Gender Stereotype and Female Entrepreneurship: An Agent-Based Model with Protocol Beliefs-Desires-Intentions (BDI)

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Chapter 1

Theoretical Introduction

1.1 Introduction to Entrepreneurship

Entrepreneurship can be defined as the mental state and the continuous effort [13] to introduce goods to the market so to gain profits from them [74]. Schumpeter is recognized as one of the first and more prominent theorists of the role of entrepreneur in economic dynamics [51]. As he theorized [61], if an entrepreneur is holding the monopoly of a good, the will to gain similar profits will bring others to become competitors [26], producing similar goods to appeal the mass [61], but trying to be more competitive, in a process called *constructive destruction* [61] [26] . That is, new entrepreneurs try to be more competitive through several means called simply *new combinations*, for instance, reducing the price, investing on technologies, improving quality and so on. This drives consumers to move money to another entrepreneur causing the consequent destruction of the previous *supply/demand equilibrium* and features of the market, leading to a new equilibrium, until new entrepreneurs will appear and the process will restart again and again [61] [26]. By doing so, as Schumpeter states, the desire of profits becomes the drive for capitalism [61], and, as anticipated by classical economists [61], the egoistic interest of entrepreneurs causes the interest of many, because, trying to overcome the market, their actions lead to economic growth [26]. As a consequence, entrepreneurship is thought to bring not only such economic growth, but also innovation and job creation [50] [64], whilst its absence is linked to difficulties of balance-of-payment and industry declining [14]. Henceforth, entrepreneurship is seen worldwide as a possible solution to the current crisis by policy makers and scholars [51] [2]. This explains why policy makers start showing interest also in funding *entrepreneurship education programs* which are expected to increase competencies, but also motivation, towards entrepreneurship [51].

1.2 Gender Gap in Entrepreneurship

An interesting feature about entrepreneurship nowadays is the worldwide lack of women in entrepreneurship, which is referred to as a *gender gap* [36] [32]. Due to the interest of policy makers cited above, this seems to be an issue that deserves to be paid attention to. Psychology scholars have focused on the subject, and the most followed hypothesis is that women are less prone than men to generate the intention to become an entrepreneur due to the effect of *gender stereotypes* facilitating men as entrepreneurs [36]. This means that psychology can help understand gender gap in entrepreneurship exploring the role and dynamics of intentions and gender stereotype.

Place	MEN	WOMEN
Latin America and Carribean	22	15
Middle East and Norh America	13	6
Sub-Saharan Africa	27	26
Asia Pacific and South Asia	14	11
Europe EU-28	10	6
Europe NO EU-28	9	6
North America	13	9

Table 1.1: GEM Report 2013: Distribution of Gender among start-ups [28]

Female firms	Tot. firms	% women
1.429.897	6.061.960	23.6 %

Table 1.2: Unioncamere Report 2013: Distribution of Gender in Italian firms [73]

1.3 Intentions to Become Entrepreneurs

Psychologists have moved from thinking of entrepreneurship as just a state of mind, that is, interested in 'becoming an entrepreneur and nothing more', to study it as a process analysing how entrepreneurs can endure in the accomplishment of their ideas [13] and from a perspective centred on personality towards a more *interactionist approach*, including also the social system of the person [13]. In this way, the focus of studies is not anymore centred on personality traits of entrepreneurs, but their *intentions* to open a start-up, how they are generated, what they are made of [13]. One model that more than anyone fits this tendency is the *Theory of Planned Behaviour* (TPB) [3]. This model was originally proposed as Theory of Reasoned Action (TRA) by Fishbein and

Ajzen [30], studying how actions derive from intentions. Once perception of behaviour control was added by Ajzen [3], the model has become what we know today. According to TPB, actions enacted by people are driven by *intentions*, that is, their motivation to generate and accomplish a behaviour, which in turn stem from *attitudes towards the behaviour* they are willing to execute, and the *subjective norms* derived from normative beliefs collected in the social context. Describing deeper, attitudes are considered as the combination of what an object (here an action) is and what value it receives [29], while subjective norms are those norms a person imposes to himself because thought to be unavoidable and highly important for those people called *referents* they want to be part of [6]. *Perceived behavioural control*, instead, the element added by Ajzen [3], refers to the belief people have on how much they can control their own behaviour and execute their intentions [60]. Perceived behavioural control can have both an indirect and direct effect on actions, the former as long as it helps generate the intention that will lead to an action, the latter because it works as a buffer against obstacles to the action [6], and, even more, because executing oftener and oftener an action, the control on it is taken for granted, and the action is executed on default [53].

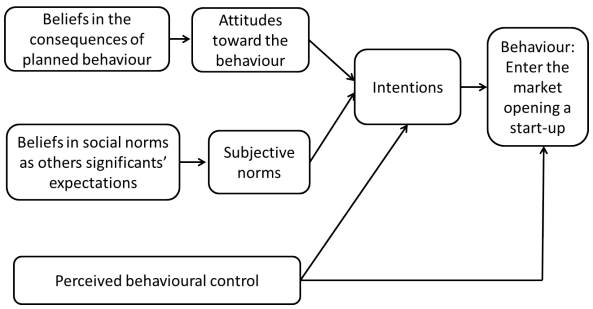


Figure 1.1: The theory of planned behaviour

Armitage and Conner [6] have demonstrated through a meta-analysis how the model can explain a good portion of variance of the behaviour of people, and Schlaegel and Koenig [60] have confirmed how this model fits entrepreneurial intentions too, even though needing to include more contextual factors, as gender stereotypes.

1.4 Gender Stereotypes

As people grow, or relates to a social context, through *socialization* they gain cognitive structures of models of how to behave within the group and beliefs on what reality is [53]. Means of socialization are imitation from others, e.g. children imitating adults, communication through media, social influence and social approval [53]. *Stereotypes* are part of this process. They are cognitive structures

containing over-generalized beliefs about what members of a group are, taken one and all, and what behave is expected towards that group [7]. So, stereotypes help people manage the complexity of reality [67]. As poststructuralist feminists affirm, *gender* is a product of socialization people are filled with from their birth and in different ways due to their sex, varying in time and place [1], according to prevailing stereotypes [23]. In this way, *Gender Stereotypes* are a subset of stereotypes were the group at stake is that of men and women, showing them what, in that social context, is considered *masculine* and what *feminine* [48]. A very popular theory concerning gender stereotypes is the *Gender Role Theory* [48], which states that in every culture the division of work between men and women is aimed at providing order and attribute duties. While in the past physical differences were easier to justify such differentiation, for instance the biggest musculature of men for their carriage duty, today this aim has passed to the social construction of gender stereotypes. Doing so, gender stereotypes become both*descriptive* of the men/women group, and *prescriptive* of what is expected from them [48]. Generally, the orientation of gender stereotypes in Western Society is defined as *communal* for women and *agentic* for men. The former means that women are expected to be expressive, kind, supportive [15] take-caring, empathic and group-oriented [48], while the latter means that men are supposed to be aggressive, autonomous, prone to instrumentality, courageous [15] [16], active, self-achieving and independent [48]. The main division of work provided by this model has been for men to be breadwinners through their salaries, while for women to take care of family and house [48]. Such a vision has been blamed by feminism to cause injustice for women and an accumulation of power for men, which has driven policy makers to take the issue into account, through legislative interventions aimed at preserving equal opportunities [48]. But, on a subtle layer, gender stereotypes are still thought to cause inequalities, as the phenomenon of *horizontal segregation*. This is the tendency of some jobs to be taken much more from women than men and vice versa, for instance, teaching for women and engineering for men [48]. These tendencies are considered the product of stereotypes adopted from socialization [48] affecting people's intentions. This has driven policy makers to pay attention to soft and wider channels throughout which these gender stereotypes can be delivered, and so defeated, such as school programs and mass media communication, requiring official guidelines [32].

