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Retirement Systems, Demography, Happiness and Welfare Redistribution

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Retirement Systems, Demography, Happiness and Welfare Redistribution[*†]

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Abstract

This research investigates whether an equity improvement within retirement-systems domain may positively influence demography, people's happiness and their financial conditions. In particular, a fertility-boosting policy has been tested, acting on the contributory rate.

This project has been carried out by using software simulation and with specific Agent-based Computational Economics (ACE) methodology. Two virtual worlds have been created, in order to try to reproduce Italian society. In the first model, (W1), vertical equity has been improved, while in the second one, (W2), it is has not. Five further variants of these two worlds have been produced by altering some parameters, in order to test our hypothesis through several simulations.

The research outcomes prove that an equity improvement can positively influence demographic trends, can increase the level of happiness in the society, and can grant a more homogeneous welfare redistribution.

Keywords

Retirement systems, demography, happiness, wealth distribution, equity, software simulation, Agent Based Computational Economics.

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1. Introduction

Nowadays, in European countries, retirement systems are burdened by a serious crisis. In particular, the ageing of society, the decline of fertility, and the expected growth of the dependency ratio[‡], suggest that the financial sustainability of pay-as-you-go systems requires close attention. Thus, to suitably face these problems, in the vast majority of modern countries, retirement systems have adopted policies to strengthen the link between contributions paid and benefits received. and have tried to provide incentives to work longer (Commission of the European Communities 2006).

Many European governments place great emphasis on the contribution which privately- funded provision can make in ensuring adequate retirement incomes, emphasising the positive role of diversification of the demographic risk between public and private schemes. However, funded systems will also be affected by population ageing. Furthermore, the effectiveness of these systems strongly depends on the existence of profitable markets, where contributions paid by workers and money saved in private retirement plans may be invested in. When economies are in crisis, like in these years, there are not so many good investment opportunities and the long-term financial sustainability of the aforesaid models is critical.

The crisis perceived in the economies of several countries of EU-25, is also due to demographic trends. Indeed, the decline of the Total Fertility Rate (TFR) and the ageing of society are causing the decline of both the productive power and consumptions. In a recent survey, the European Commission claims that in EU-15, the annual labour productivity growth decreased from 2.3 in 1990-95 to 1.7 in 1995-2001 (European Commission 2003).

Immigration could help governments in solving these problems, but that requires investment in a lot of resources. Thus, policies to boost fertility are needed to improve financial sustainability of the retirement systems and to encourage the economic growth.

A fundamental principle of modern tax-sharing systems concerns equal contributory power, and it asserts that the taxes required to finance public expenditure must be proportional to people's contributory power. This assumption is based on two equity criteria. The first regards vertical equity and claims that individuals who have high contributory power should pay more taxes than those with low contributory power. The second is related to horizontal equity, and states that the amount of taxes to be paid should be the same if people have equal contributory power.

The contributory power represents one's ability to produce wealth. Unfortunately, this kind of ability is not measurable, so governments consider income and consumption to compute it.

This project concerns retirement systems domain and investigates, through software simulation, policies aiming at improving horizontal equity. The equity goal, indeed, may be reached not only within the tax system, but also in other domains. Our aim is to understand if demographic trends, happiness and people's financial conditions may be positively influenced by retirement systems' policies designed to grant a higher level of equity.

2. Hypothesis and Methodology Adopted

Retirement systems originally implemented after the Second World War, were based on an intergenerational agreement which establishes that workers' Social Security contributions must be immediately used to pay the retirement benefits of the elderly. Acting in this way, no stocks are created, and one's Social Security contributions are not used for one's pension. They only grant workers the right to receive retirement benefits in their old age.

Pay-as-you-go systems are funded on the basis of this agreement, and can work properly only if there are many more workers than pensioners, as was the situation some decades ago. Nowadays, the situation has greatly changed. The substantial growth of life expectancy and the fact that TFR is much lower than that needed to grant population replacement[§], are causing the ageing of society. In

[‡] Population aged 65 or more related to number of people employed.

[§] To grant population replacement, TFR should be equal to, or greater than, 2.1.

particular, between 2004 and 2050 in EU-25, life expectancy is thought to increase by 7 years for men (from 73,7 years to 80,5 years) and by 5 years for women (from 80,4 years to 85,6 years). TFR, instead, is expected to remain very close to the current value of 1.5 (Commission of the European Communities 2006).

Furthermore, over the next decade, the working-age population will begin to decline when a large number of *baby-boomers* retire. Consequently, according to the latest demographic projections, between now and 2050 the economic dependency ratio is expected to grow from 37 to 70. This would mean that, while there are currently almost 3 workers for each pensioner, in 2050 there would be only 1.4 workers per pensioner (European Commission 2006). Thus, the level of contributions will diminish, while the years in receipt of benefits will increase.

In order to deal with demographic developments, pension reforms have strengthened the link between contributions paid and benefits received. However, this may not be sufficient. Both the pay-as-you-go systems and the contributory ones require positive economic trends in order to work properly, while demography nowadays is negatively influencing productivity and consumption.

Within this context, children are a very precious resource for society and, obviously, families that are numerous participate more intensely in the intergenerational agreement than those without children. Moreover, having children implies expenditures which negatively affect families' income. Hence, for the same level of gross income, a family with children has a lower contributory power than a family without children. In light of these considerations, if vertical equity were granted, then Social Security contributions would be lower for numerous families, which is not the case in Europe.

The goal here is to experimentally study the consequences of an equity improvement of the contributory system on demography, happiness and families' income. In particular, we investigate if such improvement can positively modify the demographic trends emerging from several official reports (Commission of European Communities 2006, European Commission 2006).

The economic sphere has generally seemed to be ineffective in influencing demographic trends. However, according to De Santis and Breschi (2003), this conclusion is not necessarily true. Fertility can be positively affected by economic stimuli even though the causes of its decline are different.

Simulation and, in particular, the ACE technique, is the analytical approach here used. ACE may be useful because one of its main objectives is normative understanding (Tesfatsion 2005). In particular, ACE allows the computational study of economies modelled as evolving systems consisting of heterogeneous agents. The ACE designer specifies the initial state of the economy and the agents' attributes. The economy then evolves over time without further intervention of the engineer, who has only to evaluate the output produced. Furthermore, once the model has been built, it is possible to test several hypotheses and different landscapes by changing parameters or agents' attributes.

The research has been carried out through the following steps. At the beginning, two virtual realities have been developed in the attempt to reproduce the Italian retirement system. To change the geographical context, it is sufficient to update a set of parameters.

The two models have exactly the same features, except for the management of retirement contributions. In W1, contributions diminish as the number of children living in a family increases, while in W2 the contributory rate is the same for everybody and corresponds to 35% of the gross income.

Subsequently, five alternative hypotheses have been considered by changing the importance given to children within a society and the average costs that a family has to face for each child. These alternatives have been implemented by tuning the proper parameters in W1 and in W2.

Finally, simulations have been carried out and the output data have been collected and analysed. Through a descriptive analysis, what may be inferred about demography, happiness and wealth distribution has been investigated by observing the output data. Then, a more critical inquiry has been developed using linear regressions, to understand the role of income and children in determining families' happiness.

3. The model: structure

The retirement system models needed for simulations have been implemented using SWARM, an object-oriented language widely adopted by ACE researchers.

Here W1 is described. With the exception of the aforesaid difference, W2 has the same software design and structure as W1.

The virtual world developed is an extremely simplified version of reality. To grant order and modularity, it has been conceived by following a scheme suggested in the literature (Terna 2006). This model reproduces the Italian population's characteristics, laws and demographic trends.

To transform the ideas of agent-based simulations into executable code, the literature has provided several schemes, from which we have chosen the one of Terna (2006) to define our retirement system model.

Terna's proposal is called *Enviromental-Rules-Agents* (ERA) scheme, and is represented in Figure 3.1. What Terna has done is to manage the development of the model and of its agents through four distinct layers.

The first level is the environment where agents interact, and it corresponds to the class *ModelSwarm* within SWARM protocol. In this context, agents are defined, lists are structured, events are scheduled and rules of interaction are clarified with respect to the methods of the objects created in the model. The second layer is dedicated to agents, while the third one specifies the ways through which agents decide their behaviour. For every decision, actors have to query the *Rule Master*, communicating to it the necessary data and obtaining the desired information. Finally, in the fourth layer, rules are created by generators placed in classes usually called *Rule Maker.* Generators are queried by rule masters, which have to help agents to define a proper way of behaving.

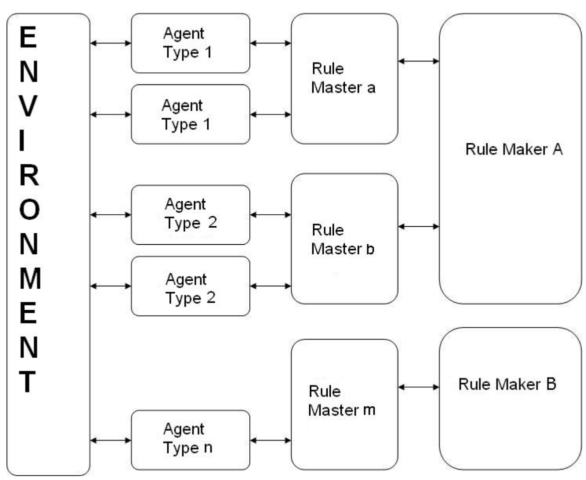

Figure 3.1 ERA Scheme (Terna et al. 2006, pag.27)

The ERA Scheme aims at making the simulation code clear, simple and modular.

