMoney Inmoney - b]] ]

if debt > 0

  [set debt debt * (int-rate + 1)
  let payBack firmMoney / 20
  set debt debt - payBack
  set firmMoney firmMoney - payBack
  ask my-links [ ask other-end [ set Inmoney Inmoney +
    payBack] ]]

```

```
let firmNumber count firms with [color != black]
set firmMoney firmMoney + random (moneyNeed / 100) + random
    (howManyDepositors / 30 - firmNumber / 10) + random
    (fin-index * howManyBanks / 40)

end
```

The latter line of the code is created to model the firm income, as we explained in the previous version. Here we try to improve the model. “firmMoney” is a function of both internal and external variables to the firm. Internal variables are “moneyNeed” and “fin-index”. External variables are the number of banks, the number of firms and the number of depositors. The number of banks can be seen as the possibility to obtain a loan. So we consider it with the financial-index. The values are multiplied to compensate their effect. Suppose to have a firm with a high credit worthiness; simultaneously there are few banks in the world. For this firm it will be not easy to get a loan. The positive effect of being credit worthiness is smoothed. On the contrary, if a firm has a low financial index but there are a lot of banks in the world, it will be financed as well.

The number of firms can be interpreted as the offer in the market, while the number of depositors represents the demand. Considering the two variables together we can calibrate the firm money on the market scenario. The firm-value will be direct proportional to the number of depositors: a higher demand corresponds to an increase of the firm-value. At the same time, the firm-value will be inversely proportional to the number of firms; a great number of firms means a high level of competition between them; the firm-value decreases. To realize this passage we create a local-variable: “firmNumber”. It reports the number of no-black firms, that means the number of working firms. Obviously we eliminate from the “offer” of the market those firms that still exist as agents, but that are blocked (they are black).

All these components are weighted. The weights values are carefully established: we want to give more importance to the market situation and less

importance to the internal variables of the firm.

### 9.6.3 The interface page

We add some counters in the interface page:

- *working firms*: it count the number of firms with a color different from black;
- *firms in bankrupt*: it reports the number of firms that are blocked: they are black. We have to pay attention in considering this counter together with the previous one: this one will always increase, it is cumulative. On the contrary, the other can increase or decrease: it is a measure of the dimension of the market.
- *banks*: it count the number of banks in the world. It differs from the number of banks imposed with the slider; the slider has an interval of variation of  $[2, 100]$ . In facts, two banks are created with the setup procedure: an ethical and a traditional one. Moreover, also banks can fail, so their number differs from the slider one.

## 9.7 Dealing with ethical items: version 6

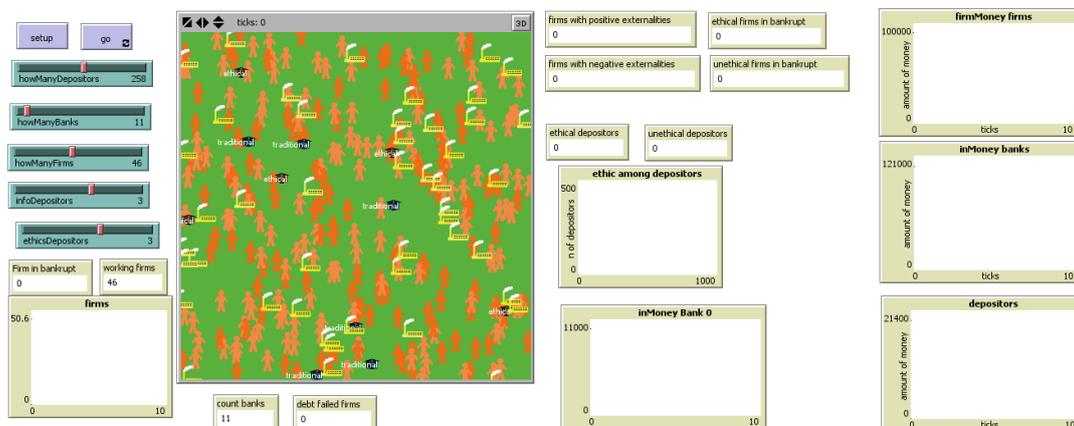


Figure 9.6: Version 6 initial interface

### 9.7.1 The setup procedure

Up to now we created a world where depositors, firms and banks interact. The aim of the firsts versions of the project was to create and improve the interactions between agents. Since our objective is analyzing a banking environment where also ethical banks act, now we introduce new “ethical” features to the agents.

First of all we introduce the attribute “ethical experience” to depositors. Our idea is that when depositors interact, they exchange ideas and can vary their levels of ethics. The variable ethical experience will vary through the interaction of depositors. When depositors are created, this variable assume the value of 1. The introduction of this variable will also procure changes in the depositor-act procedure.

We define a new variable of firms: “positive impact”. It indicates if the firm has a positive social-environmental impact: in this case it turns “true”. Otherwise it becomes “false”. When created, firms own this variable with the value 0.

After a phase of model-tuning we make some changes to variables values; mainly we decrease the interval of values in which vary the agents amounts of money:

- the variable “firm money” is created with the formula:  
in this way its interval of variation will become [1001;3000];

```
set firmMoney 3000 - random 2000
```

- the firm variable “money need” is created with a random value in the interval [0;2999];
- a banks will fail if its variable “in-money” is lower than -5000.

### 9.7.2 The go procedure

We simplify the go procedure:

```

to go
  ask depositors [ifelse random 100 > 60
    [depositorAct]
    [forward random 3 left random 360]
    set money money + random (money / 10) - random (money /
      10)
    depositors-interaction]

  ask firms [ifelse debt < 3 * moneyNeed and firmMoney >
    -10000
    [firmAct]
    [set color black ]]

  ;creating new firm
  if random 200 > 198 [createFirm]

  ask banks [if inMoney < -5000
    [die]]

tick

end

```

At every tick, only the 60% of depositors follow the procedure “depositor act”. The other part simply realize a movement in the world. On the contrary, everyone follow the procedure “depositor interaction”. The latter is a novelty that we will explain successively.

An important change characterizes the depositor action; we change the formula that determines to which bank the depositor move:

```

ifelse infoLevel * ethicsLevel * (1.1 - random-float 0.2) *
  ethicalExperience > 49
[set ethical true
ifelse any? banks with [label = "ethical"]

```

```

[move-to one-of banks with [label = "ethical"]]
  [ifelse any? banks with [label = "traditional"]

    [move-to one-of banks with [label = "traditional"]]
    [forward random 3 left random 360]]]

[ifelse ethicsLevel < 5

  [set ethical false
   ifelse any? banks with [label = "traditional"]
     [move-to one-of banks with [label = "traditional"]]
     [ifelse any? banks with [label = "ethical"]
       [move-to one-of banks with [label = "ethical"]]
       [forward random 3 left random 360]]]
  [set ethical false
   if min-one-of banks [distance myself] != nobody [move-to
     min-one-of banks [distance myself]]]]]

```

The formula is made up by four elements: the level of information, the level of ethics, the ethical experience and a number that we can define “interval of variation”. The aim of this change is consider also the ethical experience in determining which type of bank the depositor chooses. Up to now, a depositor had at least a value of 7 in both ethical and traditional levels to choose an ethical bank. Now we multiply the values of the two levels and we identify the result of 49 as instrumental value. As we can see from table 9.4, in this way the threshold values are maintained with both the ethical and traditional attributes:

0	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	2	4	6	8	10	12	14	16	18	20
3	3	6	9	12	15	18	21	24	27	30
4	4	8	12	16	20	24	28	32	36	40
5	5	10	15	20	25	30	35	40	45	50
6	6	12	18	24	30	36	42	48	54	60
7	7	14	21	28	35	42	49	56	63	70
8	8	16	24	32	40	48	56	64	72	80
9	9	18	27	36	45	54	63	72	81	90
10	10	20	30	40	50	60	70	80	90	100

Table 9.4: Possible outcomes of combination between ethic-level and info-level

Then, we multiply it to the ethical experience. When a depositor is created this attribute has value of 1. This means that initially it is unimportant for the choice of the bank. It will assume importance only with the time elapse: with the depositor experience, as the name underlines. The idea is that the ethical experience varies with the depositors interaction, as we will show successively. With the interaction, this variable will decrease or increase and it will influence the value resulting from the explained formula. The last component of the formula is a number contained in the interval  $[0.9, 1.1]$ . We named it “interval of variation”, because multiplying by it we can vary a little the result achieved with the three other components multiplication.

The depositor bank-choice is described with an if-else cycle. If the showed formula results a value equal or higher than 49, then the depositor chooses an ethical bank, but only if an ethical bank exists. This condition is expressed by “any?”; it is an agent-set primitive that requires of being followed by the agent-set to which it refers. It reports “true” if the given agent-set is not empty; otherwise it reports false. In our case the given agent-set is “ethical banks”. If at least an ethical bank exists, than the depositor chooses it. Otherwise he goes to a traditional one.

If the formula returns a value lower than 49, the depositor has two alternatives:

- if he has an ethical level lower than 5, he moves to a traditional bank. He is considered too little ethical for choosing an ethical bank. He will

do an ethical choice only if any traditional banks exists (equivalently to ethical depositors);

- if his ethical level is higher or equal to 5, he moves to the nearest bank independently from the type. His ethical level is not so high or so low to influence his choice.

About firms, in this version we refine the “firm act” procedure. First of all, we give a value at the variable “positive impact”. If a firm has an ethical score lower than its financial index, it will choose a traditional bank. In this case the variable positive impact turns “false”. On the contrary, if the ethic score prevails, the firms will ask a loan to an ethical bank: the positive impact turns “true”.

Successively, we refine the procedure to payback the loan:

```
if debt > 0
  [ set debt debt * (int-rate + 1)
    ifelse debt > firmMoney / 50