1.5 Gender Stereotype and Entrepreneurial Intentions

Entrepreneurship has been historically seen as a masculine job [47]. Schumpeter himself stated it [61], and today scholars focus on the financial risk-taking and economic achievement desire required by entrepreneurship, which best fits the agentic stereotype referred to men [71]. Besides, registered attributes associated with entrepreneurs are generally masculine, e.g. achievement orientation,

optimism, self-efficacy, internal locus of control (that is, considering ourselves as causes of consequences of our actions, [53]), cognitive skills, and tolerance for ambiguity above the ordinary [64]. In a recent research Hancock, Pe'rez-Quintana and Horniga [38] report what attitudes are associated by Spanish students to an entrepreneurial person among those provided by Bem Sex-Role Inventory [15] [16], a set of attributes aimed at individualizing the position of the participant throughout the masculine/feminine continuum. The entrepreneurial person was associated with masculine attributes, which were self-confidence, leadership, competitiveness, high propensity to take risk and ambitious, few were 'androgynous', meaning fitting both genders, as creativity, and no feminine attributes were mentioned [38]. Psychologists have used namely experimental design to confirm the idea that gender stereotype can negatively affect women decision to become entrepreneurs. Gupta, Goktan and Gunay [36] have used a paradigm called *gender threat* where communication of instruction and materials are 'gendered', e.g., describing men fitting better to entrepreneurship than women, to assess if this would affect differently males and females participants in forming the intention to become an entrepreneur. The results confirmed that when both groups were exposed to the 'male-gendered message' men reported higher intentions to open a start-up, *vice versa* if the message was 'feminine-gendered', while no differences were registered if the message was deliberately 'gender-neutral', that is, trying to avoid whatever gender orientation. But the most interesting result was that if the message was a normal message, that is, a common message similar to those from mass-media but not gender-neutral, men had equally the highest preferences, confirmimg the presence of gender-stereotype in society. Gupta, Turban and Bhawe [37] conducted a similar experiment, where the independent variable was the explicit/implicit way to express a message. According to the Stereotype Activation Theory (SAT), when a stereotype focused on some ability of a group is delivered subtly, people will confirm it, both if they are described as capable of an action or not, but, if the stereotype is expressed blatantly, people who are described as incapable of an action and consider the stereotype untrue will try to do their best to prove it to be invalid, so to have an incongruent behaviour. As a consequence, both men and women in their experiment were expected to confirm the stereotype when it was presented implicitly, but to disconfirm it when presented blatantly. This happened when masculine stereotype was presented, but not when feminine one was, and, interestingly, men reported higher entrepreneurial intentions if no stereotypical information was provided, but men and women's entrepreneurial intention turned back to be the same if entrepreneurship was presented as gender neutral [37]. The authors interpreted these results as the demonstration that the image of entrepreneur is normally accepted to be made up of masculine attributes, without people noticing it, but, due to their social construction, stereotypes can be undone if expressively addressed in education or mass-media communication [37], which is much more important considering the investments policy makers are inclined to do on entrepreneurship education [51].

1.6 Purspose of This Simulation

These studies can't foresee what the consequences of 'gender gap' in entrepreneurship could be, or the mechanisms of stereotypes beneath it. An agent-based model is here proposed to study the emergent consequences and dynamics of the phenomenon, and BDI protocol is used to simulate stereotypes and beliefs' reproduction and action.

Chapter 2

Complex Systems in Social Sciences

2.1 Complexity

Von Bertalanffy [17] defines a *system* as a group of elements interrelated, interacting constantly over time, so that the whole system is independent from its components. As Gilbert [33] states, we can imagine of both a human society and a galaxy as systems, but they are different in the way we can predict and understand their behaviour. Whereas for a galaxy we can predict its future movements through the basic equations of its motions, this can't be done for what regards societies, and even more human societies, because of their unpredictable features, and, moreover, because they are affected by their past histories [33]. What makes *social* this kind of system is how it is made up of individuals interacting within clearly defined boundaries [46], where relations among people have a deeper impact than in any other system [75]. Mathews, White and Long [46] report how in last decades societies have undergone increasing complexity, dynamism and uncertainty, which lead managers and practioners to adjust to the situation. This has driven research in social sciences towards a new theory of systems development, that is, a new assumption on how interested phenomena are interrelated [43]: the *Complex Theory*, or *Science of Complexity*, or shortly, *Complexity* [69]. This challenges the Newtonian paradigm, recognized as foundation of *traditional* natural and physical sciences [46], relying on linearity, predictability and certainty of events. But as Brown [21] states *"human behaviour can't be understood with the linear logic of reductionism"*. According with such a declaration, Complexity Science is the study of *complex adaptive networks and systems* [70]. Systems are considered as *over-lapping* and *non-nested*, not in a hierarchical relationship, but mutually adapting to each other, in an ongoing process [75], and their boundaries are delimited by space and time [46]. The overlapping and mutual adapting behaviour of the components of a system leads to a network of reciprocal cause-relationships, referred to as

path dependence [33]. Mathews, White and Long [46] show four approach that come along with complexity. They are *Dissipative Structures*, whose focus is on discontinuity in the relationship among systems, *Catastrophe Theory*, addressing how discontinuity in a system can coexist with continuing stimuli [46], while *Self-Organized Criticality* (SOC) follows the idea of a state towards which natural and social systems evolve autonomously [46]. But the approach that is associated most with complexity theory is the logic of *Deterministic Chaos*, defined by Kaplan and Glass [44] as *'aperiodic bounded dynamics in a deterministic system with sensitive dependence on initial conditions"*, meaning that the state of a system is always unique (*aperiodic*), following some fixed rules (*deterministic*) and proceeding from a precedent one (*sensitive dependence on initial condition*) that defines the range of possibilities of outcomes that the system can have (*bounded dynamics*). These approaches can be reassumed in the recognition of a circular principle of causality as described by feedbacks. A feedback is a circular arrangement of casually connected elements, so that each element has an effect on the other [25], resulting to be its producer [69]. A feedback can be *negative*, that is, the reciprocal adjustments will lead to restoration of the initial equilibrium of a system or *positive*, meaning that small changes will affect greater and greater changes so that the system will be driven far away from such equilibrium [75] . In this way, the predictability of future states of a system does not rely solely on its elements, but on their *interaction throughout time*, so to cause an *emergent behaviour* of the whole system in a nonlinear dynamical evolution [46] . Two schools have focused on the complexity of emergent systems: the *Prigogine's approach* [54] and the approach of the *Swarm community* operating in the 90's in Santa Fe' [75]. While the former is focused on the challenge that nonlinearity brings to the proportionalities of effects, resembling the effect of positive feedback, the second seeks to find the inner order of dynamical chaotic changes, resembling the negative feeback. Despite such premises, both approaches are centred on studying complex and emergent systems. While Prigogine's is focused on their external relations, Santa Fe's is on theirs inner structuration [39]. From both perspectives, instability and unpredictability are seen as the real features of an emergent system, due to their emergent behaviour, and *change* and *transformation* are the real interest of researchers [46].