The implemented model is somewhat similar to the one proposed by Terna, and is organised as shown in Figure 3.2. The first level is called *Observer Swarm* and is used to show the output of the model. The second layer, called *Model Swarm*, is the environment of virtual reality, while the third one is composed of all the different classes of agents.

The model which we have developed is a simplified ERA version. We decided to eliminate the *Rule Master* and the *Rule Maker* because, in our model, agents operate without invoking other agents to mediate decision processes. The *Rule Maker* may be considered as a heuristic function which manages agents' decision-making processes. The *Rule Master* instead, can be seen as a set of heuristic functions which are activated to let agents carry out their tasks. If there is no proper heuristic function to solve an agent's behavioural problem, it will be created by the *Rule Maker*. These kinds of features have not been implemented in our model because our agents have a limited set of alternative behaviours and they have few alternative choices.

In the following sections the structure of each layer of our model will be described in detail.

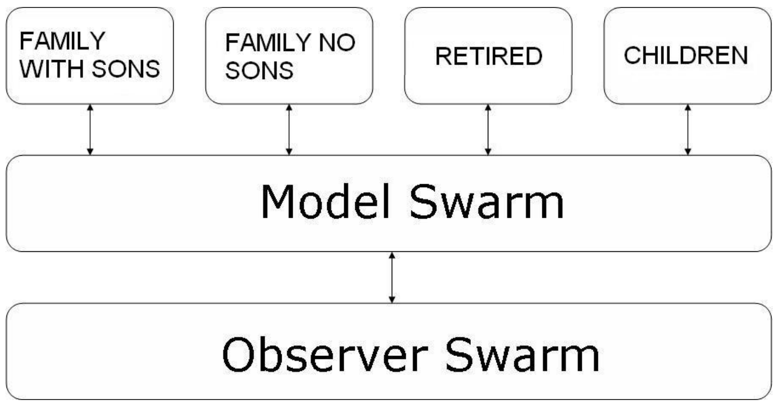

Figure 3.2 Retirement System Schema

3.1 Observer Swarm

Observer Swarm manages the graphic interface and the output visualization.

When the software is launched, a panel (Figure A1.1) allows the user to set the initial values of the variables. If no setting is specified, the default values will be used. In this phase, two further masks appear on the screen. The first mask (Figure A1.2) is used to set the frequency of visualization of the data trends, while the second (Figure A1.3) allows one to control the execution of the programme.

Furthermore, several windows appear on the screen to show the trends of the numerousness of agents (Figure A1.6), and of the average income (Figure A1.4) and happiness (Figure A1.5) of families with children and of the ones without children. Besides the trend visualization, some bar charts (Figure A1.7-9) show the values of the variables of interest in each run of the execution.

3.2 Model Swarm

Model Swarm represents the environment where agents live and interact. The most important parameters of the model, such as:

- The numerousness of actors in the virtual world;
- Income of families and of pensioners;
- Duration of working life required to receive retirement pension;
- Age at which youths start looking for a partner and for a job;
- Expenditures due to children. It should be taken into account that this kind of costs are not subject to economies of scale, so every baby will require the same amount of income (Perali 2005);
- Taxes;
- Contributory rate;

may be exogenously set to properly describe the context analyzed. To simplify the model, absence of inflation has been assumed.

After the initial phase, *Model Swarm* carries out the same sequence of steps at every run of the application. Each step will now be described, following the order established in the software.

Initially, using the function `endPens,` the system checks if there are pensioners who will die in the current run. ISTAT data (represented in Table 3.1) have been used to calculate the probability of death related to each agent.

Age	Deads	Total	Death Rate	Probability of Death
0-0	2182	527468	413,674	0,41%
1-4	402	2103859	19,108	0,019%
5-9	327	2664493	12,279	0,012%
10-14	379	2882686	13,38	0,013%
15-19	1092	2921135	37,383	0,037%
20-24	1724	3344108	51,553	0,051%
25-29	2292	4171717	54,941	0,054%
30-34	2817	4546683	61,957	0,061%
35-39	3908	4681288	83,481	0,08%
40-44	5298	4160032	127,355	0,1273%
45-49	7529	3779228	199,221	0,1992%
50-54	12070	3795411	318,016	0,3180%
55-59	17745	3408656	520,586	0,5205%
60-64	27998	3442709	813,255	0,8132%
65-69	41288	3091842	1335,385	1,335%
70-74	63081	2816955	2239,332	2,23%
75-79	88521	2297421	3853,06	3,853%
80-84	87993	1355136	6493,297	6,49%
>85	189021	1216575	15537,137	15,53%

Table 3.1 Italian death rate in 2002

In order to explain more clearly the way the death of pensioners has been dealt with, a simple example is proposed here:

Let X be a seventy-two-year-old agent. The software links X to her death probability *p*, which corresponds to 2,23%, and randomly draws a number *r* from a uniform distribution in the range [0,100]. Then, the system subtracts 2,23 from 100. If *r* is smaller than 98, X will survive, otherwise she will die. This process reproduces in the model what is claimed by ISTAT data and, indeed, the death probability of X is 2%.

The same process is applied to the other age ranges, excepting the lower one, which groups people aged 65-69 years. It has been assumed that people do not die before retirement. Thus, premature deaths are managed by increasing the chance of dying between 65 and 69 years of age.

After having managed the pensioners' dying, *Model Swarm* handles new births invoking the function `creaFigli`.

According to recent ISTAT estimates (ISTAT 2005), shown in Table 3.2, in Italy there are 1,33 children for every woman and the fertility boundary is generally fixed between 15 and 49 years. The Italian birth rate is very low because of the progressive drop in births during the last century. After a short period of upswing, during the *baby boom* in the early Sixties, there was a long phase of decline of fertility, which reached its minimum point in 1995 with 1,19 children per woman. However, starting from the Nineties, there has been a slight increase in the fertility rate.

This decline is also related to significant changes in the temporal modalities chosen by couples to procreate. Nowadays, women tend to delay the birth of their first-born until they are thirty years old. Furthermore, demographic trends have greatly transformed the average composition of Italian families and the predominant model seems to be the *only child* one. Indeed, the fertility crisis does not seem to have an impact on the first-born's birth because Italian women show that they are greatly prone to becoming mothers, even though they desire only one child.

Keeping these phenomena in consideration and aiming at developing a model as close to reality as possible, ISTAT (2001) data have been used to establish the probability of procreating associated to an object `Fam1`.

CHILDREN	COUPLES	% COUPLES WITH CHILDREN	PROBABILITY OF HAVING CHILDREN
0	4.755.427	33,89%	--
1	4.216.946	30,05%	100%
2	3.912.526	27,88%	54,51%
3	959.509	6,83%	12,23%
4	147.442	1,05%	0,18%
5	27.518	0,19%	0,028%
6 or more	10.001	0,0007%	0,0001061%

Table 3.2 Data from Italian census of 2001 (ISTAT 2001)

Moreover, it has been checked when the Italians generally decide to procreate and it has been discovered that women's education and job have a strong impact on reproductive choices. Of course, the most evident effect is the postponement of the first-born's birth, as shown in Table 3.3.

MOTHER'S AGE	JOB		EDUCATION LEVEL	
	EMPLOYED	UNEMPLOYED	AVERAGE-HIGH	LOW
Until 25	14,3%	35,1%	18,0%	36,5%
Until 30	51,8%	72,5%	58,6%	69,8%
Until 35	87,3%	92,5%	88,6%	92,0%

Table 3.3 Percentage of first-born births summed up until the age of 25, 30 and 35 and grouped by mothers' job and education level in 2005 (ISTAT 2005, p. 6)

Following the trends shown, the aforesaid fertility boundary has been reproduced in the model, and objects `Fam1` wait to be almost thirty years of age before having a child.

Once the proper age has been reached, a random number r is drawn from a uniform distribution in the range [0,1]. If the probability p of having a child, taken from Table 3.2, is greater than r, there will be a new birth, otherwise there will not.

As far as families which do not want children (`Fam2`) are concerned, it has been hypothesized that a new birth could occur only by accident and not as a consequence of a rational decision. Thus, `Fam2` may unintentionally procreate at every age within the fertility boundary. The birth process remains the same, excepting p, which in this case is 0.1%.

After handling the new births, taxes and Social Security Contributions are calculated.

Families have to pay a tax, which ideally represents how much every single person costs to society. The calculus of Social Security contributions, instead, is a very important point of focus here. Our study tries to investigate if an equity improvement may positively influence the demographic trends of a country, paying particular attention to birth rate, salary and happiness. To test this hypothesis, it has been tried to act on Social Security contributions.

Nowadays, Social Security contributions are not related to the number of children living in a family, and this research inquires into the possibility to establish different contributory levels depending on the numerousness of children in a family.

In order to continue working properly, retirement systems require a high birth rate, but a good TFR is also needed to boost productivity and consumptions, and to stimulate the economic growth. Thus, children are both a precious resource for society and a relevant expenditure for families. The families which have children contribute more to the intergenerational agreement than those who do not, and they benefit from a smaller contributory power because children have a negative impact on their salaries. Hence, a contributory relief for families with children may improve vertical equity.

In light of these considerations, the management of contributions within this system rewards families with children and penalizes the ones without children. In particular, there is a base contributory rate of 35%, a percentage which will be increased or reduced depending on the number of children living in a family, acting as specified in the following table:

NUMBER OF CHILDREN	SOCIAL SECURITY CONTRIBUTIONS
No children	`wage*((contributoryRate + 12) * 0.01)`
1 child	`wage*((contributoryRate - 13) * 0.01)`
2 children	`wage*((contributoryRate - 14) * 0.01)`
3 children	`wage*((contributoryRate - 15) * 0.01)`
4 children	`wage*((contributoryRate - 16) * 0.01)`
5 children	`wage*((contributoryRate - 17) * 0.01)`
More than 6 children	`wage*((contributoryRate - 18) * 0.01)`

Table 3.4 Social Security contributions which a family has to pay depending on the number of children.