      [let payBack firmMoney / 50
        set debt debt - payBack
        set firmMoney firmMoney - payBack
        ask my-links [ ask other-end [ set inMoney inMoney +
          payBack] ]
      ]
      [let payBack debt
        set debt debt - payBack
        set firmMoney firmMoney - payBack
        ask my-links [ ask other-end [ set inMoney inMoney +
          payBack]] ]]
```

We define an if-else cycle in order to return the borrowed sum: we identify a quantity that corresponds to an installment of the repayment plan.

- If the debt is greater than the installment, then the payback amount will coincide with the installment;

- if the debt is lower than the installment, the payback amount will be equal to the residual debt.

We modify also the procedure to request financing:

```
let minimumMoney moneyNeed / 5
let check-bank-reserve 0
ask my-links [ ask other-end [set check-bank-reserve inMoney]]
if firmMoney < minimumMoney and minimumMoney <
  (check-bank-reserve * 0.9)

  [set firmMoney firmMoney + minimumMoney
   set debt debt + minimumMoney
   ask my-links [ ask other-end [set inMoney inMoney -
     minimumMoney]] ]

let firmNumber count firms with [color != black]
random (moneyNeed / 150) - random (moneyNeed / 100) + random
  (howManyDepositors / 5 - 2 * firmNumber) + random (fin-index
  * howManyBanks / 50) + random (firmMoney / 5000)
```

We define two local variables; the first “minimum money”, that refers to the minimum amount of money a firm needs to work. It corresponds to the “money need” amount divided by 5. The second local variable is “check-bank-reserve”. The aim of this variable is verify that the bank to which the firm is linked has enough money to grant the loan. Initially, we create it with value 0. Then we attribute to it the value of the “in money” amount: it is the amount of money owned by the bank.

Two conditions have to be satisfied to get the loan:

- the firm money amount is lower than the minimum money amount;
- and the minimum money amount is lower than the 90% of the check-bank-reserve. The banks can not lend all their money, but they have to guarantee a reserve. We assume that this reserve corresponds to the 10% of the banks money.

We use the primitive “and”; it works located between two conditions: it reports “true” if both the conditions are true. If the first condition is false, then the second condition will not be run, since it can not influence the result.

The loan is accommodated only if both conditions are satisfied. In this case the firm money and the debt of the firm are increased by the amount of the loan. The same amount is subtracted by the money of the bank.

### 9.7.3 The interface page

Up to now this sheet just contained the worldview window and the sliders necessary to vary the agents numbers. Through many versions of the model we improved agents features, interactions and movements. Now we have to monitor the model evolution: we do it creating counters and plots. Some of them will not be part of the final version: they are necessary only in the successive versions to deeply analyze the model and helping in the model-tuning process.

We add seven counters:

- *debt failed firms*: it reports the sum of the amounts of the failed firms. It is useful because it provides information about the unavailable quantity of money, that corresponds to the loss of the banks;
- *firms with positive externalities*: it counts the number of firm with positive impact “true”, that means connected to an ethical bank. They are classified as ethical because they have to own an ethic score greater than the financial-index to create a link with an ethical bank. The reported number increase because new firms are created running the model. Moreover it records also the firms yet failed: they becomes black and do not work, but they continue to exists;
- *ethical firms in bankrupt*: it reports the number of firms with positive impact “true” and color black (failed firms). This is a cumulative number, and it increases with the increasing number of ticks. Once a firm fails, it will never come back to work;

- *firms with negative externalities*: it is analogous to that referred to positive impact firms. It works reporting the number of firms with positive impact “false”;
- *unethical firms in bankrupt*: it counts the failed firms with false positive impact;
- *ethical depositors*: it counts depositors with the value “true” of the attribute “ethical”;
- *unethical depositors*: it reports the number of depositors with “ethical” equal to “false”.

Six plots support the counters:

- *firms*: it is made up by two “pens” reporting the number of working firms and the number of failed firms. It is useful to monitor if our assumptions lead to the failure of too many firms;
- *firm-money firms*: it reports the sum of the variable “firm money” of all the firms of the world; it provides an idea of the dimension of the firms sector. Obviously, it takes in account only the working firms (with a different from black color);
- *ethic among depositors*: two pens form it; the former, named “ethical depositors”, plots the number of depositors with “true” as value of the attribute “ethical”. The second, named “unethical depositors” plots the number of depositors with a “false” value of “ethical”. The x-axis reports the ticks number, while the y-axis indicates the number of depositors. This plot will be essential to observe the results of the individuals interactions;
- *“in money” banks*: this plot is made up by a pen, and it shows the total amount of money owned by the entire set of banks. It is helpful to observe the impact of both depositors and firms on the bank going. An extension to this plot can be create two pens recording the ethical banks set and the traditional banks one separately; in this way we could check

if decreasing the level of ethics and consequently the deposits to ethical banks, the ethical sector will suffer a crisis;

- “*in money*” *bank 0*: it plots the amount of money owned by the bank with ID-number equal to 0. This is an important instrument to measure the loan exposition of a randomly chosen bank.;
- *depositors*: two pens form it: the first indicates the sum of the amount of the depositors variable “money”. This variable refers to the money that depositors have in their pockets. It corresponds to the total cash amount of depositors. The second pen indicates the total amount of deposits owned by depositors. This plot shows clearly which is the relation between the whole amounts of cash and deposits.

As we can observe in the interface image at the beginning of the chapter, in this version we changed the firms color. Now they are yellow to be more visible.

## 9.8 Concluding the model: version 7

The aim of this version is end the model and simplify the code, if it is possible. First of all we make some changes to the depositor act-procedure:

We introduce a probability: the 85% of the individuals will change the bank considering their ethical value; the remaining part chooses the nearest bank. The depositors moving to an ethical bank are those obtaining at least 49 from the formula explained in the previous version. These depositors are defined “ethical” (their ethical attribute turns true) and change color: they become violet. This switch allows us to focus on the proportions of ethical and unethical individuals in the population. It is essential to monitor the results of the depositors interactions.

```
to depositorAct
```

```
  ifelse random 100 < 85 [ifelse infoLevel * ethicsLevel *
    (1.1 - random-float 0.2) * ethicalExperience > 49
```

```

[set ethical true
set color 123
ifelse any? banks with [label = "ethical"]

  [move-to one-of banks with [label = "ethical"]]
  [ifelse any? banks with [label = "traditional"]
    [move-to one-of banks with [label =
      "traditional"]]
    [forward random 3 left random 360]]]

[set ethical false
  ifelse any? banks with [label = "traditional"]
    [move-to one-of banks with [label =
      "traditional"]]
    [ifelse any? banks with [label = "ethical"]
      [move-to one-of banks with [label =
        "ethical"]]
      [forward random 3 left random 360]]]]
[if min-one-of banks [distance myself] != nobody
  [move-to min-one-of banks [distance myself]]]

```

To this aim we define a new procedure: depositors-interaction:

```

to depositors-interaction
  forward random 2 right random 360
  let speaker one-of other depositors-here
  if speaker != nobody
    [ifelse [ethicsLevel] of speaker = 5
      [if ethicalExperience < 10 [set ethicalExperience
        ethicalExperience + 0.05]]
      [if ethicalExperience < 0 [set ethicalExperience
        ethicalExperience - 0.05]]] end

```

This procedure is running for all the depositors every tick. First, it makes them move following a random movement. Then, we define a local-variable:

speaker. We define as speaker one of the other depositors that are in the same patch. If a speaker exists, the procedure runs an if-else cycle: if the speaker is ethical (its ethical attribute is true), then the ethical experience of the depositor increase of 0.05. Otherwise it decreases of 0.05. The underlying idea is that interacting individuals reflect on items and change their ideas. If an individual meets another with a high level of ethics, there is a high probability that the former change his position. Obviously, the ethical level can not increase or decrease infinitely. It can increase only up to 10 and decrease only down to 0.

We try to simplify the procedure related to firms movement; in the go procedure we ask to firms to follow these commands:

```
ask firms [ifelse debt < 5 * moneyNeed and firmMoney > -10000
  [set firmMoney (firmMoney + random 50 - random 50)
  firmAct
  if firmMoney < (0.5 * moneyNeed) [ask-for-a-loan]
  if debt > 0 [ifelse positiveImpact = true
    [ethical-moving-money]
    [traditional-moving-money]]]

  [set color black ]]

if random 200 > 198 [createFirm] ; creating new firm
```

If they have enough money to work (even if it is necessary ask a loan), they develop many actions:

- increase or decrease their money, to simulate the profit or the loss of the firms work;
- follow the procedure “firmact”;
- if the firm money is lower than a half of the firm money need, they ask for a loan;
- moreover, if they have debt, they will pay back the loan developing the procedure moving money.

Dealing with the procedure “moving money” we introduced an if-else cycle to distinguish ethical firms from unethical ones. The objective is give favorable conditions to firms financed by ethical banks. This reasoning find correspondence in the reality. Usually, ethical banks pay lower interests to their depositors compared to traditional ones. Moreover the ethical banking sector is characterized by low risk-profile investments. We impose lower interest rates on the debt for loans granted by ethical banks. Firms with positive impacts are privileged also by lower installments of the payback sums:

```

to ethical-moving-money
  set debt debt * (int-rate + 1)
  ifelse debt > firmMoney / 100

    [let payBack firmMoney / 100
     set debt debt - payBack
     set firmMoney firmMoney - payBack
     ask my-links [ ask other-end [ set inMoney inMoney +
       payBack] ] ]

    [let payBack debt
     set debt debt - payBack
     set firmMoney firmMoney - payBack
     ask my-links [ ask other-end [ set inMoney inMoney +
       payBack]] ]
end

to traditional-moving-money

  set debt debt * (int-rate + 1)
  ifelse debt > firmMoney / 70

    [let payBack firmMoney / 70
     set debt debt - payBack

```

```

set firmMoney firmMoney - payBack
ask my-links [ ask other-end [ set inMoney inMoney +
  payBack]]]

```

```

[let payBack debt
set debt debt - payBack
set firmMoney firmMoney - payBack
ask my-links [ ask other-end [ set inMoney inMoney +
  payBack]]] end

```

Traditional banks divide firm-money by 70 to establish the installment of the returning plan; ethical banks propose lower installments, dividing the firm-money by 100. The procedure “ask for a loan” is new, but it represents just a part of the code yet described:

```

to ask-for-a-loan
  let loanAmount moneyNeed - firmMoney
  let check-bank-reserve 0
  ask my-links [ ask other-end [set check-bank-reserve
    inMoney]]
  if loanAmount < (check-bank-reserve * 0.7)

    [set firmMoney firmMoney + loanAmount
set debt debt + loanAmount
ask my-links [ask other-end [set inMoney inMoney -
  loanAmount]]]
end

```

The only difference is that here we define the local variable “loan amount”. It corresponds to the difference between the money need and the money owned by the firm.

The reserve imposed to banks increases to the 30% of their money, while it was just the 10% in the previous versions.

## 9.9 The definitive model: version 8

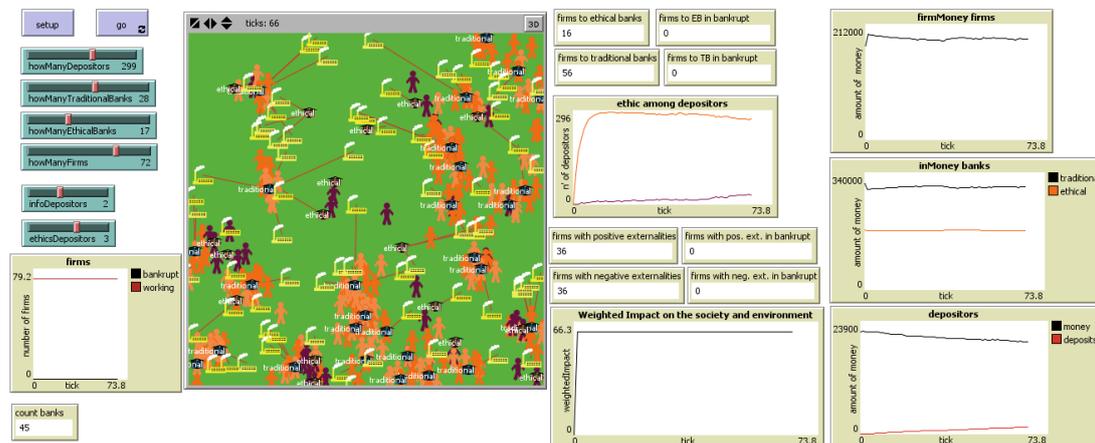


Figure 9.7: Version 8-interface after few ticks

The model is almost complete. We already think in the direction of the model experiments. It is necessary a phase of model cleaning, in particular for what regards the interface page. Furthermore, is not enough evident which is the social-environmental impact of the firms. How much they influence the society? How much does the result vary if the ethical banking sector develops? These questions show that we have to highlights these items in our model.

### 9.9.1 Defining a social-environmental weight for firms

We define two more attributes for firms: “weighted impact” and “se-weight”. They are necessary to the construction of a plot. Firms are set up with the value of 0 for both attributes. A definition of them is provided in the go procedure:

```
ask firms [ifelse debt < 5 * moneyNeed and firmMoney > 0
  [set firmMoney (firmMoney + random 50 - random 50)
  firmAct
  if firmMoney < (0.5 * moneyNeed) [ask-for-a-loan]
  if debt > 0 [ifelse positiveImpact = true
```

```

                                [ethical-moving-money]
                                [traditional-moving-money]]
set se-weight se-index - 5
set weightedImpact se-weight * moneyNeed / 1000]