2.2 A method for Complexity

Ostrom [52] states that in their search to propose a model for social systems, scientists can use three *symbol system*: verbal argumentation, mathematics and computer simulation. The first can be associated to qualitative method, using the flexibility of a verbal discourse to highlight relationships among elements of a system, as events of history [18]. The problem with this method is that its data cannot be generalized to other contexts [34]. Moreover, due to their nature, qualitative data have nothing more than an *impressionistic* value [33]. On the contrary, the second method uses formal and mathematical formulas and methods, such as mathematical equations and statistics [18], so to be asso-

ciable to quantitative method. Through the mathematical relationships used, data derived can indeed be generalised [34] and verified [18], but, as Gilbert [33] states, individuals are here seen as *atoms* without paying attention to their interactions. As a result, this method has not flexibility like the former [18] and results inadequate to study emergent behaviour in complex systems [33]. In this way, both methods appear unable to understand the transformation of nonlinear complex systems [41]. These limits can be overcome by the *third scientific discipline* [10] [41], that is, *computer simulation*, as it can combine the flexibility of the first method through an informatics code and the mathematical analysis of the second through the computing machine [18]. As Borshchev and Filippov synthetize, a *simulation model* is a set of rules that define how the system will change in the future, given its present state affecting its *execution* over time [19]. Used mostly in the field of natural sciences [34], this method has been applied in the field of social sciences too for the last 40 years [42]. A computer itself is an organization of elementary functional components [66], so that computer simulation can turn into a social simulation when these components act like an artificial society [33]. The innovation of this method is for Axelrod [10] to combine deductive and inductive method: like deduction the model is built on expressed rules that do not produce theoretical theorems, but that are tested inductively throughout the data produced by that rules themselves in the simulation [10] . If the data used come from real world, then simulation could be used to reproduce a *real world society*, whereas if unrealistic data are used, then social simulation can reproduce a society that *could have been* or *could be* [35]. Axelrod [10] individualizes three purposes for which social simulation can be useful to study social systems: prediction, proof and discovery. *Prediction* means the way we develop a theory watching what could happen in a society built upon it. As Byrne [24] points out, *prediction is not prescription*, meaning that simulation cannot help us know what will happen, but what can be made to happen [24]. *Proof* refers to the possibility to detect common and robust characteristics of a system and its theory, while *Discovery* happens when a simulation reveals unexpected consequences or relationships implicit in the theory used [10]. Due to this three uses, social simulations can be considered as a *new way of conducting science* [10].

2.3 Agent-based Models

Borshchev and Filippov [19] organize the subjects of research interested by computer simulation according to their level of abstraction, precision of details, level of analysis and purpose of activity. At the bottom of their diagram there is the mere physical simulation, as the analysis is centred on an *operational level*, characterized by low abstraction, more details, micro level of analysis of individual objects with exact sizes, distances, velocities and timings, for instance an automotive control system. At the meso level there are the analysis of business process and service systems whose models are more centred on schedules and timing, even though the physical movement is still the central aspect. This

is the example of an emergency department and is defined as a *tactical level*, characterized by a middle level of abstraction, filled with medium precision of details. The top of the diagram is the macro level of analysis, named *strategic level*, with a high level of abstraction and relying less on details. The objects of this levels are aggregates variables, global causal dependencies, trends and feedback dynamics and what matters is not the single object, but its relationships with others. So, this is the level of the pure social simulation. The authors individualize four types of possible simulations to be implemented throughout their model. *Dynamic Systems* (DS) are characterized by mathematical models of dynamic systems relying on differential equations of integrated continuous variables with a strictly physical meaning, such as pressure and accelerations that are not aggregated of other entities, so that they are adopted only for the physical simulation. At the middle level there are *Discrete Events* (DE) which are a flowchart of the relationships among the events of a process. At the macro level there are *System Dynamics* (SD), descendant of Dynamic System, and centred on the interrelationship of feedbacks for the success of the organizational system, using mathematical models of aggregated and not just physical entities. Borshchev and Filippov [19] indicate *Agent-based Models* (ABM) as a simulation method able to fit both social and natural systems. Gilbert [33] defines agent-based model as a set of software objects, the *agents*, which interact within a virtual environment, programmed under the model of *Distributed Artificial Intelligence* (DAI) [45] which seeks to provide them with the characteristics of *Reactiveness* (being able to receive and respond to the environment) *Intentionality* (using meta-rules to define goals to be achieved) and *Sociality* (producing models of expectations and motives of other agents). The programmer has just to provide the fixed rules to be followed, derived from the theory to be tested or the data collected, building a *bottom-up model* where the agents will operate autonomously. In this way, *the macro behaviour of the system will not arise from the agents, but from their interactions* [19], resulting the most suitable to reflect the complex nature of society [33]. Neverthless, Squazzoni and Casnici [68] find out that articles published on JASSS, *Journal od Artificial Societies and Social Simulation* even though of social interest, are most cited by journals of natural sciences. This can be viewed as an obstacle to popularity of agent-based models and social simulations in social sciences, but also as a proof of increasing interdisciplinary awareness as promoted by social simulations.

2.4 NetLogo

NeLlogo [76] is a programming language and modelling environment for agent-based social simulations of both natural and social complex phenomena over time, developed by Uri Wilensky's team at Northwestern University in 1999 and arrived to its six version 5.0.5. It comes from the modelling language StarLogo [56] which used the programme language Logo developed by Seymour Papert and Wally Feurzeig in 1968 [72] for educational purpose, but to whom it adds agents and concurrency using Java language [72]. In the environment

where the simulation runs, called *world* three types of agents take place: *turtles*, able to move, *links* between two turtles and *patches*, squares of the grid where turtles move. Three tabs are presented to the user called *observer*: Interface, Info and Code. *Interface* is where the world appears together with some tools. These are *buttons*, which activate a procedure, *sliders* for assessing continuous variables, *switches* for dichotomous variables and *choosers* for categorical ones. The most important buttons are usually *Setup* which builds the world and *Go* that runs the simulation if activated as a *forever button* repeating its actions. Besides, outputs can be summarized in monitors and plots, and more information provided with notes and outputs. At the bottom of the Interface tab there is the *Command Center* where the observer can put algorithms to simultaneously manipulate the simulation. In the *Code tab*, the observer specifies the *breeds*, that is, the different types of species of agents operating in the simulation and their related variables. The fixed rules to be followed are presented under the shape of algorithms in this tab. As a *simulated parallel environment*, NetLogo will reproduce the same simulations, following the given order. Through the Application Programmers Interface (API), other extensions can be added, such as *Believes-Desires-Intensions (BDI)*. The *Info tab* finally provides useful information to the observer.