The contributory rate has been calculated, as shown in Table 3.4, through a process of fine tuning. Proceeding by trial and error, we have established the proper Social Security Contributions rate to get from families without sons exactly the wealth which they would have saved avoiding to procreate (20% net income, Perali 2005).

Contributions are collected in a pension fund which is used to pay current pensions and to save extra contributory yield for the future. If the gathered wealth is not sufficient for granting the current pensions, taxes will be increased to cover the deficit and to comply with the intergenerational agreement. It is clear that in this kind of economic system, the demographic risk *in toto* lies on current workers, who, if necessary, will have to pay more taxes to grant the pensions of the elderly.

The retirement benefit corresponds to 60% of workers' salary, which in this simplified reality is supposed to remain constant during the whole life-cycle.

Then, the age of every agent, the new net salary, the families' happiness level and the graphs are updated.

The software carries on managing the birth of new families. The main task of this function is to identify when children become independent and start working.

Similarly to what emerges from ISTAT (2001) statistics, in the software, agents try to start working when they are 23 years of age. Nevertheless, they may have to wait a short time before finding a job, because also frictional unemployment has been implemented in the model.

At the same age, they look for a partner, even though they will wait until they are 30 years of age to marry and have children. When two agents decide to get married, they will have to choose whether to create a `Fam1` or a `Fam2`. This choice will be influenced both by one's preferences and by the level of happiness reached by families with children and by the ones without children. For example, if families with children are happier, it will be more likely that the new family will have children too. In fact, in the software, as well as in reality, agents' choices are affected by what happens in the world in which they live.

The software then proceeds to check who is going to become a pensioner. To simplify the model, both members of a family retire at the same time.

Agents have to work for 40 years before retirement. When a family retires, it communicates to all its children that it will not financially support them any more and two new pensioners are created.

After these steps, *Model Swarm* saves all the modifications produced.

3.3 Agents

As mentioned above, the software consists of four types of agents, which will now be described in detail.

The first class of agents analysed is the one which gathers together families without children. This kind of family represents couples of agents who do not want to have children.

Every family without children is an object of the class `Fam2` and its attributes are:

- The age, used to calculate the years of contributions and to establish when it is possible to have a child;
- The net salary obtained by subtracting from the gross income taxes, social security contributions and costs related to children;
- The level of happiness.

As far as the level of happiness is concerned, there are several ways of measuring Self Well Being (SWB).

Economists typically adopt the view that happiness depends on actual life circumstances and that it can be inferred by simply observing such circumstances. At most, this view measures peoples' SWB by calculating their wealth and by believing that if people have more goods they must be better off. Clearly, economists recognise that SWB is influenced also by other circumstances apart from the mere amount of money, but they assume that a substantial increase in wealth implies an increase of SWB as well.

Over the past thirty years, there has been a gradual accumulation of evidence which contradicts this view, like the Chinese trend of SWB measured between 1994 and 2005. Even though Chinese salaries have increased by 250%, people seem to be less and less happy (Kahneman and Krueger 2006).

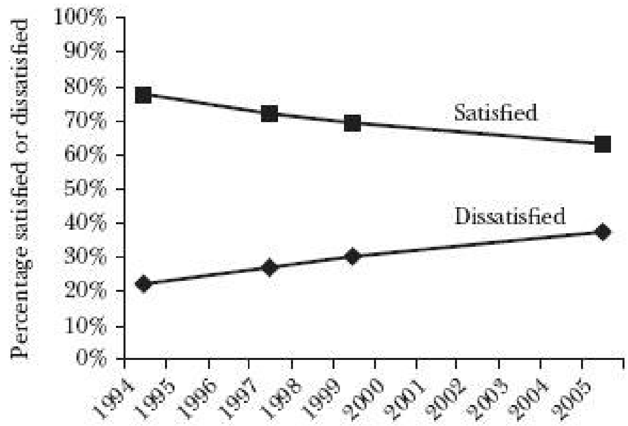

Figure 3.3 ***Life satisfaction*** **in China (Kahneman and Krueger 2006, p. 16)**

In general, as has emerged from several surveys, limited agreement has been reached concerning the way happiness varies during the human life-cycle. However, Kahneman and Easterlin's views have been chosen and merged within this model since they are quite similar, because they consider both economic and psychological aspects, and because they develop some interesting ideas which are widely accepted within certain domains.

Kahneman and Krueger (2006) claim that the impact which life circumstances have on SWB, is mitigated by psychological processes through which people level off peaks and dips due to peculiar events. This model, known as the *set-point model*, has been widely accepted by researchers and supports the hypothesis that happiness tends to stabilize at a level related to personality and genetic inheritance. Life circumstances, like a wedding or a disease, can only temporarily change the SWB level, which will soon return very close to the original value. Kahneman and Krueger (2006) mention, as examples, lottery winners or paraplegics, whose happiness, after a great change, returns quite close to the original level within two years after the occurrence of the circumstance which has changed their life.

Such transitoriness is called *hedonic treadmill* and has been justified by conceiving the hedonic treadmill as an *aspiration treadmill*. According to this idea, people dynamically adjust their aspirations, depending on the utility level which they reach everyday. Hence, an increase of utility may not imply a higher level of satisfaction (Kahneman and Krueger 2006).

Furthermore, Easterlin (2006) points out that happiness level is strongly related to agents' age. Indeed, according to him, SWB increases until it reaches its peak when people are middle-aged, and then it starts to decrease[**].

In our model, the happiness function operates in agreement with these theories and, in particular, according to a research carried out by Easterlin (2006) that we used to define SWB. Happiness is conceived as the result of the aggregation of life satisfaction, perceived within some domains of interest, and the outcome is thought to represent the level of matching between reality and goals. The advantages related to this approach are twofold.

Firstly, this theory considers both the subjective factors, related to the psychological field, and the objective ones concerning the actual life circumstances, related to the economic point of view. In the software, it has been supposed that the software engineer has a complete knowledge of agents' goals, and that their satisfaction depends both on reaching such goals and on an uncertain component representing subjective aspirations and the unpredictability of life.

Secondly, classifying events in different domains has simplified Easterlin's interviews, because people naturally associated life circumstances, which altered their SWB, with each domain, making

[**] There are authors who do not agree with this view and who claim that the young and the old are on average happier than the middle-aged (Agryle 1999), while others point out that SWB constantly increases, or at least does not decrease, as time goes by (Diener et al. 1999).

the calculation of happiness easier and more precise. Even though this research does not use interviews, the domain method allows one to distinguish happiness trends related to the fields of interest, and to get a more precise aggregate result.

There is no universal agreement about the scopes which should be taken into account when defining SWB, but the vast majority of the surveys[††] carried out within this field considers the following:

- Financial condition;
- Family;
- Job;
- Health.

The implemented software respects this vision and states five variables to calculate happiness, each of which is associated with one of the specified domains:

- `alfa` concerning the SWB related to financial situation;
- `beta` representing happiness coming from family life;
- `gamma` measuring the SWB due to the birth of a child (subset of family domain);
- `delta` concerning health;
- `epsilon` representing job satisfaction.

These variables are computed at every run of the software and for every family in the model. Their values are obtained by drawing a random number from a normal distribution with variance 0.25. A right, or left, shift of the mean will imply a greater or smaller chance of being happy.

As far as the calculation of `alfa` is concerned, the following considerations have been taken into account. A research by Kahneman (Kahneman et al. 2006) claims that a rise in salary does not necessarily imply a higher happiness level, because relative income seems to be far more important than the wage itself. Indeed, people seem to be greatly interested in earning more than their peers. Furthermore, individuals adapt very quickly to material goods; thus, wage increases, which are expected to raise SWB by raising consumption, may actually have little-lasting effect because of hedonic adaptation, and because the consumption of material goods has little effect above certain levels.

Moreover, people's aspirations change depending on their possibilities, so the more they earn, the more they desire to earn. As income increases, people's time usage does not seem to shift towards activities associated with improved affection. In fact, the activities that higher-income individuals spend more time engaged in, are generally associated with little happiness and a considerable amount of stress and tension (Kahneman et al. 2006).

Finally, Easterlin (2006) points out that financial satisfaction does not follow the salary trend and is significantly influenced by age. As a matter of fact, while wage increases until people are middle-aged and then declines, financial satisfaction moves almost inversely, starting to rise noticeably in midlife and increasing further in late life, when income typically declines, as shown in Figure 3.13.

[††] Some examples of empirical studies which have used the *life domain approach* and which agree in considering the domains specified in this paper are the study by Salvatore and Muñon Sastre (2001), the one written by Saris *et al.*(1995), the research conducted by Van Praag e Ferrer-I-Carbonell (2004), and the one carried out by Van Praag, Frijters and Ferrer-I-Carbonell (2003).