[set color black
set weightedImpact 0]]
if random 200 > 198 [createFirm] ;creating new firm

```

“se-weight” means “social-environmental weight”. It is computed subtracting 5 to the social-environmental index of the firm. The objective is to create a weight that varies in the interval  $[-5, +5]$ . In this way if the firm has a positive impact its weight will be positive. Otherwise negative whether its positive impact is false.

In the following line of the code we define the second new variable: “weighted impact”. It results as the product of the social-environmental weight and the money need of the firm. The money need is weighted depending on its ethical nature. We consider the money need of the firms as a measure of the firm dimension. So a bigger firm (with a high money need) will have a deeper impact on the society, which can be either positive or negative.

We use the weighted impact to construct a plot (Figure 9.8).

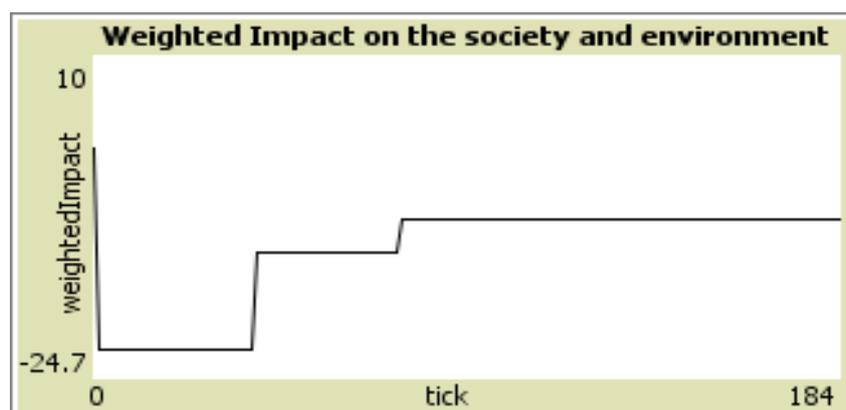


Figure 9.8: Weighted Impact Plot after about 150 ticks

It plots the sum of the weighted impact of firms. So it shows which is the impact of the firms sector on the society. Its value can also be negative: firms with a false positive impact have a negative value of the weight social-environmental index, and consequently of the weighted impact. If the plot-pen shows a negative value, it means that firms with negative impacts are prevailing.

### 9.9.2 The distinction between ethical and traditional banks

Up to now ethical and traditional banks have been taken into account jointly both in the setup and in the plot of their total amount of money. Now we want to separate them, to better observe each influence in our economic world. We create two sliders, each one can create 50 banks. Furthermore we eliminate the bond of having at least two banks: a traditional and an ethical one. Now there is also the possibility to design a world without banks.

We realize the same separation in the plot *“in money” banks*. It reports the sum of the money of all the banks in the world, representing the dimension of the banking sector. Now we distinguish two plot pens; a black one indicates the sum of the traditional banks money; an orange one represents the ethical banks money. Moreover, the x-axis counts the number of ticks, while the y-axis represents the amount of money.

### 9.9.3 Cleaning the interface page

Since we complete the model we remove from the interface all the tools useful to the model-tuning phase. We add some counter and plots that help us to observe the dynamics of the world from an ethical point of view.

As we explained before, we add a new plot: *“in money” banks*. We add also four counters to expand its explanation:

- *firms with positive externalities*: we differentiate firms that ask a loan to ethical banks from firms with positive externalities on the society. A firm chooses an ethical bank if its social-environmental score is higher than its financial index. But it may be the case of a firm with a higher financial

index and a very high social-environmental score. In this case the firm chooses the traditional banks because the financial index prevails; but it has also a positive impact on the society.

We identify 0 as the threshold value for determining the positivity influence. If a firm records a positive value (greater than 0) in the social-environmental weight, then it has a positive outcome for the society. On the contrary, it has a negative outcome if the social-environmental weight is negative. In this case it is monitored by the counter *firms with negative externalities*.

- *firms with positive externalities in bankrupt* and *firms with negative externalities in bankrupt* are two counters that we can observe near the previous ones. They count the number of failed firms respectively for firms with positive and with negative externalities.

We modify the plot *Ethic among depositors*, creating two pens; the orange one indicates the number of unethical depositors; the violet one counts the number of ethical depositors. Since this plot show very clearly the depositors ethics information, we remove the two counters created to fulfill this objective.

For the same reason we remove the *counters firms in bankrupt* and *working firms*; the plot *firms* synthesizes their information.

Others monitors are removed because they were created to support the model-tuning phase: they are the *debt failed firms* counter and the *in money Bank 0* plot.

# Chapter 10

## Experiments with the model

Our experiments plan aims to observe the dynamics of our world focusing on the evolution of the ethical banking sector. The experiments are developed considering two dimensions of the market: first a big market composed by a high number of turtles, then another case decreasing the number of agents. For each market we analyze the behavior of agents through an increasing-ethics procedure. The procedure makes us start with an environment characterized by low levels of ethics. At each experiment we increase or change the ethics levels, up to find the best solution from the ethical banking point of view.

### 10.1 The Big Market environment

We start considering a Big Market as an environment characterized by a high number of agents. We establish the quantity of each breed of agents to avoid bias in the experiments. The number of agents remains fixed for all the experiments of this group. It can only vary in the composition of banks; we decide a fixed number of banks, but the proportion between ethical banks and traditional banks varies.

The Big Market is formed by:

- 500 depositors;
- 50 banks;

- 100 firms.

The world will be highly populated and this is important for the interaction standpoint. Depositors will interact frequently and the speed of changes will be higher respect to less populated environments.

Our procedure focuses on analyzing a set of assumptions after given quantities of ticks. This because many of the agents attributes are defined randomly in intervals of value. We want to test how much the experiments results are linked to these initial values.

### 10.1.1 Scenario 1: no ethical banks

This is the worst scenario from the ethical point of view. There are no ethical banks because all the 50 banks are traditional. We setup the info-level and ethic-level sliders on 0. The values to ethics and information are assigned randomly by the setup procedure: the user does not modify them with the sliders.

As we could expect in the worldview window, after 5000 ticks there are no ethical depositors (violet depositors). Interactions do not improve depositors ethics level because their initial values were too low. The plot *Ethic among depositors* confirms this situation. The orange pen (representing the unethical depositors) draw a parallel line to the x-axis at the level of 500 depositors. The violet pen (representing ethical depositors) coincides with the x-axis.