Chapter 3

BDI and FIPA-ACL

3.1 Development of BDI and Communication in Agent-based models

In their review Costin, Zoran, Hans-Dieter and Ivanovic' [11] cite how around the middle 90's scientists in agent-based models tried to reproduce intelligents agents the more *human-like* possible, and this was thought to be achievable throughout the simlation of an *intentional system* under the theorization of the philosopher Daniel Dennett in 1971. It was recognized that to reproduce the complexity of human societies it was necessary to provide the agents with *mental attitudes* (beliefs, desires, intentions, commitments) mediating their interaction with the environment, adding *prognostic* and *predictive* capabilities to models that until that moment were only prescriptive and normative [42]. An agent possessing such attitudes, and not only a relationship with the world under the shape of the stimulus-response mechanisms was considered to represent a *strong notion of agency* similar to men [77].
Besides such attitudes, it was recognized the primary role that communication should have had for such an intentional system and the difficulties that should be overcome. As Hutchins and Hazlehurst affirm, *human language* provides a mechanism for distinguishing between relevant objects in the natural environment, but to be used it requires two components shared by the community, that is, *forms* and *meanings* [40]. Similarly, Michael Coen [27] considers agents as programs that engage in *dialogs* and *negotiate*, able to coordinate transfer of *information*, so to reach the condition of *humanized agents* to whom a deeper *interdisciplinary* of different fields as psychology and philosophy is devoted.

As Costin, Zoran, Hans-Dieter and Ivanovic' [11] summarize, agents were required to reach a cycle consisting of three ongoing steps:

- **Sense**

  Processing incoming information parsing messaging coming from others agents.

- **Think**

  Executing more or less complex decision procedures as rules or plannings.

- **Act**

  Sending outgoing information preparing answers in a human-like style.

As the authors report [11], more than 100 agent platforms and toolkits for agent development environment were accomplished, most of them using Java language. NetLogo is one of them, throughout the work of the Department of Applied Informatics, University of Macedonia aimed at developing BDI and FIPA-ACL inspired Libraries [59].
Henceforth, the development of BDI and FIPA-ACL for Agent-based models can be delineated.

BELIEFS-DESIRES-INTENTIONS

Beliefs-Desires-Intentions (BDI) are an architecture to simulate the *mental states* desired in agents. They are the second kind of architecture individualized by Costin, Zoran, Hans-Dieter and Ivanovic' [11], following the Agent-oriented Programming (AOP) and preceding the new hybrid models of AOP and BDI [11]. *Agent-oriented Programming* (AOP) comes from object-oriented programming but tried to give the receivers of a message or input a higher degree of autonomy, deciding if the actions have to be executed [11]. From the architecture AOP several languages for programming agents have derived: Agent0, Placa, Agent-K, MetateM, April and Mail, VIVA, GO! [11], most of them elaboration of the first. Beliefs-Desires-Intentions (BDI) are cited for the first time in a simulation on aircraft management by Rao and Georgeff [55] as an attempt to add to AOP a quantitative-decision theoric perspective and a symbolic reasoning perspective, recognizing the difficulites and costs of previous simulations [55]. The authors present BDI as explicitly derived from the philosophical model of Michael Bratman [20] in *Intention, Plans and Practical Reason*, because seen by the authors as the best to fit the intended modularity of the system.
In his speculation, the philosopher argues that people could bear a goal in mind at any moment, but this could be not sufficient. They have to commit to the one they repute achievable, that is, not in conflict with others. It means that for instance they can't want to "be at the beach" and "to ride a bike" at the same time. A rational agent should select only not conflicting options, so to form a *stack* of chained intentions, for instance, "to ride a bike to go to beach, and *then* be at the beach" [20]. *Beliefs* are defined by Rao and Georgeff [55] as informative components of the environment, *Desires* are the motivational state of the system, indicating the agents the objectives they have to accomplish, and finally *Intentions* are the deliberative state of the model, as intentions of agents

will endure even though the instantaneously changes in the environment [55]. The execution of these mental states was imagined to be performed by a *BDI-interpreter* repeating its actions, also in parallel, if not conflicting desires were at stake [55]. Rao and Georgeff proposed the language AgentSpeak that was later implemented in Jason in 2004 [11], besides AF-APL, 3APL, 2APL, JACK Agent Language and Jadex. *Other languages* are derived as a mixture of AOP and BDI, able to perform reason and calculi, under the shape of *declarative paradigms* [11]. Languages derived from this architecture are Goal, Golog, Flux and Claim.

FIPA-ACL

As Costin, Zoran, Hans-Dieter and Ivanovic' [11] stress out, communication in agent-based modeling has been namely devoted to cooperation, both for intentions and results.They individualize five main languages in simulating communication among agents. ARCOL presents a small set of communication primitives, KIF (Knowledge Interchange Format) is centered on knowledge as a content of messages and Cool is aimed at enhancing cooperative behaviour among agents [11]. But the two most important languages are *KQML* and *FIPA-ACL*. KMQL stands for *Knowledge Query Manipulation Language* as centred on performative messages delivered throughout communication, but with the error to be interpreted with highly possibilities in different ways by several agents. FIPA-ACL is the most reliable at the moment. FIPA is for *Foundation for Intelligent Physical Agents*, an organization founded in Swiss in 1996 to improve agent technology [11]. Since 2005 it has been the participant of the IEEE Computer Society appointed to provide standards for, but not only, multi-agent systems communication. ACL instead is for *Agent Communication Language* derived from Austin [9] and Searle's [62] *Speech Act Theory*, bearing FIPA standards in mind, from which the FIPA-ACL acronym derives. This states that each act of language is an action producing effects. Messages in FIPA-ACL want expressively to reproduce *illocutionary acts*, that is, acts able to generate in the receiver the change desired by the speaker throughout the implicit force of the utterance transmitted.

3.2 Implementation in NetLogo

Scholars of the Department of Informatics of the University of Thessaloniki have been using NetLogo for educational purposes in teaching *Complex Agent and Multi-agent Systems* (AMAS) since around 2003 [59]. In their intention to provide students with a more complex usage of the intelligent system throughout choise and coomunication among agents, they have developed, and have been defining, two lybraries to be implented in any simulation: one for mental states under the architecture of BDI and one for communication under the model FIPA-ACL. For both of them the use of the commands *_include* and *ticks* is necessary [57], and all turtles must have beliefs and intentions as variables, initially set to *empty* when the turtles are created.