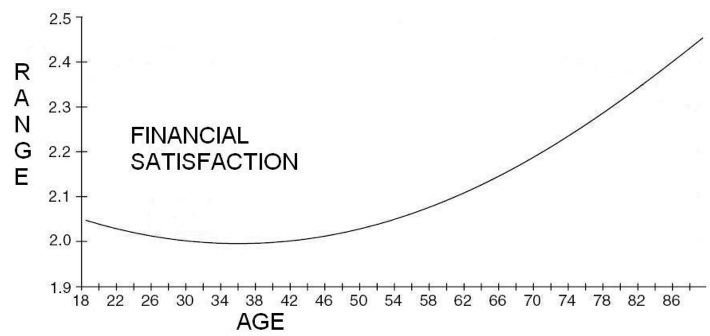

Figure 3.4 Financial Satisfaction Trend (Easterlin 2006, p.474)

The trend shows how a model based only on objective circumstances does not correspond to reality. A possible explanation for the phenomenon (Easterlin 2006) is related to the aforesaid *aspiration treadmill*. Indeed, early in adult life, material aspirations may rise faster than income, and households incur a growing burden of debt which creates financial worries. These emotional strains reduce the rise of financial satisfaction due to income growth. Then, late in life, aspirations level off and finally decline, and the pressure of debt payments on income declines. As financial worries decrease, financial satisfaction increases.

There are two key variables which should be considered when calculating `alfa`: peers' average salary and age.

At first, agents' age is checked and the mean of the normal distribution is set as specified in Table 3.5, increasing the chance of being happy as time goes by.

WEALTH	
AGE	**MEAN**
< 26	2.06
26<age<46	2
46<age<58	2.05
> 58	2.1

Table 3.5 Value of the mean of the normal distribution depending on agent's age.

Then, applying Kahneman's idea concerning the importance of relative wage, the income is compared with the average salary of one's peers, and if the family's wage is higher than the average one, 0.1 will be added to the mean, otherwise the mean will be decreased by 0.1.

Finally, to get the value of `alfa,` a random number will be drawn from a normal distribution with variance of 0.25 and the mean calculated as specified above.

As far as family-life satisfaction is concerned, the trend that emerged in Easterlin's research (2006) has been reproduced in the model. According to the considered point of view, as families are built, satisfaction with family life rises, while in midlife and beyond, it tends to decline because children leave home, or events like widowhood occur, following the trend shown in Figure 3.14.

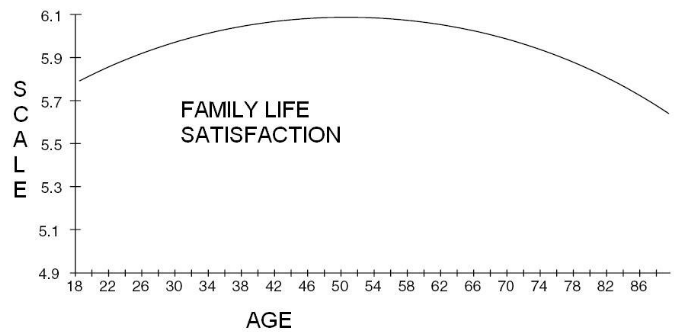

Figure 3.5 Family Life Satisfaction Trend (Easterlin 2006, p.474)

Agents' age is checked and the mean of the normal distribution is set as specified in Table 3.6.

FAMILY LIFE	
AGE	**MEAN**
< 26	5.88
26<age<46	5.97
46<age<58	6
> 58	5.97

Table 3.6 Value of the mean of the normal distribution depending on agent's age.

Finally, to obtain the value of `beta`, a random number is drawn from a normal distribution with variance 0.25 and the mean calculated as specified.

As far as the trend of `gamma` is concerned, it captures the SWB related to the birth of a new child. This kind of event has not been specifically considered by Easterlin, who has studied only family life in general, but it has been integrated here because it is of particular interest within this study.

As claimed by Kahneman and Krueger (2006), life circumstances, like the birth of a new child, cause a deep change in the trend of happiness in the two years following the event, and we would like to reproduce here such a phenomenon.

The value of the variable `gamma` is 0 if a family has no children. When a family has a child, *hedonic treadmill* and goals are taken into account. `Fam2` objects do not desire babies, so it is likely that their happiness will collapse if a birth occurs. However, according to the *set-point model*, after two years, happiness will level off very closely to the initial value. Given these considerations, the mean of the normal distribution from which `gamma` is drawn is calculated in this way:

- if there are no children in a family, both the mean and `gamma` are equal to 0;
- in the year of a baby's birth, 0,4 is subtracted from the mean;
- in the following year, the mean is increased by 0,05;
- after two years, 0,05 is added;
- then no further action on the mean is planned until another birth occurs.

Finally, to get the value of `gamma`, a random number is drawn from a normal distribution with variance 0.25 and the mean is calculated as specified.

Figure 3.6 Health Satisfaction Trend (Easterlin 2006, p.474)

As far as the parameter `delta` is concerned, the trend (Figure 3.15) of SWB emerging from Easterlin's study shows that health satisfaction tends to decrease during the life cycle. Thus, the mean of the normal distribution from which `delta` is drawn is manipulated as described in Table 3.7.

HEALTH	
AGE	**MEAN**
< 26	5,9
26<age<46	5,65
46<age<58	5,4
> 58	5,3

Table 3.7 Value of the mean of the normal distribution depending on agent's age.

The value of `delta` is obtained by drawing a random number from a normal distribution with variance 0.25 and the mean calculated as specified.

Finally, the parameter `epsilon` is computed. Besides following the trend suggested by Eastelin's research, in the model, `epsilon` is related to a random component which represents subjective abilities and luck, which can imply a better or a worse job career.

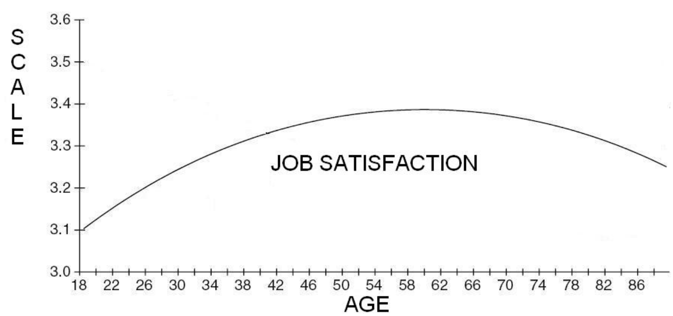

Figure 3.7 Family Life Satisfaction Trend (Easterlin 2006, p.474)

If an agent has a brilliant career, Easterlin's trend is shifted upward and the mean of the normal distribution from which `epsilon` is drawn is manipulated as described in Table 3.8.

BRILLIANT CAREER	
AGE	MEAN
< 26	3.2
26< age <46	3.35
46< age <58	3.75
> 58	4.1

Table 3.8 Value of the mean of the normal distribution depending on agent's age.

If not, the mean will respect what is specified in Table 3.9.

NO BRILLIANT CAREER	
AGE	MEAN
< 26	3.1
26< age <46	3.25
46< age <58	3.65
> 58	3.9

Table 3.9 Value of the mean of the normal distribution depending on agent's age.

The value of `epsilon` is obtained by drawing a random number from a normal distribution with variance 0.25, and the mean is calculated as described before.

The happiness value is the result of the addition of `alfa`, `beta`, `gamma`, `delta` and `epsilon`.

The second class of agents analysed is the one which groups together families with children. Families with children are elements of the class `Fam1`. Their structure is the same as that of `Fam2`, with the exception of the calculation of the value of `gamma`. In particular, when an object of the class `Fam1` has a child, the software operates on the mean of the normal distribution used to draw `gamma` in this way:

- if there are no children in a family, both the mean and `gamma` are equal to 0;
- in the year of a baby's birth, 0,4 is added to the mean;
- in the following year, the mean is decreased by 0,05;
- two years after the birth, the mean is decreased by 0,05;
- no further action on the mean is planned until another birth occurs.

The class `Figli,` instead, collects in a list all the children of the families in the model. An identity field links every child to its parents. When a member of `Figli` class builds a new family, s/he is deleted from the children's list and a new family is created.

Eventually, when the age of retirement is reached, the object `Fam1` or `Fam2` is deleted and two new pensioners are created. The class `Pens` collects together all pensioners. Every object belonging to this class has a field indicating its age to statistically calculate the time of death.

4. Simulations

After having implemented the software, simulations were carried out to investigate what the model allows one to infer.

For every simulation, the software is launched fifty times and performs 120 runs before being stopped. The output data are saved in a list of fifty matrices.

Each matrix is scanned to calculate the mean of every variable. The means are saved in another matrix (`TabM`) with fifty rows and a column for every variable considered.

Simulations were carried out, using two models which differ only as regards the management of Social Security contributions. In one reality, (W2), the contributory rate for everyone is 35% of their gross income, while in the other, (W1), it varies depending on the number of children living in a family.

Using this approach, some hypotheses have been tested, investigating what happens by changing the amount of expenditures due to a child, and the level of happiness related to a new birth.

In particular, child expenditures have been tuned as follows:

PERCENTAGE OF NET FAMILY INCOME SPENT FOR A CHILD:	
Model 1	10%
Model 2	20%
Model 3	30%

Table 4.1 Different types of virtual reality

Model 2 reflects the typical Italian expenditure for a child (Perali 2005).

After having fixed the average percentage of income spent for a child at 20%, the level of happiness due to a new birth has been modified. The aim was to investigate how the effects of a contributory relief vary, depending on the relational value associated with a child.

In Model 4, families think that children are very important and precious; thus, their happiness greatly increases after a new birth. In particular, considering `Fam1`, the software operates on the mean of the normal distribution used to draw `gamma` in this way:

- if there are no children in a family, the mean is 0;
- in the year of a baby's birth, 0,6 is added (subtracted for `Fam2`) to the mean;
- in the following year, the mean is decreased (increased for `Fam2`) by 0,05;
- two years after the birth, the mean is decreased (increased for `Fam2`) by 0,05;
- no further action on the mean is planned until another birth occurs.