Furthermore the world image shows us that a lot of firms are not linked to banks. These are firms with a social-environmental score higher than the financial-index. Normally, they ask for a loan to ethical banks only because traditional banks do not finance them; their credit worthiness is too low. Maybe these firms have a good impact on society but they are not considered creditworthy by traditional banks.

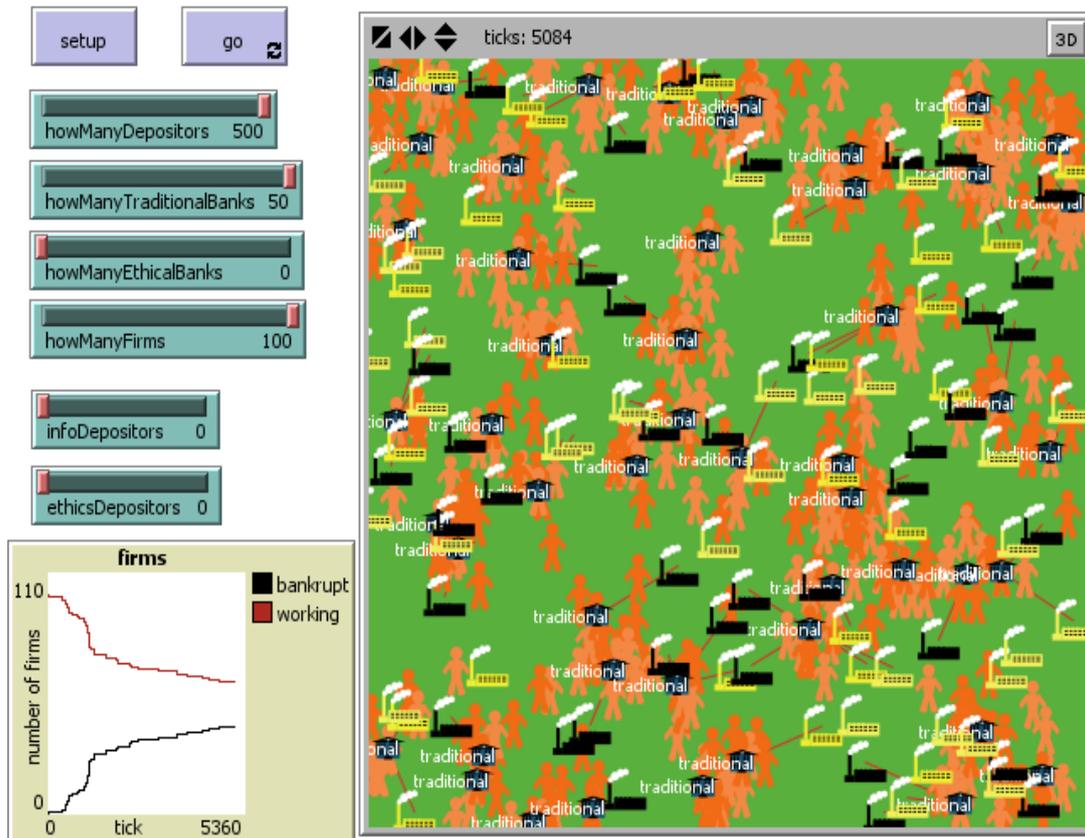


Figure 10.1: Bme- Scenario 1 interface after 5000 ticks

For simplicity we name *ethical* firms those firms that create a link with an ethical bank, if it exists. We expect that ethical firms will fail quickly since they have not the possibility of being financed. If they reach the condition that leads to ask for a loan, they die. We expect also a negative firms Weighted Impact on society.

Figure 10.2 reports the firms social-environmental *weighted impact*. This is the situation after about 5000 ticks:

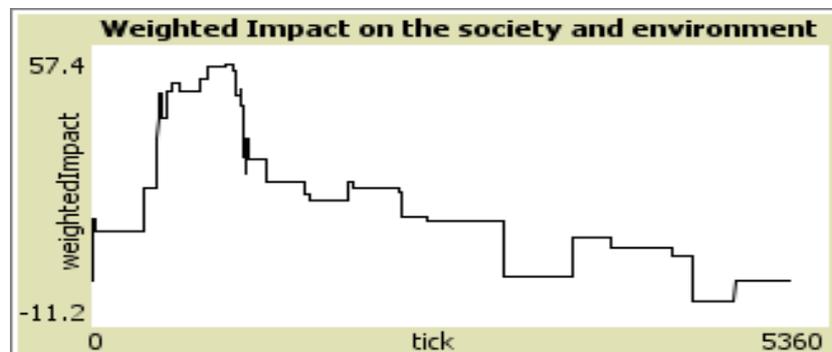


Figure 10.2: Scenario 1 -weighted impact plot after about 5000 ticks

Initially it is observable a positive increase of the index. This contrasts with our expectations, but the phenomena can be explained. At the beginning the presence of “ethical firms” does not depend on ethical assumptions. We imposed 500 firms and they are classified as ethical or not according to a random procedure. The positivity of the Weighted Impact increases. In this phase ethical firms are working well and do not need loans. But after about 1500 ticks the line decreases: at 5000 ticks it reaches negative values. Ethical firms have difficulties; as soon as their firm-value goes down the threshold value ( $0.5 * \text{money-need}$ ) they die.

We let the simulation running up to 10000 ticks but the result does not change, as showed in Figure 10.3.

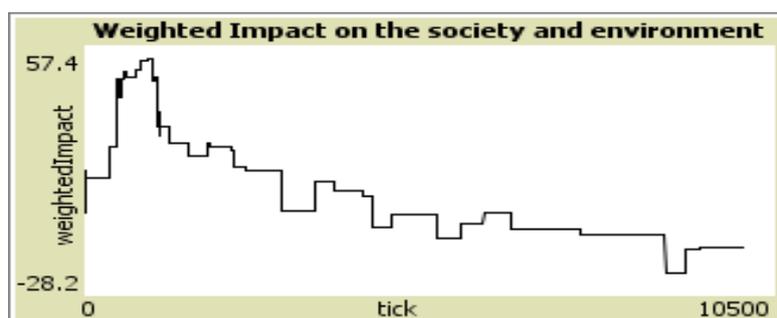


Figure 10.3: Scenario 1 - Weighted Impact plot after about 5000 ticks

After 10000 ticks the line report the value of -11,8.

We can conclude that in a world where the ethical banking sector does not

exists, the social-environmental impact of the firms sector is negative and it goes worst as time goes on.

### 10.1.2 Scenario 2: medium levels of ethics

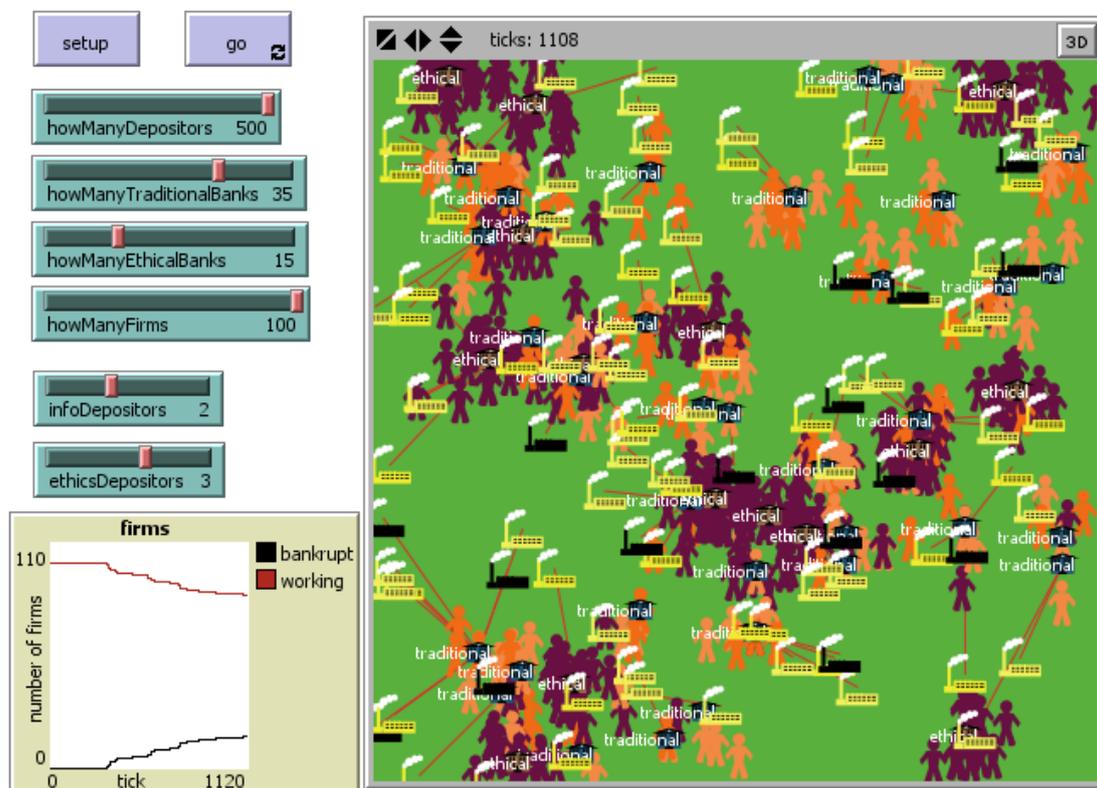


Figure 10.4: Scenario 2 - interface after about 1000 ticks

We change scenario trying to reproduce an environment nearer to our reality. We modify the banks proportions: ethical banks will be a smaller part while traditional banks will be the bigger part. We opt for 15 ethical banks and 35 traditional banks.

With the sliders we increase the levels of ethics and information among the population. We impose a value of 2 to ethic-level and 3 to info-level. We reproduce a population with a quite high level of ethic.

We observe the results of depositors interaction after 1000 ticks. Figure 10.5 shows how the number of ethical depositors (violet line) overcomes the

number of unethical depositors (orange line) yet after 500 ticks. Anyway it is also clear that the two lines are becoming parallel; it means that the number of ethical depositor becomes constant around 350 individuals. We can conclude that the levels of ethics and information assumed in this experiments lead to a good result from the ethical point of view; but they are not enough to convert the entire population to ethical behaviors.

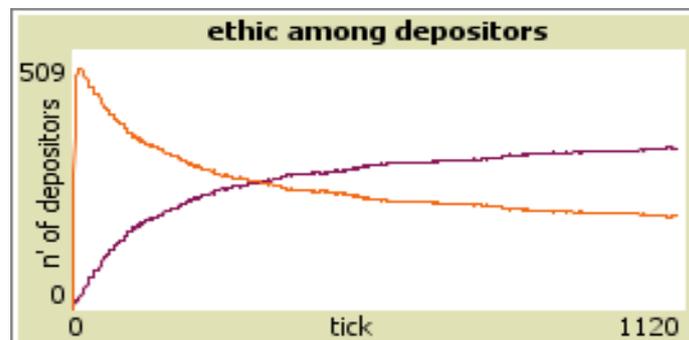


Figure 10.5: Scenario 2- ethci among depositors plot after 1000 ticks

The described outcomes are confirmed by the *in-money banks* plot (Figure 10.6):

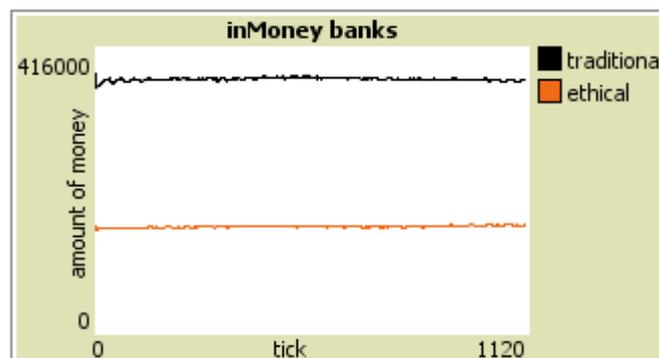


Figure 10.6: Scenario 2 - inMoney banks plot after 1000 ticks

The two lines representing the sum of all the banks-money are almost parallel. Ethical banks survive and increase a little bit their volume of money; but they are not able to overcome the traditional banks in the market.

The positive impact result is improved with respect to the previous scenario. Figure 10.7 shows that the weighted impact value remains always positive, but apart from an initial important increment (it reaches a positive value of 90), it fluctuates around a value of 20.

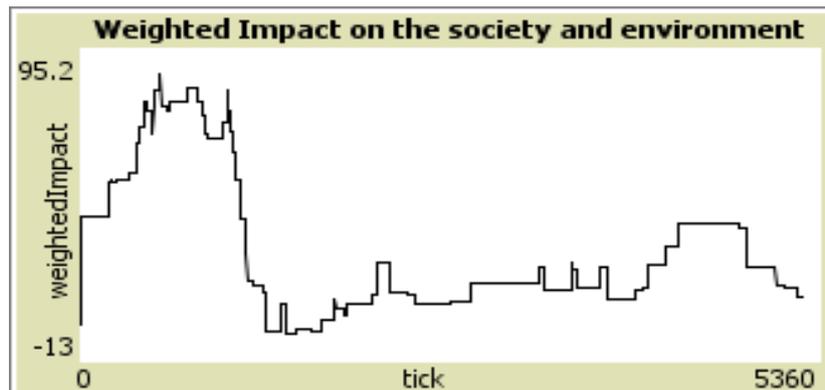


Figure 10.7: Scenario 2 - Weighted Impact plot after about 5000 ticks

### 10.1.3 Scenario 3: increased levels of ethics

We proceed making little changes to our model:

- we increase the number of ethical banks to 20 and we decrease the number of traditional banks to 30;
- we switch the slider of info-level to 3.

Our objective is to check if these few variations leads to different results.

From the depositors point of view we obtain similar results to the previous case: an increment of the ethical depositors number, up to reach the level of 350. Then the situation becomes stable and the two lines indicating the number of depositors run in parallel.

Relevant changes are recorded on the Weighted Impact graph. After 5000 ticks the average value of the positive impact is around 40 (Figure 10.8) :

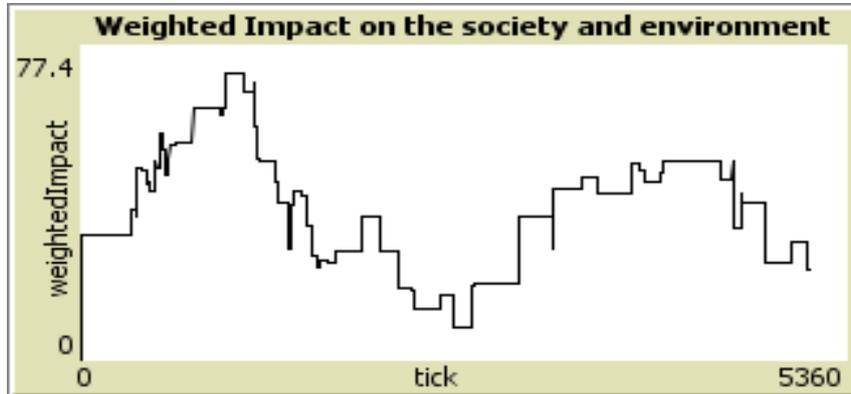


Figure 10.8: Scenario 3 - Weighted Impact plot after about 5000 ticks

The improvement is testified by the firms counters. Figure 10.9 reports the counters of firms linked to ethical banks and to traditional ones and the respective quantities of failed firms:

firms to ethical banks 31	firms to EB in bankrupt 12
firms to traditional banks 89	firms to TB in bankrupt 38

Figure 10.9: Scenario 3 - Firms counters

As we can observe, the number of firms bankrupt is higher for those related to traditional banks. The reduced number of traditional banks in the world can explain this phenomena. As more unethical firms fail, the positive impact of the firms sector increases. We have to underling that this result is smoothed by the assumption that not all the firms with positive impact apply to an ethical bank. The social-environmental score determines to which type of banks a firm applies to. If the se-score is higher than the financial index, the firm creates a link with an ethical bank. Otherwise the firm apply to a traditional bank. It may be the case that the firm has a very high se-index and an even more higher fin-index. In this case the firm has a positive impact on society.

When we observe traditional banks-linked firms failing, we have to consider the already mentioned case: they may be firms with a positive impact. The

phenomena is proved by the other firms-related group of counters (Figure 10.10).

firms with positive externalities 61	firms with pos. ext. in bankrupt 25
firms with negative externalities 59	firms with neg. ext. in bankrupt 25

Figure 10.10: Scenario 3 - Firms counters

Here the difference in the firms failure is not maintained. The number of firms in bankrupt is the same for both the categories, even if the percentage is slightly higher for firms with negative externalities.