- Beliefs-Desires-Intentions

Beliefs are considered here with a more flexible usage then in Rao and Georgeff, as they represent any kind of knowledge stored in the agent, not just of the environment around [59]. Indeed, beliefs components are divided into *belief type* (called also *b-type* or *bel*) that declares the type of belief and *belief content*, that is, its content. There can't be two beliefs of the same type, as they would be equivalent, but they can have several contents. In this way, the rational conflict among desires of Bratman [20] is avoided. The belief can be of any type, as integer, string and list. A swtich button named *show-intentions* also is recommended. The principal commands are:

1. **create-belief [b-type content]** to create the belief. It means that the belief is in the system, not that turtles already possesses it.
2. **add-belief [bel]** to provide the turtle with that belief.
3. **exists-belief [bel** that can be combined with the command *if* or others to modulate the simulation. It works just if there are beliefs of any type.
4. **exists-beliefs-of-type [b-type]** that can be combined with the command *if* or others to modulate the simulation. It can be focused on the exact type of the beliefs.
5. **read-first-belief-of-type** that can be combined with the command *if* or others to modulate the simulation. It detects the first belief, considering that several types can be part of a content of the same belief.

- Intentions

Intentions constitute the plans that have to be delivered so to turn the turtles into *proactive agents* [58]. Intentions are divided into *Intention name* (I-name) to individualize it, and the *Intention-done* (I-done) that represent the final state to be reached. For example, an intention like ["move-towards-dest [23 20]" "at-dest [23 20]"] means that the turtle will have to move towards the patch 23 20 just until it is on the turtle 23 20 [59]. Due to the fact that intentions will be executed as repeated plans followed by the agents, as in the model of the BDI-interpreter of Rao and Georgeff [55], they will have to be declared when the turtle is formed, before the simulation runs, and then to be activated within the ongoing comand of GO. Intentions are set within a *stack*. It means that the first will be executed after the last in the stack (that appears at the bottom of it) will be accomplished. This is another way to reproduce the rational sequence of the practical reason of Bratman [20].

1. **add-intention [name done]** to add the intention to the stack.
2. **execute-intentions** to be implemented within the forever button Go to activate the intentions.

3. **get-intention** that can be combined with the command *if* or others to modulate the simulation.

- Messages

Messages within the model FIPA-ACL are programmed as a *queue* that is created by the observer operating on the messages. The first characteristic of the messages are the *performative*, that is, what's the effect that the message has to produce, following Austin [9] and Searle's [62] theory of illocutionary acts, and its effective *content*. The observer himself has to *add* senders and receivers to the message. To take part to the message, the agents must possess the variable *incoming-queue* to whom the agent is added that has to be set at first to zero.
So, the queue within which a communicative message takes place has this shape:

> ["performative" "sender: *id* of the sender turtle" "receiver: *id* of the receiver turtle" "content"]

1. **create-message [performative]** to add the message and its performative action.
2. **add-content [content msg]** to add the effective content of the message.
3. **get-performative [msg]** to make a turtle receive a message.
4. **send [msg]** to make a turtle send a message.

3.3 Considerations and Conclusions

Rao and Georgeff claim that Bratman's model was the best to suit the complexity of mental states desired due to its modularity [55], and even though they conclude they did not succeed in simulating such complexity, the use of BDI let them manage a simulation sensitive to the context, balanced between goal-directed and reactiveness, and flexibile through representation. This was undoubtedly a mile stone in the social simulation programming, as the development of NetLogo libraries at the University of Thessaloniki demonstrates. Also the FIPA-ACL model for cooperative communication shows a good advantage in the information system within the artificial society. Their work to generate a flexible extensions adaptable to other simulations has turned programming simulations easier for users, according to NetLogo facilities. But some pitfulls can be attribuited to the BDI and FIPA-ACL architectures , due to their modularity and flexibility and regarding their social dimension.

- BELIEFS-DESIRES-INTENTIONS

1. Beliefs

BDI architecture fits correctly Fodor's [31] model of human mind, as resembled in Bratman. The author posted that the mind has a language of its own, made up of the atomic components of semantic area, that is, a *piece of knowledge* of the world that can be logically combined. Even though NetLogo programmers have turned the specifity of beliefs more flexible than in Rao and Georgeff [59] as shown when a belief is built under the shape of *type*, that is, a semantic area, e.g. "value" and any *content* is then added. But, unfortunately, recent progresses in cognitive sciences have criticized the idea of a mind as a closed system based exclusively on its logical inner system [63] as in Fodor and Bratman, and moved toward a model more and more accepted of *embodied cognition*, that is, a computational mind able to integrate informations coming from the interaction with the environment, also based on sensorial perception [5]. More than a mind that operates in the outside world after elaborating its modules represented in BDI by beliefs, nowadays science is keen to believe in an *adapting mind* able to learn and be reactive to the costant interaction with this world [22]. In this way, human agents are able to gain a *procedural knowledge* from the ongoing processing of information. This is something that seems impossible to BDI agents, whose beliefs mechanisms resemble the only *declarative knowledge* based on declaration and classification of reality [5]. With NetLogo a programmer could turn the interaction more complex through combinations like "if...then", but this could hardly been thought as equivalent of human procedural knowledge.

2. Desires and Intentions

As Desires and Intentions are imagined by Rao and Georgeff as motivational and deliberative state [55], they embrace the fields of study of motivations. The architecture of BDI fits the approach to motivation promoted by the stream of cognitivism, which stems for Atkinson's statement that people seek to achieve success and avoid unsuccessful outcomes [8]. This is what agents do as long as they execute intentions they have been built with, but their actions still follow the repetitiveness of actions of Rao's BDI interpreter [55]. In this way, they appear to fail an important feauture of cognitivism's approach to motivation: the elaboration of information useful to achieve the intended objectives. Due to the programmation of Intentions, agents in BDI, despite of the flexibility of NetLogo, lack of the above mentioned flexibility of an intelligent system, and exhibit a closed-loop behaviour hard to be find in human beings.

- FIPA-ACL

FIPA-ACL architecture is inspired by Austin [9] and Searle's [62] *Speech Act Theory*, through the notion of *illocutionary acts*, but some flaws seem to be there. The model of Austin and Searle is clearly part of that approach that

adds *meta-communication* [4] to communication itself. As Bateson [12] cites, when people communicate they are within a network of relations where two elements are simultaneously passed: the *news*, that is the content of the message, and the *order* that stresses the relation and eventually the hierarchy among communicators. In this way communications affect the social construction of *human relations* and their meanings. In this way emotions lead to the most abstract level of Speech Act Theory: the *Performative Utterance*, that is, the consequences we want to have in our audience. Despite wath is reported by Costin, Zoran, Hans-Dieter and Ivanovic' [11], it appears quite reasonable that these acts also drove FIPA-ACL development. NetLogo's name for messages itself is *performative*. But NetLogo's programmers [59] choise in detail have some flaws in reproducing communication. Their model looks like to be the perfect replica of Shannon and Weaver's model [65]. This was one of the first model of communication exclusively centred on the passage of information, but it has been equally criticized for the abscence of the psychological and social dimensions of participants [5].
Even though the noise is present in this model as an obstacle to communication, this is absent in NetLogo programming, where each agent has not other option but communicate and receive a clear message once the programmer has added it to the incoming-queue. Honestly, this participation to communication is totally unreal. Two principles explains why:*pars pro toto* and *totum ex parte* [4]. The former states that speakers can reproduce just a part of what they mean to say, due to the physiological limits of communication, but also due to the abscence of shared meanings and languages [40], while the latter indicates that people can elaborate just a part (of the part) intended by the speaker, due to the effect of physical obstacles and not shared meanings. In sum, FIPA-ACL seems to lack the presence of meta-communication and social dimension in the model proposed, besides reproducing a model of perfect communication that is hardly accepted by literature. The predominance of the programmer in *adding* agents to communications instead of letting them *contribute* seems wisely objectionable.