In contrast, in Model 5, children are not considered as crucial resources by families; thus, the mean of the normal distribution used to draw `gamma` for `Fam1` is modified in this way:

- if there are no children in a family, both the mean and `gamma` are equal to 0;
- in the year of a baby's birth, 0,2 is added (subtracted for `Fam2`) to the mean;
- in the following year, the mean is decreased (increased for `Fam2`) by 0,05;
- two years after the birth, the mean is decreased (increased for `Fam2`) by 0,05;
- no further action on the mean is planned until another birth occurs.

Initially, a descriptive analysis of the outcomes of the simulations has been carried out. Then, linear regressions have been implemented to fully understand the existing correlations among key variables.

4.1 Results: Descriptive Analysis

The descriptive analysis focuses on the observation of three variables of interest: income level, happiness and birth rate. The behaviour of such variables has been studied both by comparing the output data of the different models, and by developing some graphs for a more comprehensive analysis.

For each variable, a table gathering the means has been set up. The values collected in such tables have been calculated as the average values of the `TabM` data.

Income

Looking at the impact of the contributory relief on wealth, it is clear that passing from W2 to W1, `Fam1`'s income grows, while `Fam2`'s decreases. In all the models, (1, 2, 3, 4 and 5), the gap between salaries is almost the same. In particular, moving from W2 to W1, `Fam1`'s net income increases by 6%, while `Fam2`'s falls by 24%, which is roughly the same cost as the one due to a child (Perali 1999). This demonstrates that the policy adopted in W1 grants vertical equity, because those who do not want children are required to contribute to the intergenerational agreement with the additional money that they would have saved, being free from children expenditures. In contrast, `Fam1` are rewarded for their precious social contribution, represented by their children, and a reduced contributory rate has been applied to them. Indeed, every single child has a negative impact on their wage and so, for the same level of gross income, they have a lower contributory power.

Thus, in W1, both the value of the resource children and the differences among agents' contributory power have been recognised.

INCOME														
VERSION WITH CONTRIBUTIVE RELIEF FOR FAMILIES WITH CHILDREN – W1														
Model1			Model2			Model3			Model4			Model5		
Fam1	Fam2	RM	Fam1	Fam2	RM	Fam1	Fam2	RM	Fam1	Fam2	RM	Fam1	Fam2	RM
17.77	14.45	15.87	16.23	14.46	15.10	14.71	14.46	14.33	16.26	14.50	15.14	16.27	14.45	15.12
VERSION WITHOUT CONTRIBUTIVE REDUCTIONS FOR FAMILIES WITH CHILDREN – W2														
Model1			Model2			Model3			Model4			Model5		
Fam1	Fam2	RM	Fam1	Fam2	RM	Fam1	Fam2	RM	Fam1	Fam2	RM	Fam1	Fam2	RM
16.73	18.40	17.32	15.18	18.39	16.54	13.67	18.39	15.78	15.22	18.39	16.57	15.20	18.38	16.55

Table 4.2 Average income level of families with children (Fam1), of the ones without children (Fam2), and of the two together (RM), in the different models (1, 2, 3, 4 e 5)

Because of the lack of vertical equity in W2 as the average cost due to a child increases, the gap between the net salary of `Fam1` and of `Fam2` rises. As a matter of fact, in Model 1, it corresponds to 1.67, in Model 2 it becomes 3.21, and then reaches the value of 4.92 in Model 3.

Per contra, thanks to the contributory relief in W1, a better level of vertical equity is granted and the difference between `Fam1` and `Fam2`'s wages diminishes as expenditures due to children grow. In fact, in Model 1, the gap value is 3.32 and, passing to Model 2, it becomes 1.87, and then reaches 0.25 in Model 3. Hence, it could be said that by introducing an equity improvement, a more homogeneous wealth distribution may be achieved.

Such trends are represented in the following graphs, which also prove that incomes are far more variable in W2 than in W1, and that the variability of `Fam1`'s wages grows as costs due to children increase. The salaries of families without children are in general more stable.

The graphs show minimum, first quartile, median, third quartile and maximum of the considered distributions.

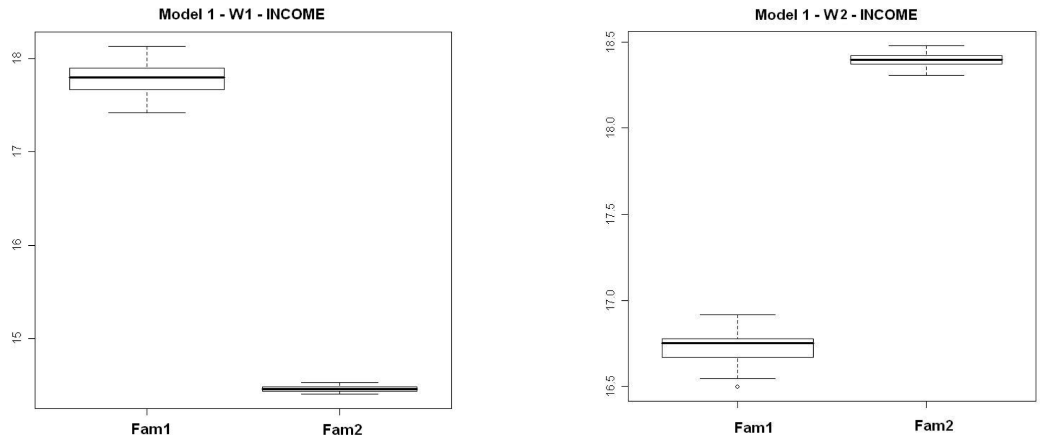

Figure 4.1 Distribution of income in Model 1

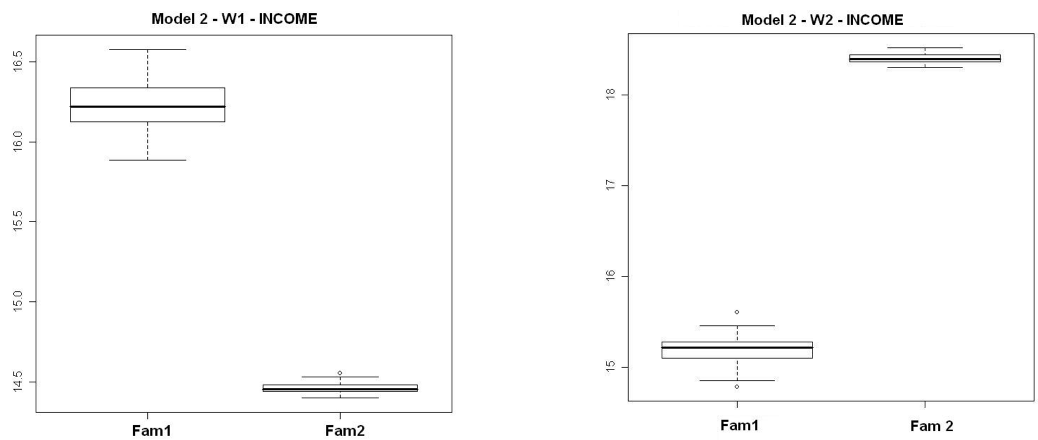

Figure 4.2 Distribution of income in Model 2

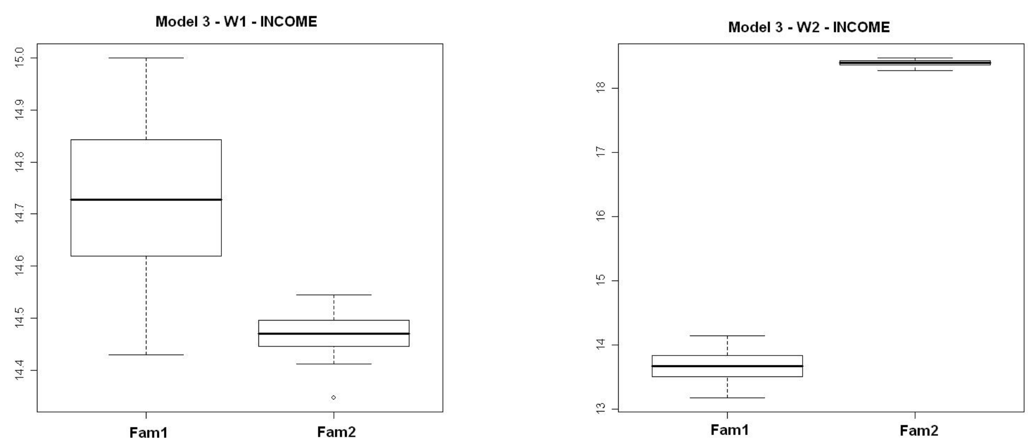

Figure 4.3 Distribution of income in Model 3

Clearly, as the output data confirm, the average income does not change, if the happiness due to children grows (Model 4) or lessens (Model 5).

Happiness

HAPPINESS									
VERSION WITH CONTRIBUTIVE RELIEF FOR FAMILIES WITH CHILDREN – W1									
Model1		Model2		Model3		Model4		Model5	
Fam1	Fam2	Fam1	Fam2	Fam1	Fam2	Fam1	Fam2	Fam1	Fam2
17.1287	16.5112	17.1282	16.5766	17.1409	16.6186	17.2109	16.5757	16,9694	16,5799
VERSION WITHOUT CONTRIBUTIVE REDUCTIONS FOR FAMILIES WITH CHILDREN – W2									
Model1		Model2		Model3		Model4		Model5	
Fam1	Fam2	Fam1	Fam2	Fam1	Fam2	Fam1	Fam2	Fam1	Fam2
17.1213	16.6313	17.1134	16.6292	17.1068	16.6327	17.1704	16.6325	16,9479	16,6317

Table 4.3 Average happiness level of families with children (Fam1) and of the families without(Fam2) in the different models (1, 2, 3, 4 e 5)

As far as the happiness trend is concerned, all the simulations prove that families with children tend to be happier than the ones without children. Furthermore, when contributory relief is granted, `Fam1`'s happiness increases further (i.e. in Model 3, it passes from 17,10 to 17,14), while `Fam2`'s decreases (i.e. in Model 3, it passes from 16,63 to 16,61) as shown in Figure 4.4. This implies that in W1, a higher level of average happiness has been reached, because `Fam1` objects are far more than `Fam2` ones.