#### 10.1.4 Scenario 4: increased number of ethical banks

We maintain the same info-level and ethic-level of the second scenario, but we increase the number of ethical banks. Now there exist 50 ethical banks in the world. We state before that creating the second scenario we tried to reproduce an actual situation. We use it as basis to develop different alternatives that may lead to an increasing ethical society. The solution proposed here can be interpreted as the limit case where all the banks convert themselves as more ethical institutions.

We report the results after 1000 ticks:

- the population is almost completely ethical (Figure 10.11):

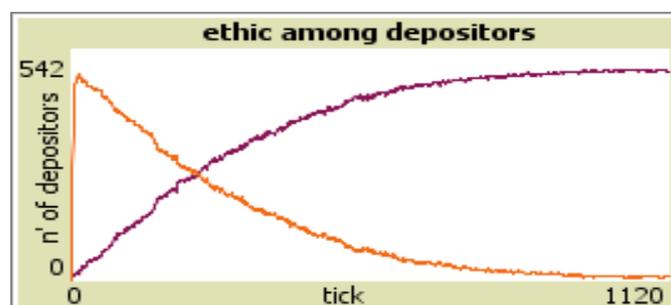


Figure 10.11: Scenario 4 - Ethic among depositors plot

- the lack of traditional banks leads to the failure of many unethical firms (Figure 10.12):

firms to ethical banks 25	firms to EB in bankrupt 3
firms to traditional banks 79	firms to TB in bankrupt 19

Figure 10.12: Scenario 4 - Firms counters

As the counters show, the percentage of failure of traditional banks-linked firms is widely greater compared with the case of ethical firms. As soon as a firm linked to a traditional bank needs to be financed in order to keep on working, it goes bankrupt. It does not exist a traditional bank that gives it a loan.

As explained before, also firms with positive externalities may incur in this situation; anyway the trend is confirmed by the second firms-related group of counters (Figure 10.13):

firms with positive externalities 50	firms with pos. ext. in bankrupt 7
firms with negative externalities 54	firms with neg. ext. in bankrupt 15

Figure 10.13: Scenario 4 - Firms counters

The number of failures among firms with negative externalities doubles the number of failures in case of firms with positive impact;

- the bankrupt of a high number of firms with negative externalities leads to an important positive impact of the firms sector on society (Figure 10.14):

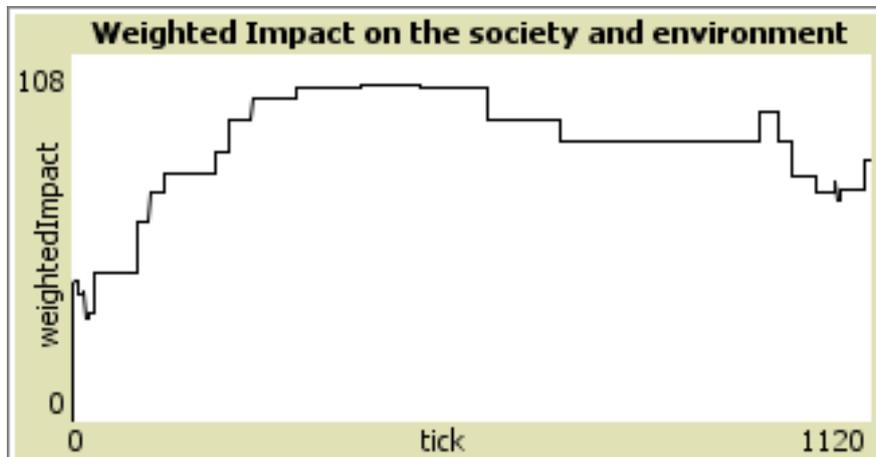


Figure 10.14: Scenario 4 - Weighted Impact plot

The plot shows as the value of the Weighted Impact has a rapid increment in the first 300 ticks. Then it follows fluctuating around a value of 85: it is widely positive.

Up to now it is the best result reached by our experiments from the Weighted Impact point of view.

### 10.1.5 Scenario 5: best environment from the ethical point of view

The fourth scenario is improved by imposing the maximum levels of ethics and information among depositors. The sliders are positioned on the value 5. For the other part of the set of hypothesis we confirm the agents quantities of the previous scenario.

We can observe from Figure 10.15 that the world is completely populated by ethical depositors:

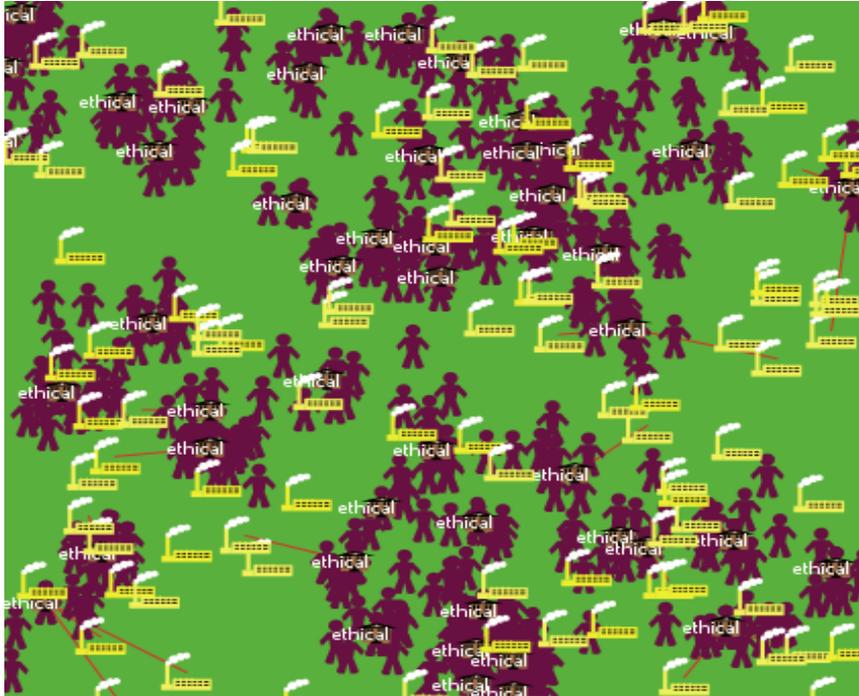


Figure 10.15: Scenario 5 - Worldview

This situation is reached after about 50 ticks, as confirmed by the *Ethics among depositors* plot (Figure 10.16):

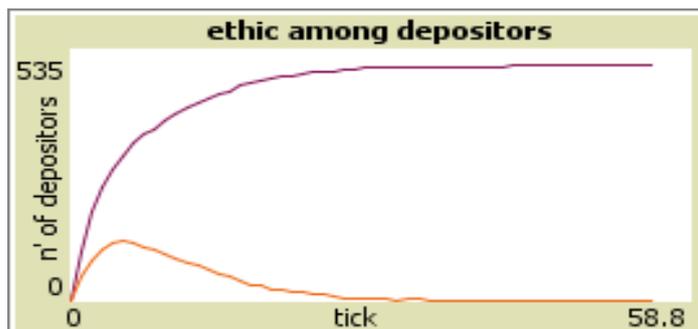


Figure 10.16: Scenario 5 - Ethic among depositors plot

The violet line representing ethical depositors rises exponentially to 500 (the total amount of individuals of the world). On the contrary, the orange line falls to 0. Initially both the line increase; this occurs because depositors become ethics or not when they have to choose a bank (referring to the model,

when they run the depositor-act procedure). But at each tick only the 60% of depositors compute the procedure depositor-act.

From the ethical point of view we obtain good results also considering the Weighted Impact; we report the plots and the counters after 1000 ticks (Figure 10.17)

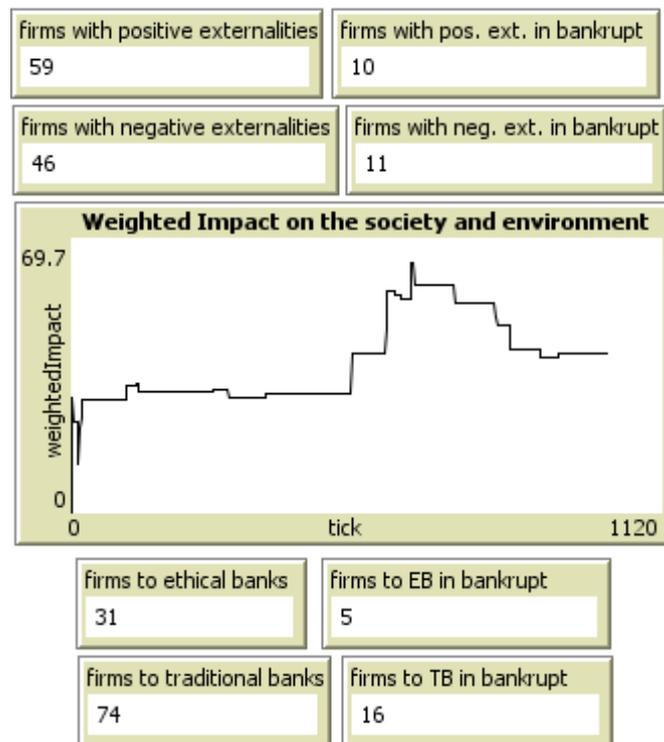


Figure 10.17: Scenario 5 - Interface

Both the groups of counters prove that respectively unethical and negative impacts firms suffer bankrupt; the phenomena affects weakly ethical firms and firms with positive impact. The situation leads to a positive impact of the firms sector on the society. The Weighted Impact value is always positive, reaching maximums of 63 and maintaining an average of 30.

## 10.2 The Medium Market environment

The medium dimension market is characterized by smaller quantities of agents; we divide the numbers of the Big Market, imposing:

- 250 depositors;
- 25 banks;
- 50 firms.

Our expectations are to obtain the same results of the Big Market, but with a dilation of the processes development time. Consequently to a decrease in the number of depositors, interactions between them will be less intensive. To observe the same results as in the previous market, we will have to run the simulation for longer time.

We do not reproduce the outer scenarios, considering exceptional those scenarios where only ethical or traditional banks exist. They correspond to Scenario 1 and Scenario 5 of the Big Market set of experiments. Furthermore, they are negligible with respect the objectives of our research.

### 10.2.1 Scenario 1: medium levels of ethics

This scenario is based on the same assumptions of the Big Market scenario *Medium levels of ethics*, but with a minor number of agents. We try to maintain the same proportions between ethical and traditional banks, opting for 5 ethical banks and 20 traditional ones .

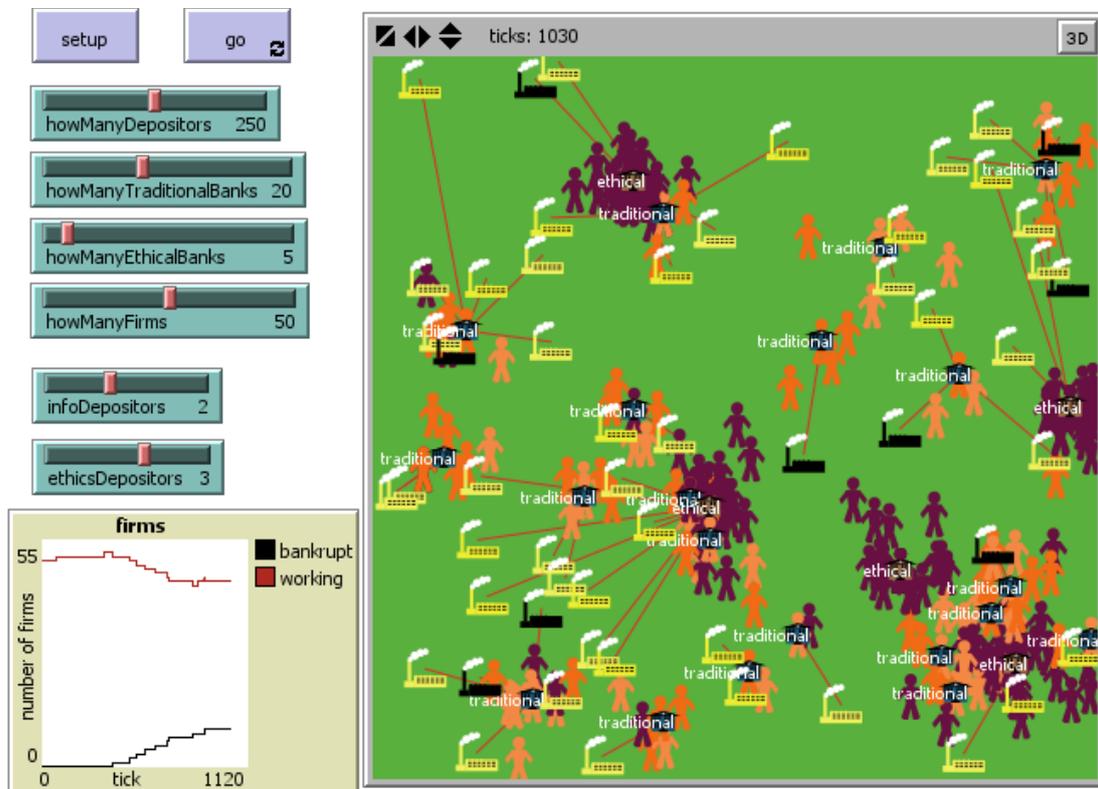


Figure 10.18: Scenario 1 - Interface

Similarly to our hypothesis we notice that the model realizes the same trend as in the compared scenario, but with longer times. Ethical depositors influence the ethical experience of unethical depositors; but with less frequent interactions they need more time to “convert” other banks customers. We can see clearly this situation matching the plot *Ethics among depositors* of the previous scenario (Figure 10.19 ) with the following one:

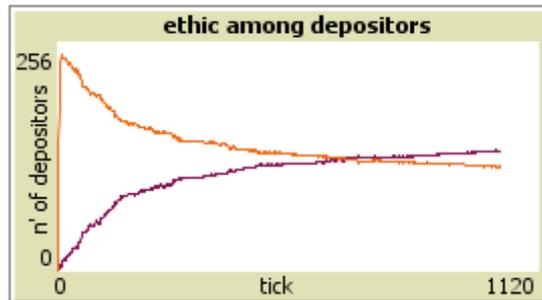


Figure 10.19: Scenario 1 - Ethic among depositors plot

In this case ethical depositors need 800 ticks to overcome the number of unethical ones. In the previous case 400 ticks were sufficient to get the same result.

From the Weighted Impact standpoint is recorded a positive value, as in the compared scenario. It presents an initial increment, reaching a high point of 68, and then it decreases maintaining an average value of 20 (Figure 10.20).

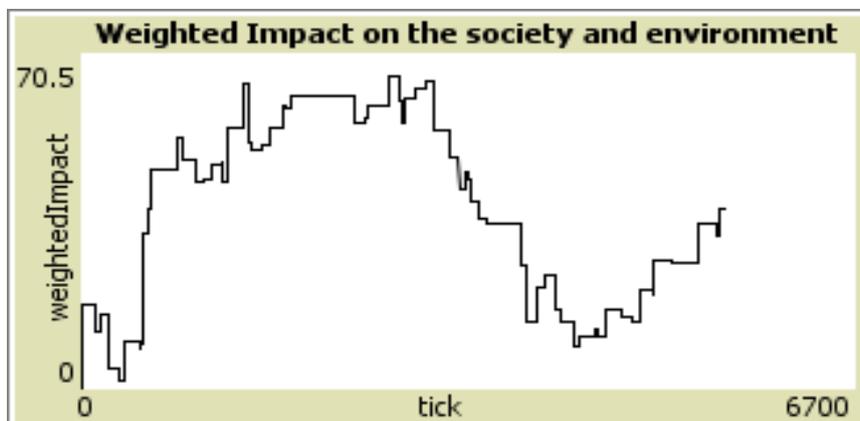


Figure 10.20: Scenario 1 - Weighted Impact plot

### 10.2.2 Scenario 2: increased levels of ethics

In order to compare this scenario with the *increased levels of ethics* of the Big Market environment, we make little changes to the previous scenario; now we have:

- 15 traditional banks
- 10 ethical banks
- 3 info-level

In the corresponding situation of the Big Market we notice that the numbers of depositors became constant. Initially there was an increment of ethical depositors and a deep reduction of unethical depositors. But after that the violet line overcame the orange line, the situation became stable.