In conclusion, BDI and FIPA-ACL architecture, moreover as implemented in NetLogo, con turn a simulation efficient and interesting, and the platform does not add more to the original models. They both seem to be fixed to the theoretical paradigms of mind and communication as closed and logical systems, causing, paradoxically, the lack of social presence within them. Cognitive Sciences have accepted an opposite conceptions of adaptive mind and communication affected by emotions and relationships. So, the models inspiring the two architecture could seem quite old-fashioned and needing a revise. For what concerns FIPA-ACL in NetLogo, besides, the model of communication simulated is too unrealistic, both for clarity of messages and participation of agents.

Chapter 4

Simulation

4.1 Introduction

The purpose of the agent-based simulation here presented is to study the dynamics and economic outcomes of gender gap in entrepreneurship. The simulation relies on the interaction of two main agents: *people* eligible to become entrepreneurs and *arounds* that influence the former through communication and that will be their consumers too. *People* have the initial shape of a square and their gender is identified by their color: blue for men, pink for women. *Arounds* have the shape of a person and a different bright of green according to their age and they accept a stereotype promoting males or females as better entrepreneurs with a percentage chosen by the observer. Through the communication of the stereotype they believe in, *arounds* can influence the activation in *people* of the components hypothesized as promotors of entrepreneurial intention according to the *Theory of Planned Behaviour* (TPB) of Fishbein and Ajzen [3]. Once *people* choose to become entrepreneurs, they get the shape of a triangle, their gender and color is the same, and the enterprise they start is to build and rent apartment houses, following the strategy of the *price differentiation* [26].
This strategy moves from the idea that consumers have a *reservation price*, that is, the highest pirice they are willing to pay for a good, and every consumer has a *surplus* associated, identified by the positive difference between what they pay and what their reservation price is. By differentiating the prices of a good, entrepreneurs can turn the consumer surplus into *producer surplus*, that is, getting more money than they would if the price were the same. For instance, if the subject A has a reservation price of 6 and the subject B a reservation price of 3, a price of 4 by the consumer would be accepted only from the subject A, but not B. If the price were 3, it would be accepted from both of them, and perhaps the subject A would be also more "willing", as he would have paid the double. Knowing attitudes among groups, and their reservation prices, could help producers to get the highest profits they can from the market [26]. The

differantiation price here depends on the age of *arounds* who have a reservation price of their own. Once they come across an apartment house, they are unknown of the effective market price of the house, as they know just the price they are offered. If this is lower than their reservation price, they will pay the rent and reside in the building. So, entrepreneurs can increase their capital to be reinvested in building new apartment houses, in a never-ending process.

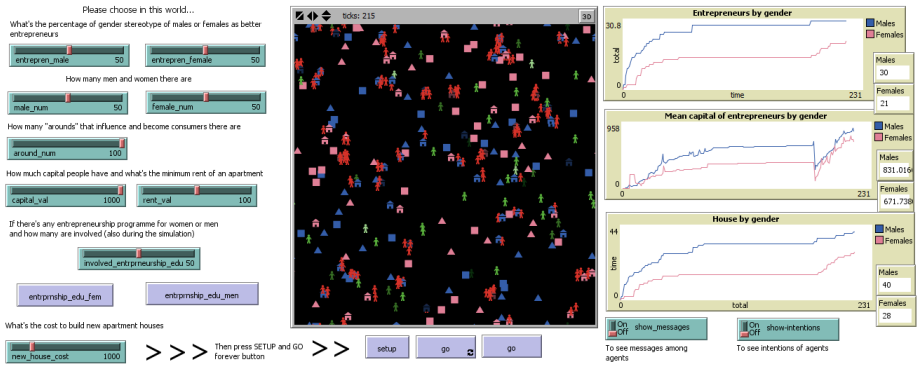


Figure 4.1: The simulation during its execution

4.2 Principal Codes

- **Intentions**

The component *beliefs* of BDI is used to reproduce values of *people* and stereotype aderence of *arounds*. *People* are divided into three groups. For each, the *belief-type* is *value*, meaning what is really important to that person, while the *belief-content* varies according to the three features of entrepreneur stereotype as found in literature. The three features are *self-achieving*, *independence* and *risk-taking*. As the algorithms are the same, only the ones concerning *risk-taking* are here reported.

> ask n-of (count people / 3) people [add-belief create-belief "value" "risk-taking" add-intention "receive-msg" "false"]

Arounds are divided in two groups, according to the belief of males or females as more eligible to become entrepreneurs. The width of the group depends on the sliders *entrepren-male* or *entrepren-female*.

> ask n-of ((around-num / 100) * entrepren-male) around [add-belief create-belief "entrepreneurship" "male-gender"]

An educational intervention fostering entrepreneurial intentions for those who have less probabilities to become entrepreneurs is simulated. It is activated by the buttons *entrprnship-edu-men* for males, or *entrprnship-edu-fem* for females. This will increase their probabilities, by turning the weight of perceived behavioural control to **.5**.

```
ask n-of ((count people with [color = pink] / 100) * involved-entrprneurship-
edu) people with [color = pink] [ add-belief create-belief "I can be an
entrepreneur" "even though they state the opposite" set per-be-con
.5]
```

- **Sending Communication**

Arounds are forced to communicate, through the command *comunicate-entrepreneurship*, activated within the component *intention* of BDI.