Figure 4.4 Happiness comparison between the world with contributory relief and the one without, in Model 2

Another interesting trend should be taken into account. In W2, the happiness of families with children diminishes as the expenditures due to children grow, while the SWB of families without children remains stable. Instead, in W1, both `Fam1` and `Fam2`'s happiness rises, passing from Model 1 to Model 3. This phenomenon can be explained by considering simultaneously the behaviour of happiness and income.

As asserted by Kahneman and his co-authors (2006), the component of happiness related to income depends on agents' age and on peers' wage level. Clearly, in W1, as the expenditures due to children increase, the salaries of `Fam1` decrease. The more substantial this decline is, the closer are the incomes of families without children to the ones of `Fam1`. Consequently, the objects `Fam2`, are more likely to reach the average income level of their peers, thereby increasing the value of the component of happiness related to their salary.

As far as families with children are concerned, the benefit of the contributory relief will be more strongly perceived, if the expenditures due to children increase. Moreover, passing from Model 2 to Model 3, the decline of `Fam1`'s incomes does not have an impact on their happiness because it equally affects all the salaries of the class members. Thus, SWB does not fall because, when comparing their income to that of their peers, agents only consider if they earn more or less than their colleagues.

Hence, through contributory relief, vertical equity is improved, incomes are more homogeneous, and a higher level of collective happiness is reached.

In Model 4 and in Model 5, instead, the SWB of `Fam2` remains stable because these families do not care about children; hence, no changes will be noticed in their happiness trend if the calculus of `gamma` is modified. *Per contra*, `Fam1`'s happiness is far higher in Model 4 than in all the others, while it falls in Model 5. This phenomenon demonstrates that alterations of the happiness due to children have a strong impact on families that desire them, while the others do not perceive anything in their SWB trends.

It should be taken into account that changes in the happiness values are significant even though they are of the order of 10^{-1} or 10^{-2}. Indeed, according to the *setpoint model* (Kahneman and Kreuger 2006), and to the results of Easterlin's research (2006), SWB rises and falls but, in the long term, it always remains in the proximity of the initial level.

Birth Rate

Within the present project, we aim at investigating whether an equity improvement may positively influence the worrying demographic trends that have emerged from several official reports (Commission of European Communities 2006, European Commission 2006).

As suggested by De Santis and Breschi (2003), in order to test this hypothesis, after having applied the public policy chosen to boost fertility, the demographic trends have been measured and compared with the previous ones, analysing if and how the birth rate changes.

The outcomes of the simulations demonstrate that, after the introduction of the fertility boosting policy, the birth rate rises in all the models, except Model 5. Indeed, thanks to the contributory relief, the financial pressures related to a new birth become lower, and families are more likely to have babies, if they desire them.

The output data also show that the birth rate increase is higher in Models 2, 3 and 4. This phenomenon corresponds to what is expected, because the more the expenditures due to children increase, the more relevant is the negative impact of a new birth on income. Thus, since the costs due to children are very low in Model 1, families only slightly perceive the lack of equity and, moving from W2 to W1, the birth rate remains almost stable. *Per contra*, as children's expenditure rises (Models 2, 3 and 4), the equity improvement is more strongly perceived and the birth-rate growth becomes appreciable.

The outcomes of simulations summarized in Table 4.4 demonstrate that, in Model 5, the birth rate remains stable when passing from W2 to W1. This happens because the public policy applied does not aim at modifying the agents' preferences. Its goal is only to remove some obstacles which may prevent families from having a baby. In Model 5, children are not considered important; thus, the birth rate remains at the same level even when the contributory relief is granted.

BIRTH RATE				
VERSION WITH CONTRIBUTIVE RELIEF FOR FAMILIES WITH CHILDREN – W1				
Model1	Model2	Model3	Model4	Model5
Birth Rate	Birth Rate	Birth Rate	Birth Rate	Birth Rate
3.7302	3.9062	3.8021	3.8806	3.7242
VERSION WITHOUT CONTRIBUTIVE REDUCTIONS FOR FAMILIES WITH CHILDREN – W2				
Model1	Model2	Model3	Model4	Model5
Birth Rate	Birth Rate	Birth Rate	Birth Rate	Birth Rate
3.7285	3.8214	3.7375	3.7861	3.7474

Table 4.4 Summary of birth-rate average values.

4.2 Linear Regression Analysis

The study of the outcomes of simulations continues with the examination of the existing relationships among the variables of interest. Linear regression models with one or more independent variables have been used to carry out these analyses. The dependent variable is happiness.

1st Analysis: Quantitative regressor Average Wage – Dummy Contributory Relief

This model investigates what effect the average wage has on happiness in W1 and in W2. In order to carry out this inquiry, a simple linear model has been adopted, with one independent variable and a dummy I_A, whose value will be 1 if the field Contributory Relief is 1 (in W1), 0 if it is 0 (in W2).

Thus, the function which describes the linear model is:

[1] Happiness = $\beta_0 + \beta_1$AverageWage + I_A ($\delta_0 + \delta_1$ AverageWage) + ε

The results of the linear regression have been synthetized in the following table:

<table>
<tr><th colspan="6">RESIDUALS</th></tr>
<tr><td>MIN</td><td>1° QUARTILE</td><td>MEDIAN</td><td colspan="2">3° QUARTILE</td><td>MAX</td></tr>
<tr><td>-1.67060</td><td>-0.26944</td><td>-0.03181</td><td colspan="2">0.26901</td><td>1.58016</td></tr>
<tr><th colspan="6">COEFFICIENTS</th></tr>
<tr><td></td><td>Estimated</td><td>Std. Error</td><td>T value</td><td>Pr(>|t|)</td><td></td></tr>
<tr><td>Intercept</td><td>18.410146</td><td>0.080855</td><td>227.69</td><td><2e-16</td><td>***</td></tr>
<tr><td>AverageWage</td><td>-0.093097</td><td>0.004885</td><td>-19.06</td><td><2e-16</td><td>***</td></tr>
<tr><td>ContributoryRelief</td><td>-2.361364</td><td>0.127231</td><td>-18.56</td><td><2e-16</td><td>***</td></tr>
<tr><td>AverageWage:
ContributoryRelief</td><td>0.146387</td><td>0.008133</td><td>18.00</td><td><2e-16</td><td>***</td></tr>
<tr><th colspan="6">PREDICTIVE POWER OF THE MODEL</th></tr>
<tr><td>Multiple R-Squared</td><td colspan="5">0.01824</td></tr>
<tr><td>Adjusted R-Squared</td><td colspan="5">0.01811</td></tr>
<tr><td>F Statistic</td><td colspan="5">p-value < 2.2e-16</td></tr>
</table>

Table 4.5 Summary of the results of the first analysis

As far as the model validation is concerned, the residuals behave in the proper way because the median is roughly 0 and minimum and maximum, first- and third- quartile values are symmetrical. Moreover, R-Squared value (Multiple R-Squared and Adjusted R-Squared) is very close to 0; hence, the implemented model has not got a very good predictive power.

Finally, F-Statistic has a p-value far smaller than 0.05; thus, the model has a solid structure.

Considering what the linear regression may explain, it is clear that in W2 a unitary increment of the average wage causes a slight decrease of the level of happiness. Indeed, the function to calculate the happiness expected value is:

[2] HappinessA = 18.410146 – 0,09 AverageWage

and generates the fuchsia line in the following graph.

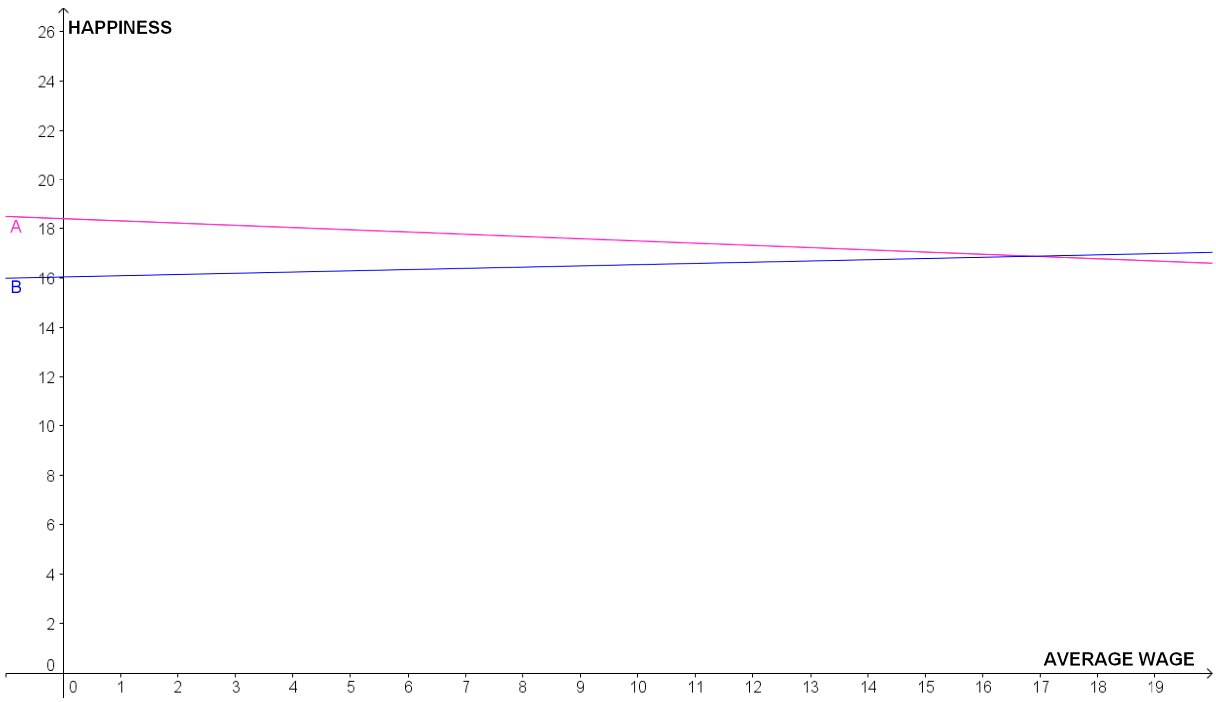

Figure 4.5 Impact of a unitary increment of the average wage on happiness in W2 (A fuchsia line) and in W1 (B blue line).