Here the evolution is similar. As in the first scenario of the Medium Market, ethical depositors need more time to influence unethical ones. We could see clearly that after 5000 ticks the depositors behavior is still evolving, even if very slowly, as Figure 10.21 shows:

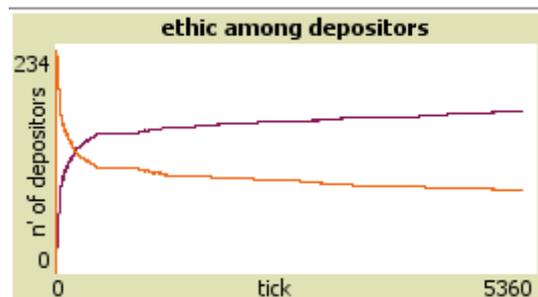


Figure 10.21: Scenario 2 - Ethic among depositors plot

To deeply analyze the evolution we run the model until 13000 ticks. The two lines diverge slowly until they reach the maximum values, respectively the 100% and the 0% of the depositors total quantity. Figure 10.22 shows that after 10000 ticks the process regain speed, completing the total passage to an ethical population.

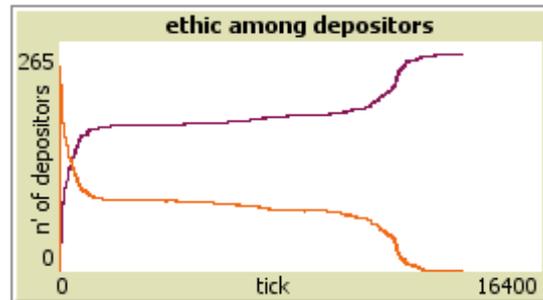


Figure 10.22: Scenario 2 - Ethic among depositors plot

The scenario leads to a quite ethical world, confirmed by the Weighted Impact plot. An info-level of 3 combined to an ethic-level of the same value brings depositors to ethical banks. Traditional banks have less in-money and can finance few “unethical” firms. This process causes a reduction of firms with a negative social-environmental impact, resulting a positive value of the Weighted Impact, as we can observe in the following plot (Figure 10.23).

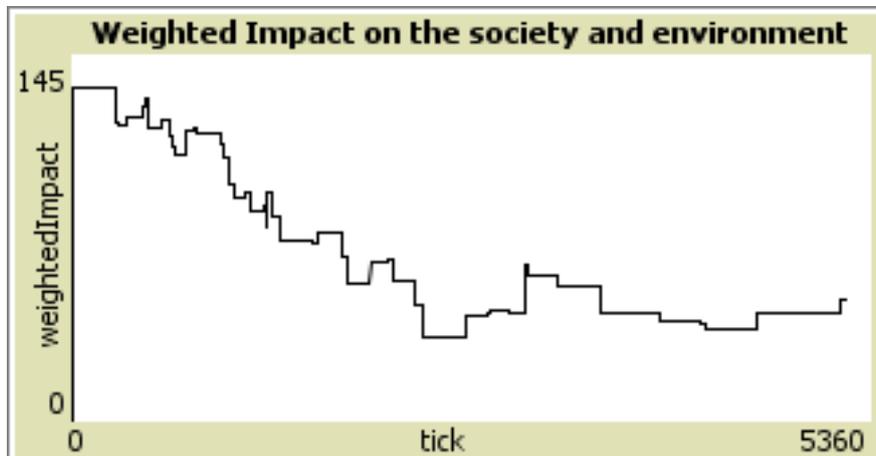


Figure 10.23: Scenario 2 - Weighted Impact plot

Anyway the initial high value of the Weighted Impact can be considered a bias for the result. It does not depend on the process just described, but it is due to the random generation of firms values.

### 10.2.3 Scenario 3: increased number of ethical banks

This is the last scenario of the Medium Market set of experiments; we report the initial conditions of the *Increased numbers of ethical banks* scenario (scenario 4) of the Big Market environment. The assumptions are:

- 25 ethical banks;
- 0 traditional banks;
- same info-level and ethic-level of the *medium levels of ethics* scenarios.

The results are analogous to the Big Market situation. The model reaches the completely ethical evolution; are necessary about 1600 ticks in order to convert all the depositors in ethical ones; this confirms the dilation of time previously explained (Figure 10.24).

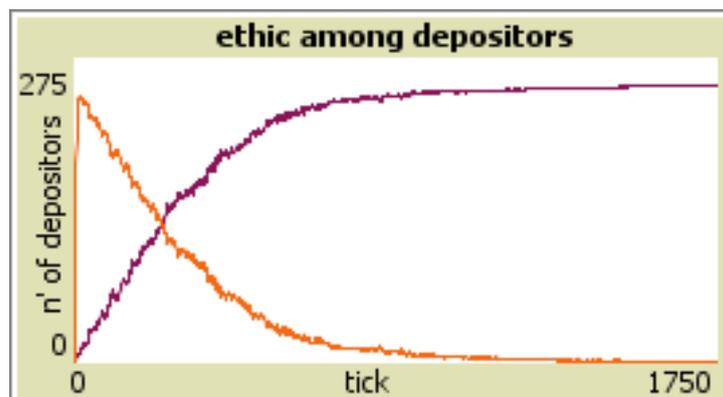


Figure 10.24: Scenario 3 - Ethic among depositors plot

Analyzing the Weighted Impact plot (Figure 10.25) we can observe the evolution from two standpoints:

- with respect to the correspondent scenario of the Big Market environment we get analogous results: the Weighted Impact value is always positive, maintaining a notable average;
- it realizes an improvement with respect to the Weighted Impact of the *Medium levels of ethics scenario* of the Medium Market environment, because it is more stable and it has a higher equilibrium point.

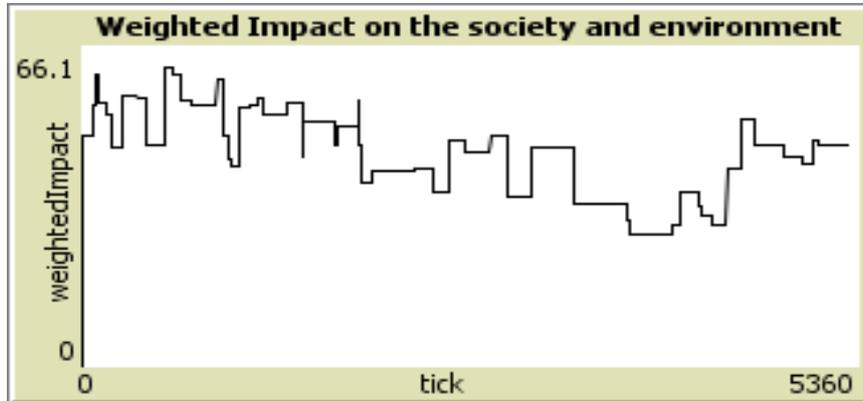


Figure 10.25: Scenario 3 - Weighted Impact plot

# Conclusions

My research is divided in two parts: an analysis of the current situation of the ethical banking environment and an exploration of its possible developments. Ethical banks have sprouted among the world founding many consolidated networks such as FEBEA, ENAISE and GABV, to support and sponsor the ethically oriented finance and the institutions sharing ethical finance principles. This class of banks is characterized by transparency in money-collecting activities and integrated judgment procedures, inspecting not only the creditworthiness of the activities requesting financing but also their social-environmental impact. Furthermore they sponsor and promote sectors such as non-profit associations, social and public services, fair trade and culture. I outlined the Italian ethical banking sector thoroughly studying the case of Banca Popolare Etica. I inspected its credit policy and its evaluation procedure: following the features of ethical banks, Banca Popolare Etica develops a social-environmental analysis in order to monitor the impacts of the financed projects.

After describing the present situation I explored the possible evolutions of the ethical banking system. I opted for Agent Based Modeling as a good tool to investigate the future developments. The main topic upon which I focused my model was the interaction between depositors, banks and firms. Interacting, agents exchange information and make money circulates, determining the evolution of the model to a more (or less) sustainable world.

Experiments were diversified for two environment: a crowded one and a smaller one. They lead to the same result, but, in the second case, less frequent interactions caused a delay in the phenomenon occurrence. It emerges that

sensible increments of the ethical level of depositors bring to higher incomes for ethical banks. Consequently, more firms with positive externalities are able to obtain loans facilitating their operations. On the contrary, traditional banks have more difficulties in having deposits and they can not grant funding. It results a positive value of the social-environmental impact of the firms sector on society. This is the case of the Scenario 2 of the Big Market Environment and of the first scenario of the Medium Market Environment. An increment of the ethical banks number brings to analogous outputs as well, as we can see in Scenario 3 and Scenario 4 of the Big Market Environment and in Scenario 2 and Scenario 3 of the Medium one.

The model I created is based on restrictive assumptions; for instance in the first versions I defined a detailed formula to determine the periodic firms income; it was depending on many indicators, such as the number of firms in the world (meaning the market competition) and the number of depositors (representing the market demand). In last versions this formula was substituted by a simpler one, because it seemed quite difficult to match it with the rest of the code. First of all the model can be improved refining the mechanisms upon which it is based: the economical features we considered were of basic-level; they can get more sophisticated.

Moreover, the model is characterized by random values, regarding interest rates, depositors incomes, deposited and lent sums, etc.. In this direction it can be improved substituting model data with real ones, for instance inserting real depositors data, cash flows and money movements. In this way it is possible to observe alternative evolutions of reality, particularly on a short time horizon; the model could become a monetary policy tool.

Otherwise the model can be used by a single bank to inspect its credit policy. The credit policy features can be compared with a larger banks context. For instance, if an ethical bank wants to grow, it can adapt the model following its own concerns. It can change some indicators like the interest rates or the boundaries for accepting firms to explore the banking sector reactions.

# Final version code