1. Entrepreneur stereotypes
   This kind of messages has a unique label of the message, *entrepreneurs-stereotype*, and its contents change, according to the three chosen stereotypes found in literature:

   ```
   if any? people-on neighbors [send add-receiver people-neighbors add-
   content "Entrepreneurs are risk-takers" create-message "entrepreneurs-
   stereotype"]
   ```

2. Gender Stereotypes
   This kind of messages has the label of the message *gender-stereotype*, while the content of the message varies according to one of the three feature of entrepreneurship found in literature. Thus, the messages concerning gender stereotypes are as follows:

   - *Stereotypes promoting males as entrepreneurs*

     ```
     if any? people-on neighbors [if exists-belief ["entrepreneurship" "male-
     gender"] [ send add-receiver people-neighbors add-content "Males are
     risk-takers, females are cautious" create-message "gender-stereotype"]]
     ```

   - *Stereotypes promoting females as entrepreneurs*

     ```
     if any? people-on neighbors [if exists-belief ["entrepreneurship" "female-
     gender"] [ send add-receiver people-neighbors add-content "Females
     are risk-takers" create-message "gender-stereotype"]]
     ```

- **Receiving Communication**

People are forced to receive the communications from arounds, through the intentions they execute called *receive-msg*. Receiving such messages modifies the components of the TPB:

1. Attitudes Towards Behaviour
   If the content of the messages about the stereotypes of entrepreneurs fits the values of the person, they will gain a weight equal to **.5** for the attitudes towards behaviour

   ```
   let msg get-message if get-performative msg = "entrepreneurs-stereotype"
   and get-content msg = "Entrepreneurs are risk-takers" [if exists-belief
   ["value" "risk-taking"] [set att-to-be .5]]
   ```

2. Social Norms and Perceived Behavioural Control
   This two components of the TPB are influenced by the communications of the gender stereotype, and the weight of **.5** for both of them is gained when the content of the message fits the gender of the people receiving it and their value, as follows:

   - *For males:*

     ```
     set msg get-message if get-performative msg = "gender-stereotype"
     and get-content msg = "Males are risk-takers, females are cautious"
     [if exists-belief ["value" "risk-taking"] [if color = blue [set sbj-norm
     .5 set per-be-con .5] if color = pink [set sbj-norm 0 set per-be-con 0]]]
     ```

   - *For females:*

     ```
     set msg get-message if get-performative msg = "gender-stereotype"
     and get-content msg = "Females are risk-takers" [if exists-belief ["value"
     "risk-taking"] [if color = blue [set sbj-norm 0 set per-be-con 0] if color
     = pink [set sbj-norm .5 set per-be-con .5]]]
     ```

- **Becoming Entrepreneurs**

Following the TPB, if the sum of the components of *social norms*, *attitudes towards behaviour* and *perceived behavioural control* is more than **1**, *people* will become entrepreneurs. Their breed and shape will change, leaving the same colour of gender. As the enterprise proposed is that of renting apartment, through the command *sprout* a turtle whit the shape of a house is generated, bound to the entrepreneur through the variable *myOwner*

```
ask people [if (att-to-be + sbj-norm + per-be-con ) >= 1 [set breed en-
trepreneur set shape "triangle" let aName who if color = blue [ask patch-
here [sprout-house 1 [setxy random-xcor random-ycor set color blue set
shape "house" set myOwner aName]]] if color = pink [ask patch-here
[sprout-house 1 [setxy random-xcor random-ycor set color pink set shape
"house" set myOwner aName]]]]]
```

- **Economic strategies**

1. Price Differentiation
   Price Differentiation is gained through the addition of a *surplus* to price market, varying due to the age of arounds indicated by the bright of their color. Just one category is given as example:

```
ask house with [color = blue or color = pink] [if any? turtles-here
with [color = green + 6] [set surplus 100] ]
```

2. Decreasing rent
   As every entrepreneur is a competitor to others, when a house in the neighbors has a different *myOwner*, the surplus will decrease of **.05** unit

```
ask house with [color = blue or color = pink] [if any? house-on
neighbors [if any? house with [myowner != [myowner] of myself]
[while [rent >= rent-val + 1] [set rent rent - .5]]]]
```

3. Trading
   Arounds come across a house. If its price is lower than their reservation price, they will choose it, spending the rent required, stopping here and becoming red.

```
ask around [ifelse any? house-here [if sum [rent] of house-here <=
[reservation-price] of self [ set expense sum [rent] of house-here set
color red stop]] [fd 1 rt 360]]
```

   Once they are in the house, identified as red, the money they spend will pass to the capital of that house.

```
ask house with [color = blue or color = pink] [set capital sum [ex-
pense] of turtles-here with [color = red]]
```

   When the capital of the house is higher than the cost of building a new one, assessed through the slider *new-house-cost*, there will be an investement of the entrepreneur in building a new house, through the command *hatch*, that will reproduce a house identical to the first. New houses have a brighter colour, those who have reached the level a darker one.

```
ask house with [color = blue or color = pink] [if capital > new-house-
cost [hatch 1 [setxy random-xcor random-ycor] set color color - 3
]]
```

   Finally, through the combination of the variables *aName* of entrepreneurs and *myOwner* of houses, the capital of the house will increase the capital of the entrepreneur.

```
ask house with [color = blue or color = pink] [if any? house-on
neighbors [if any? house with [myowner != [myowner] of myself]
[while [rent >= rent-val + 1] [set rent rent - .5]]]]
```

4.3 Results

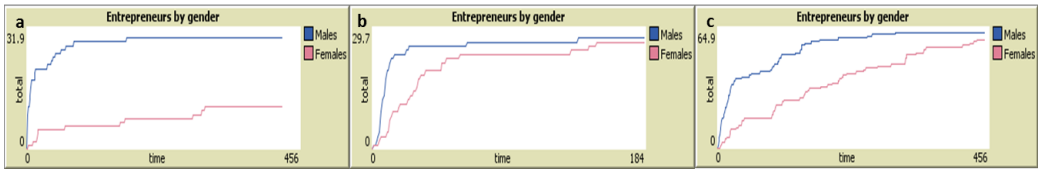
Three plots were used, detecting the number of *Entrepreneurs by gender*, *Houses by gender*, and the *Mean capital of entrepreneurs by gender*. Each of them has a monitor associated for both males and females. The variables considered to

assess the emergent outcome of the simulation are *predominance of stereotypes promoting males or females*, *number of males or females*, *number of arounds*, *cost to buy a new house*, *presence of the educational intervention*. The most relevant results follow, showing the comparisons among situations necessary to support them.

- The highest participation of a gender to entrepreneurship compared to the other is not due to the highest presence of the stereotype associated with that gender, but to the *difference between them*. The higher is the difference, the higher is the probability for the members of that gender to become entrepreneurs.

Situation	M.E.	F.E.	N.M.	N.F.	N.A.	N.H.	E.E.
a	75	20	50	50	100	1000	NO
b	50	50	50	50	100	1000	NO
c	40	10	50	50	100	1000	NO

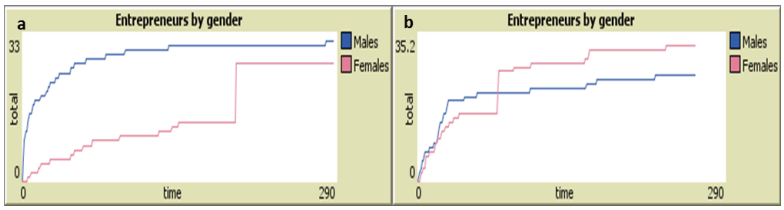
Table 4.1: M.E = Males Entrepreneurs, F.E. = Females Entrepreneurs, N.M. = Number of Males, N.F. = Number of Females, N.A. = Number of Around, N.H. = cost of New Houses, E.E. = Entrepreneurship Education intervention



- An intervention aimed at promoting entrepreneurial intentions among disadvantaged groups can *overcome the distance* between them, but if equality is already reached, it can cause a *new disequality* in the opposite direction.