Such behaviour reflects the hypothesis made concerning the role played by income in determining SWB. Indeed, happiness due to wealth is influenced by two components: age and relative income of one's peers.

In W2, there is a small number of families, without children, with a high income, and a large number of families, with children and a far lower salary. Within such domain, a unitary increment of the average wage does not imply a more equitable wealth distribution. Hence, the poorer agents do not have a greater chance of reaching the average salary, when comparing their income to it. Therefore, the happiness component related to relative wage will be negatively influenced by this wealth distribution and will have a trend with a slightly negative slope.

With the introduction of the contributory relief, the situation changes. The function to evaluate the expected value of happiness becomes:

[3] HappinessB = 16.048782 + 0.05329 AverageWage

and generates the blue line in the previous graph.

The contributory relief for families with children improves vertical equity and implies a more homogeneous wealth distribution in the system. Thus, a unitary increment of the average salary will imply a slight increase in happiness, because it is more likely that the vast majority of families (`Fam1`) will reach the average income level.

In light of these considerations, it may be asserted that the contributory relief improves the component of happiness related to relative income and the happiness level itself.

2nd Analysis: Qualitative regressor Children – Dummy Contributory Relief

This model investigates what effect children have on happiness in W1 and in W2. To carry out this inquiry a simple linear model has been adopted, with one independent qualitative variable and a dummy.

The qualitative variable I_F explains whether a family has children or not. It is equal to 1 for `Fam1` and to 0 for `Fam2`. The value of the dummy I_A will be 1 if the field Contributory Relief is 1 (in W1), 0 if it is 0 (in W2).

Thus, the function which describes the linear model is:

[4] Happiness = $\beta_0 + \beta_1 I_F + I_A (\delta_0 + \delta_1 I_F) + \varepsilon$

The results of the linear regression have been summarized in the following table:

RESIDUALS					
MIN	1° QUARTILE	MEDIAN	3° QUARTILE	MAX	
-1.379192	-0.129403	0.001032	0.129603	1.245597	
COEFFICIENTS					
	Estimate	Std. Error	T value	Pr(>|t|)	
Intercept	16.629192	0.002766	6011.29	<2e-16	***
Children	0.482027	0.003912	123.21	<2e-16	***
ContributoryRelief	-0.051864	0.003912	-13.26	<2e-16	***
Children: ContributoryRelief	0.070048	0.005533	12.66	<2e-16	***
PREDICTIVE POWER OF THE MODEL					
Multiple R-Squared	0.5942				
Adjusted R-Squared	0.5941				
F Statistic	p-value < 2.2e-16				

Table 4.6 Summary of the results of the second analysis

As far as the model validation is concerned, the residuals behave in the proper way because the median is roughly 0 and minimum and maximum, first- and third-quartile values are symmetrical. Moreover, R-Squared value (Multiple R-Squared and Adjusted R-Squared) is quite close to 1 and, hence, the implemented model has a good predictive power.

Finally, F-Statistic has a p-value far smaller than 0.05; thus, the model has a solid structure.

Considering what the model allows one to infer, the happiness expected values have been calculated:

[5] HappinessA1 = 17.1 if $I_A = 0$ thus in W2 and if $I_F = 1$ thus for Fam1

[6] HappinessA2 = 16.62 if $I_A = 0$ thus in W2 and if $I_F = 0$ thus for Fam2

[7] HappinessB1 = 17.12 if $I_A = 1$ thus in W1 and if $I_F = 1$ thus for Fam1

[8] HappinessB2 = 16.57 if $I_A = 1$ thus in W1 and if $I_F = 0$ thus for Fam2

Clearly, children imply a considerable increase in the happiness expected value and the contributory relief further strengthens this effect. In fact, in W1, `Fam2`'s happiness tends to diminish, while `Fam1`'s increases.

This occurs because the contributory relief improves vertical equity and recognizes the value of the resource "children" for society. Moreover, such policy reduces the negative impact that a new birth has on families' wage, grants a more equitable wealth distribution and allows the ones having children to benefit from the happiness that a child gives, avoiding exceedingly heavy negative financial consequences. Instead, `Fam2` objects have a higher contributive power and contribute less to the intergenerational agreement because they do not have babies. In light of this evidence, a higher contributory rate has been applied to them, and their happiness, which in general is lower than `Fam1`'s, decreases further.

These results and the effect of the contributory relief on the birth rate show that the equity improvement positively influences demographic trends, acting both on financial conditions and on SWB of `Fam1`. Indeed, when a new family is created, the couple decides to have children or not, taking into consideration not only their preferences, but also the happiness of people with children living in the society. This happens in the software implemented as well as in realty; hence, if the SWB of people having children rises, the number of families with children will tend to increase too.

3rd Analysis: Qualitative regressor child – Dummy Contributory Relief

This model investigates the relevance of the impact of the average wage and of children on happiness, both in W1 and in W2.

The qualitative variable I_F explains whether a family has children or not. It is equal to 1 for `Fam1` and to 0 for `Fam2`. The value of the dummy I_A will be 1 if the field Contributory Relief is 1 (in W1), and 0 if it is 0 (in W2).

Hence, the function which describes the linear model is:

[9] Happiness = $\beta_0 + \beta_1$ AverageWage + $\beta_2 I_F + I_A$ ($\delta_0 + \delta_1$ AverageWage + $\delta_2 I_F$) + ε

The results of the linear regression have been summarized in the following table:

RESIDUALS					
MIN	1° QUARTILE	MEDIAN	3° QUARTILE	MAX	
-2.131747	-0.138399	-0.003716	0.135543	1.941850	
COEFFICIENTS					
	Estimate	Std. Error	T value	Pr(>ltl)	
Intercept	17.739255	0.055702	318.46	<2e-16	***
AverageWage	-0.073597	0.003719	-19.79	<2e-16	***
Children	0.422855	0.004377	96.60	<2e-16	***
ContributoryRelief	-1.922204	0.088088	-21.82	<2e-16	***
AverageWage: ContributoryRelief	0.128944	0.006149	20.97	<2e-16	***
ContributoryRelief :Children	0.075929	0.006190	12.27	<2e-16	***
PREDICTIVE POWER OF THE MODEL					
Multiple R-Squared	0.4408				
Adjusted R-Squared	0.4407				
F Statistic	p-value < 2.2e-16				

Table 4.7 Summary of the results of the third analysis

As far as the model validation is concerned, the residuals behave properly because the median is roughly 0, and minimum and maximum, first- and third-quartile values are symmetrical. Furthermore, R-Squared value (Multiple R-Squared and Adjusted R-Squared) is close to 1 and, hence, the model has an appreciable predictive power.

Finally, F-Statistic has a p-value far smaller than 0.05 and, so, the structure of the model is consistent.

Considering what the model allows one to infer, the happiness expected values have been calculated in the following way:

[10] HappinessA1 = 17.73 - 0.073 AverageWage if $I_A = 0$ thus in W2 and if $I_F = 1$ thus for Fam1

[11] HappinessA2 = 18.15 - 0.073 AverageWage if $I_A = 0$ thus in W2 and if $I_F = 0$ thus for Fam2

[12] HappinessB1 = 15.81 + 0.05 AverageWage if $I_A = 1$ thus in W1 and if $I_F = 1$ thus for Fam1

[13] HappinessB2 = 16.30 + 0.05 AverageWage if $I_A = 1$ thus in W1 and if $I_F = 0$ thus for Fam2

Since β_2 is far greater than β_1 and since δ_2 is far greater than δ_1, certainly the impact which children have on happiness is much more relevant than that related to wage.

As far as the trends are concerned, this model confirms what has been previously claimed.

In W2, a unitary increment of wage causes a slight decrease of happiness, even though the happiness trend is shifted upwards (red line in Figure 4.6) in the presence of children.