```
extensions [array]
breed [depositors depositor]
breed [banks bank]
breed [firms firm]
depositors-own[infoLevel ethicsLevel ethical money deposits
  depositVector ethicalexperience]
banks-own[seTest inMoney]
firms-own[moneyNeed se-index fin-index firmMoney debt int-rate
  positiveImpact weightedImpact se-weight]

to setup
  clear-all
  setup-patches
  setup-turtles
  reset-ticks
end

to setup-patches
  ask patches [set pcolor green]
end

to setup-turtles

  create-banks howManyTraditionalBanks
```

```
[set shape "building_institution"  
set color brown  
setxy random-xcor random-ycor  
ask banks[if any? other banks-here[move-to one-of  
  patches]]  
set inMoney 7000 + random 7000  
set color 93 set label "traditional"]  
ask banks[if any? other banks-here[move-to one-of  
  patches]]
```

```
create-banks howManyEthicalBanks
```

```
[set shape "building_institution"  
set color brown  
setxy random-xcor random-ycor  
ask banks[if any? other banks-here[move-to one-of  
  patches]]  
set inMoney 7000 + random 7000  
set label "ethical"]  
ask banks[if any? other banks-here[move-to one-of  
  patches]]
```

```
create-depositors howManyDepositors
```

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[set shape "person"  
set size 2  
set color orange + random 2  
setxy random-xcor random-ycor  
set infoLevel random-float 5 + infoDepositors  
set ethicsLevel random-float 5 + ethicsDepositors  
set money random 150  
set ethical nobody  
set deposits 0  
let howManyBanks howManyTraditionalBanks +  
  howManyEthicalBanks
```

```

    set depositVector array:from-list n-values howManyBanks
      [0]
    set ethicalExperience 1
  ]

create-firms howManyFirms
  [set shape "factory"
  set size 2
  set color yellow + random 2
  setxy random-xcor random-ycor
  set firmMoney random 3000
  set se-index random-float 10
  set fin-index random-float 10
  set moneyNeed 3000-random 2000
  set positiveImpact 0
  set weightedImpact 0
  ]

end

to go

ask depositors [ifelse random 100>60
  [depositorAct]
  [forward random 2 left random 360]
  set money money + random (money/10)-random
  (money/10)
  depositors-interaction]
ask firms [ifelse debt<5*moneyNeed and firmMoney>0
  [set firmMoney (firmMoney + random 50-random 50)
  firmAct
  if firmMoney<(0.5*moneyNeed) [ask-for-a-loan]
  if debt>0 [ifelse positiveImpact = true
    [ethical-moving-money]

```

```

                                [traditional-moving-money]]
set se-weight se-index-5
set weightedImpact se-weight*moneyNeed/1000

[set color black
set weightedImpact 0]]

if random 200>198 [createFirm] ;creating new firm

ask banks [if inMoney<-5000
           [die]]

tick

end

to depositorAct

  ifelse random 100<85 [ifelse
    infoLevel*ethicsLevel*(1.1-random-float
    0.2)*ethicalExperience>49
      [set ethical true
set color 123
ifelse any? banks with [label =
  "ethical"]

      [move-to one-of banks with
        [label = "ethical"]]
      [ifelse any? banks with [label
        = "traditional"]
        [move-to one-of banks with
```

```

        [label = "traditional"]]
    [forward random 3 left
     random 360]]]

[set ethical false
ifelse any? banks with [label =
 "traditional"]
 [move-to one-of banks with
  [label = "traditional"]]
 [ifelse any? banks
  with [label = "ethical"]
  [move-to one-of banks with
   [label = "ethical"]]
  [forward random 3
   left random 360]]]]]
[if min-one-of banks [distance myself]
 != nobody
 [move-to min-one-of banks [distance
 myself]]]

if any? banks-here [if money>150
 [let myDeposit money*0.1
 set money money-myDeposit
 set deposits deposits + myDeposit
 ask banks-here [set inMoney inMoney +
 myDeposit]
 let a first [who] of banks-here
 array:set depositVector a (array:item
 depositVector a + myDeposit)]

if money<50
 [let a first [who] of banks-here
 if array:item depositVector a>0

```

```

        [let myWithdraw array:item
          depositVector a
          set money money + myWithdraw
          set deposits deposits-myWithdraw
          ask banks-here [set inMoney
            inMoney-myWithdraw]
          array:set depositVector a (array:item
            depositVector a-myWithdraw)]]]
end

to depositors-interaction
  forward random 2 right random 360
  let speaker one-of other depositors-here
    if speaker != nobody
      [ifelse [ethicsLevel] of speaker>5

        [if ethicalExperience<10 [set ethicalExperience
          ethicalExperience + 0.05]]
        [if ethicalExperience>0 [set ethicalExperience
          ethicalExperience-0.05]]]
end

to createFirm

create-firms 1
  [set shape "factory"
  set size 2
  set color yellow
  setxy random-xcor random-ycor
  set moneyNeed random 3000
  set se-index random-float 10

```

```
    set fin-index random-float 10
    set firmMoney 3000-random 2000
    set positiveImpact 0
    set weightedImpact 0]
end

to firmAct

let ethic-score se-index-5 + (fin-index/2) ; creating link
    between bank and firm
ifelse ethic-score<fin-index

    [set positiveImpact false
    if any? banks with [label = "traditional"]
        [create-link-with min-one-of banks with
            [label = "traditional"] [distance myself]
        [set color red]]
    if fin-index<4 [set int-rate 0.006]
    if fin-index>4 and fin-index<8 [set int-rate
        0.004]
    if fin-index>8 [set int-rate 0.002 ]]

    [set positiveImpact true
    if any? banks with [label = "ethical"]
        [create-link-with min-one-of banks with
            [label = "ethical"] [distance myself]
        [set color red]]
    if ethic-score<4 [set int-rate 0.003]
    if ethic-score>4 and ethic-score<8 [set
        int-rate 0.002]
    if ethic-score>8 [set int-rate 0.001 ]]
```

end

```
to ask-for-a-loan
```

```

let loanAmount moneyNeed-firmMoney
let check-bank-reserve 0 *
ask my-links [ ask other-end [set check-bank-reserve
  inMoney]]
if loanAmount<(check-bank-reserve*0.7)

```

```

  [set firmMoney firmMoney + loanAmount
  set debt debt + loanAmount
  ask my-links [ask other-end [set inMoney
    inMoney-loanAmount]]]

```

```
end
```

```
to ethical-moving-money
```

```

set debt debt*(int-rate + 1)
ifelse debt>firmMoney/70

```

```

  [let payBack firmMoney/70
  set debt debt-payBack
  set firmMoney firmMoney-payBack
  ask my-links [ ask other-end [ set inMoney inMoney +
    payBack] ] ]

```

```

  [let payBack debt
  set debt debt-payBack
  set firmMoney firmMoney-payBack
  ask my-links [ ask other-end [ set inMoney inMoney +
    payBack]] ]

```

```
end
```

```
to traditional-moving-money
```

```
set debt debt*(int-rate + 1)
ifelse debt>firmMoney/50

  [let payBack firmMoney/50
   set debt debt-payBack
   set firmMoney firmMoney-payBack
   ask my-links [ ask other-end [ set inMoney inMoney +
     payBack]]]

  [let payBack debt
   set debt debt-payBack
   set firmMoney firmMoney-payBack
   ask my-links [ ask other-end [ set inMoney inMoney +
     payBack]]]
end
```

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