Situation	M.E.	F.E.	N.M.	N.F.	N.A.	N.H.	E.E.
a	70	20	50	50	100	1000	YES
b	50	50	50	50	100	1000	YES

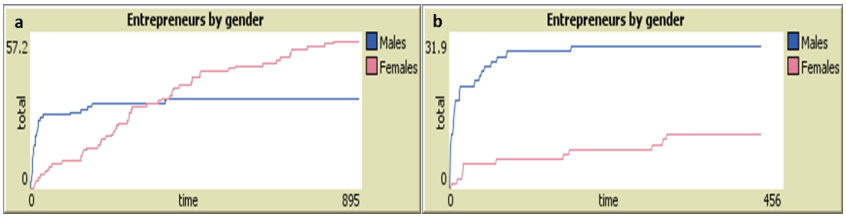
Table 4.2: M.E = Males Entrepreneurs, F.E. = Females Entrepreneurs, N.M. = Number of Males, N.F. = Number of Females, N.A. = Number of Around, N.H. = cost of New Houses, E.E. = Entrepreneurship Education intervention



- The most intriguing result is that *the group most disadvantaged has the highest participants in entrepreneurship, if the number of its member is higher*. This could be explained by the duration of the exposure to the message. That is, using the examples of females, even though males become immediately entrepreneurs due to the most predominant stereotype, they will be continuously exposed to the stereotype concerning them, nevertheless it has a lower percentage. This could be what is found in literature as Moscovici's theory of *minority influence*, according to which social change can be reached if the minority group shows consistency among its members (*synchronic consistency*) and over time (*diachronic consistency*) [49]. The *arounds* promoting females as better entrepreneurs could be acting as a minority group, and females, as numerically higher and forced to listen to their messages, could benefit from this minority group, leading to *social change*.

Situation	M.E.	F.E.	N.M.	N.F.	N.A.	N.H.	E.E.
a	75	20	50	100	100	1000	NO
b	75	20	50	50	100	1000	NO

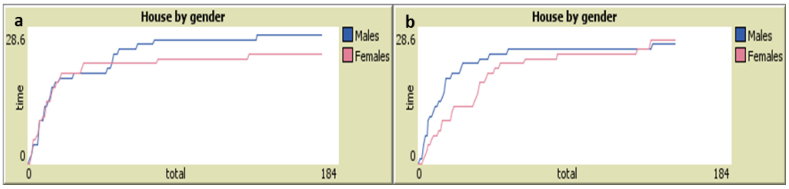
Table 4.3: M.E = Males Entrepreneurs, F.E. = Females Entrepreneurs, N.M. = Number of Males, N.F. = Number of Females, N.A. = Number of Around, N.H. = cost of New Houses, E.E. = Entrepreneurship Education intervention



- The highest price to build a new house doesn't affect the economic dynamics of the simulation, but *slows them down*. This can be detected through the condition of gender equality.

Situation	M.E.	F.E.	N.M.	N.F.	N.A.	N.H.	E.E.
a	50	50	50	100	100	1000	NO
b	50	50	50	100	100	3000	NO

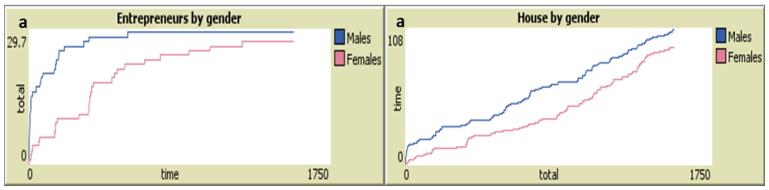
Table 4.4: M.E = Males Entrepreneurs, F.E. = Females Entrepreneurs, N.M. = Number of Males, N.F. = Number of Females, N.A. = Number of Around, N.H. = cost of New Houses, E.E. = Entrepreneurship Education intervention

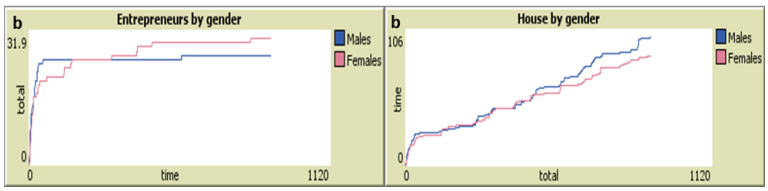


- The higher number of *arounds* doesn't affect the effect of gender stereotypes, nor the number of entrepreneurs nor their activity. It only seems to make *the appearance of entrepreneurs and trading of houses quicker.*

Situation	M.E.	F.E.	N.M.	N.F.	N.A.	N.H.	E.E.
a	50	50	50	50	50	1000	NO
b	50	50	50	50	100	1000	NO

Table 4.5: M.E = Males Entrepreneurs, F.E. = Females Entrepreneurs, N.M. = Number of Males, N.F. = Number of Females, N.A. = Number of Around, N.H. = cost of New Houses, E.E. = Entrepreneurship Education intervention





4.4 Conclusion

BDI protocol was used in the simulation here presented to study mechanisms and effects of entrepreneur stereotype and gender stereotype through communication as a possible explanation of the gender gap in entrepreneurship, and to simulate the model of the Theory of Planned Behaviour in entrepreneurial intention activation. Results seem to confirm that gender stereotype communication can influence people's intention to become entrepreneurs through 3 domain: *predominance of a stereotype over another*, *duration of exposure* and *number of receivers*. These could be of valuable interest for policy makers due to the interest they are paying to entrepreneural education [51].
The first domain shows how it is not necessary to introduce a new stereotype or changing a previous one, as long as attention hasn't being paid to the difference of this new stereotype with the predominant one. This means that research should be made first on what are the relations and magnitudes of sociocognitive antecedents, that is *beliefs* of social agents in order to improve the effectiveness of an intervention. The aspect of duration seems really intriguing, as it could be seen as a hope that social change, even though hard to be achieved, can happen in the future if the efforts are continuous, but also that ignoring a negative stereotype can turn it even more widespread in the future. The third aspect too is of a relevant interest, because it shows how the number of participants involved in the phenomenon studied can affect the outcome of the intervention. Thus, through the discovery of this three domains the simulation seems to demonstrate how the use of agent-based models can be a valuable support to policy makers involved in social change. Whilst most of the studies conducted about the gender gap in entrepreneurship have focused exclusively on the content of stereotype activation [36], the results here reported show how the focus should be more complex, including not only *what a stereotype says* and *what's the most followed*, but also how much it is "more followed" *compared to* others, *how long* it has been followed, and *how many people* have been its target.
Obviously, this simulation has some limits, first of all the simplicity in communication, as all agents are forced to communicate, and this could have affected the results. More sofisticated simulations can be wished, also for what concerns the economic dynamics and outcomes of the trading here reproduced, but we can affirm that the simulation conducted shows how the method of agent-based simulations can be an effective support to insights of social sciences and choices of policy making.

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