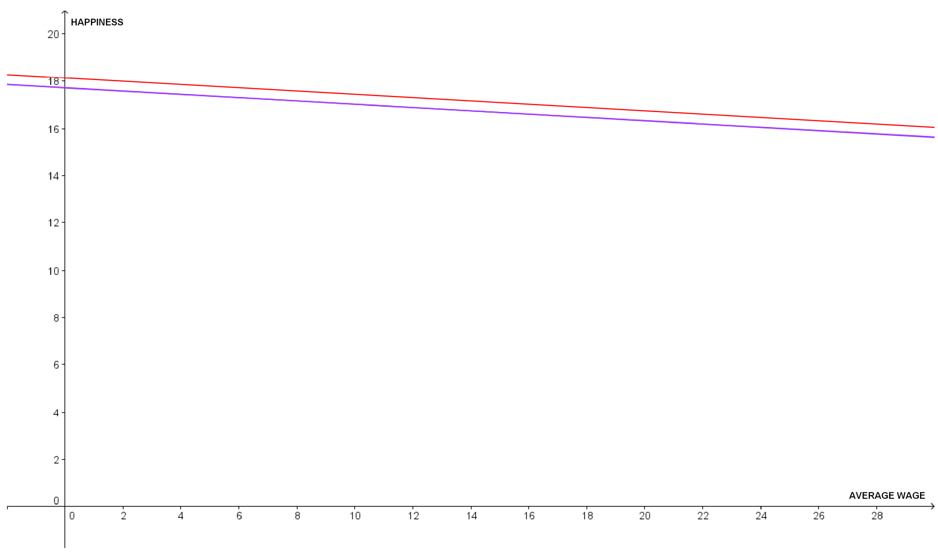

Figure 4.6 Impact that a unitary increment of average wage has on happiness in families with children (red line) and in those without (blue line) within W2 world.

In W1, instead, happiness slightly rises after a unitary increment of salary and, similarly to what happens in W2, the happiness trend is shifted upward if there are children in a family.

Furthermore, the linear regression model shows that children have a more positive impact on happiness in W1 than in W2 and, indeed, the upward shift is 0.42 (β_2) in W2 and 0.49 ($\beta_2 + \delta_2$) in W1. This is the consequence of the vertical-equity improvement and of the recognition of the added value connected to a new birth.

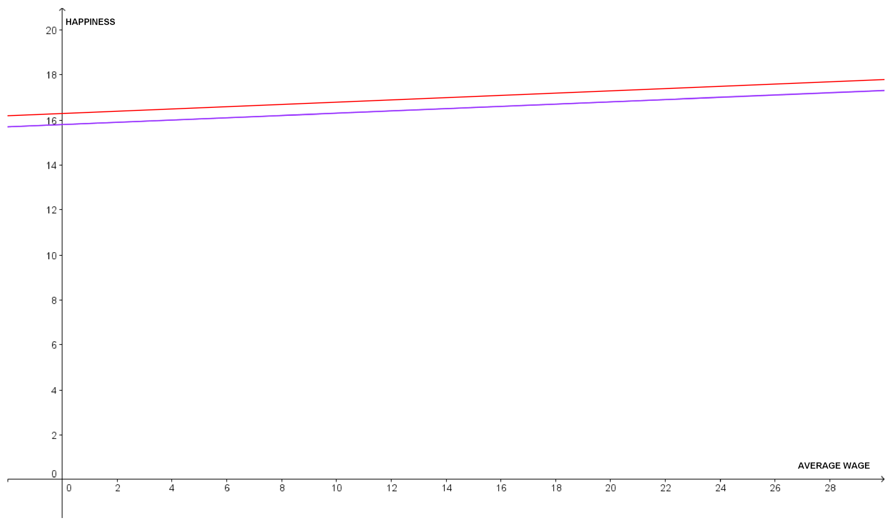

Figure 4.7 Impact that a unitary increment of average wage has on happiness in families with children (red line) and in those without (blue line) within W1 world.

5. Conclusions and future developments

Within the theoretical frame here assumed from the outcomes of simulations, one could state that an increase in the vertical-equity improvement has a positive impact on demographic trends, increases the happiness level and grants a more equitable wealth distribution. This influence on demography is to be considered as a consequence of two trends: the income trend and the happiness one.

The introduction of the contributory relief, in fact, implies a growth of `Fam1`'s average salary, which in W2 is burdened by children expenditures, and is generally below the average wage level. Instead, `Fam2`'s contributory rate rises because `Fam2` objects are free from children expenditures and, therefore, they have a higher contributory power. The consequence of this policy is the downturn of their net income.

Hence, in W1, families without children have a lower net income and the gap between `Fam1` and `Fam2` wages is far smaller than in W2. Agents tend to have salaries which are very close to the average one and the happiness component, related to relative income, benefits from this effect because these agents are more likely to earn at least as much as their peers.

Analysing the simulation results, it is clear that the happiness of families with children rises, passing from W2 to W1, while the SWB of families without children diminishes. Given that `Fam1` objects are far more than `Fam2` ones, this trend implies that average SWB tends to be higher in W1 than in W2. This is considered as one of the most important causes of the positive effects perceived on demography. Indeed, when a new family has to decide whether to have children or not, it will be influenced both by its preferences and by what happens in society. Thus, the happier the ones having children are, the more likely is it that the new family decides to have a child. This implies that the birth rate benefits from the increase of `Fam1`'s SWB.

Moreover, linear regression analysis shows that children play a far more important role than the one played by income in determining people's happiness level. The values of linear regression parameters also demonstrate that contributory relief further increases the happiness which a new birth may imply. In the third analysis, indeed, $\beta_2 + \delta_2$ is greater than β_2.

Considering the increasing importance of the second and of the third pillars of retirement systems, it may be of great interest to complete the developed model, including also these elements. In particular, a wide range of private retirement saving programmes could be implemented in the virtual reality in order to try to investigate what kind of policies and financial instruments could be more effective. Within this domain, a more comprehensive equity improvement may be conceived and the analysis of the outcomes could be useful to confirm or refute what has been discovered during this research.

Further, in the literature, several authors have pointed out various behavioural anomalies related to private retirement saving decisions, like hyperbolic discounting (Frederick, Loewenstein, O'Donoghue 2002), bounded self interest (Mullainathan and Thaler 2000), bounded self control (Mullainathan and Thaler 2000) and so on. Through the evolution of the software implemented so far, it may be possible to investigate the effectiveness of human- learning processes, of educational programmes, of information campaigns and of different kinds of financial services in solving these behavioural anomalies, analysing also their impact on SWB, on financial conditions of people during the whole life cycle and on demography.

Appendix

A.1 Observer Swarm Interface

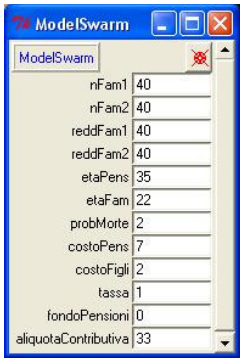

Figure A1.1 Screenshot of *Model Swarm* panel used to set the initial values of variables

Figure A1.2 Screenshot of the panel used to set the frequency of the visualization of the output trends.

Figure A1.3 Screenshot of the control panel

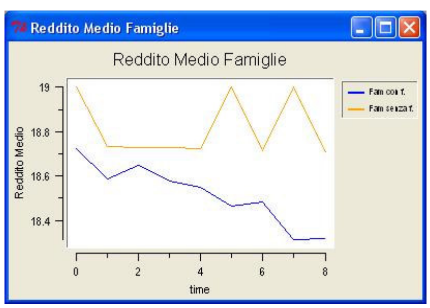

Figure A1.4 Average income trend

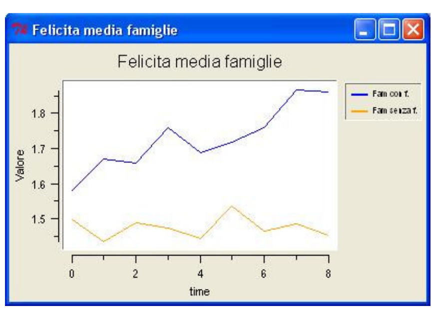

Figure A1.5 Average happiness trend

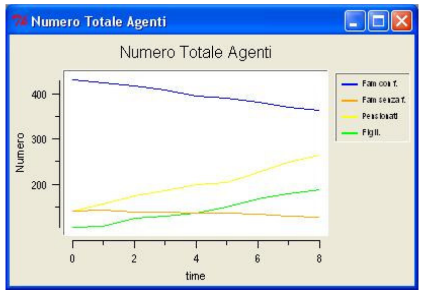

Figure A1.6 Numerousess of agents trend

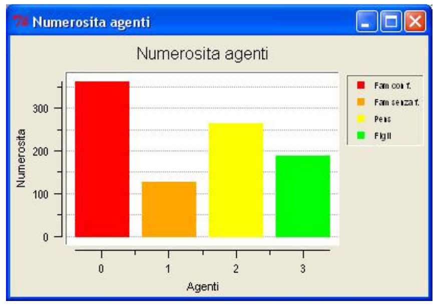

Figure A1.7 Bar chart concerning the numerousness of agents

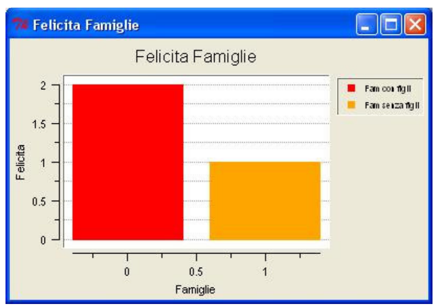

Figure A1.8 Bar chart concerning families' happiness

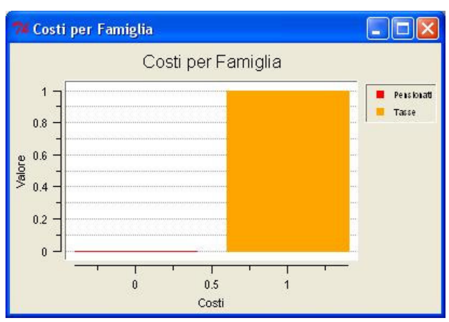

Figure A1.9 Bar chart concerning the average level of taxes and average level of social security contributions.

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