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**THE ROLE OF EMOTIONS IN THE
CREATION OF WEALTH IN NETWORKS:
A STUDY ON SOCIAL CAPITAL**

Tesi di Laurea in Simulation Models for Economics

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Introduction

The idea at the base of this work comes from wondering how emotions, fundamental part of the human decision process, affect the creation of wealth in networks among agents.

Network analysis is a theoretical construct useful in social sciences to study the relationships between individuals, group or organizations.

The ties through which any given social unit connects represent the convergence of the various social contacts of that unit. An axiom of social network approach is that social phenomena should be primarily conceived and investigated through the properties of relations between units, instead of the properties of these units themselves. Thus, one common criticism of social network theory is that individual agency is often ignored.

Usually the social network theory has been studied inside the classical economic theory framework. According to the classical economic theory, human decision-making is emotion-free and involves logical reasoning based on cost-benefit calculations. This theory assumes that individuals have unlimited time, knowledge and information processing power and can therefore make perfect decisions.

Unsatisfied by these assumptions, we started to get fascinated by the behavioral studies and agent-based modeling.

Behavioral economic theory proposes that emotions play a critical role in our ability to make fast, rational decisions in complex and uncertain situations. Furthermore it highlights inefficiencies such as under or over reactions to information as causes of market trends. Such reactions have been attributed to limited investor attention, overconfidence, overoptimism.

Agent-based model (ABM) is a class of computational models for simulating the actions and interactions of autonomous agents with a view to assessing their effects on the system as a whole.

The model simulates the simultaneous operations and interactions of multiple agents, in an attempt to re-create and predict the appearance of complex phenomena.

We choose to use ABM to investigate the creation of wealth in networks, and to implement the model with behavioral features in order to establish their relevance in economic choices.

Listed below the chapters that compose our work. We will not describe in detail the arguments of each chapter, as an introduction is already present at the beginning of every chapter. We will provide only a general description.

Chapter 1 is a review concerning some of the most relevant concepts of social capital.

This part is fundamental in order to have a clear idea of one of the two pillars at the base of our simulation.

We start describing some of the more interesting insights that help constructing the social capital theory. Historically, we will briefly summarize the foundation of Aristotle, the Mediaeval contribution of Thomas Aquinas, the conservative view of Burke, the debate of community versus modernization of society and individualism and the structural holes theory of Burt. A paragraph is dedicated to the development of the definition of social capital in the field of the creation of human capital and his importance in the nowadays communities.

Fundamental is the section dedicated to the conceptualization of social capital aimed at simplify the complexity of the social world to better its dynamic and structures.

Chapter 2 is dedicated to the second pillar of our simulation: emotions.

Emotions are defined as a set of subjective and conscious experiences that are characterized primarily by psychophysiological expressions, biological reactions and mental states. Emotions enter in the modern formulation of economic theory just recently, but with great emphasis, establishing an important branch named behavioral economics.

As for the chapter dedicate to social capital we briefly describe the main contributions to this theory from an historical point of view.

Of particular interests the last two paragraphs. One is dedicated to behavioral economics, in which we will see how some psychological features tried to improve the classical economic theory. The last paragraph is dedicated to an interesting paper of Parisi and Petrosino “Robots that have emotions” that deals with the possibility of introducing emotions in robots and the relative increase in their performance. This work has been of great influence, giving us tips for our simulation.

Chapter 3 is the core of our work. Our simulation has the purpose to help understand the dynamic at the base of the behavior of agents in an environment with networks. The simulation is divided in two parts. The first one analyzes how agents create networks and consequently wealth under rationality assumptions. In the second part of our simulation we implement emotions on our agents, variables that now collaborate in driving their decision process.

We will describe in deep the axioms at the base of the program and the program code. Finally an exhaustive set of experiments will be performed, letting us infer on the increase/decrease in performance after the implementations of emotions. Conclusions will follow.

1. Social Capital

1.1 Definitions of Social Capital

Social Capital is a field that have been of interest mainly of sociologists for long time, just recently economic researchers discover and start studying the economic aspects derived by the interconnections between individuals.

There is not a formal, unique and definitive definition of social capital, scientists have given different interpretation and underlie different aspect of this capital (Adler and Kwon, 2002).

The first time social capital was mentioned was in an essay of the 1920 of Lyda Judson Hanifan, an American scholar that stated:

I do not refer to real estate, or to personal property or to cold cash, but rather to that in life which tends to make these tangible substances count for most in the daily lives of people, namely, goodwill, fellowship, mutual sympathy and social intercourse among a group of individuals and families who make up a social unit... If he may come into contact with his neighbor, and they with other neighbors, there will be an accumulation of social capital, which may immediately satisfy his social needs and which may bear a social potentiality sufficient to the substantial improvement of living conditions in the whole community. The community as a whole will benefit by the cooperation of all its parts, while the individual will find in his associations the advantages of the help, the sympathy, and the fellowship of his neighbors. (1920)

Is relevant in the study of this field, to have a solid base on which starting our analysis.

1.1.1 Foundation of Aristotle

We start our preface about the definition of social capital, taking advantage of one of the most famous contribution of Aristotle.

The studies of the Greek philosopher, that here we report, can be elected as the first attempt to give a role to social capital in the development of society.

This contribution is of interest because point out, how through the synergies between individuals, discussion and conciliation the polis¹ can achieve the higher result regarding rule making process.

In his work “Politics” he classified government into three types.

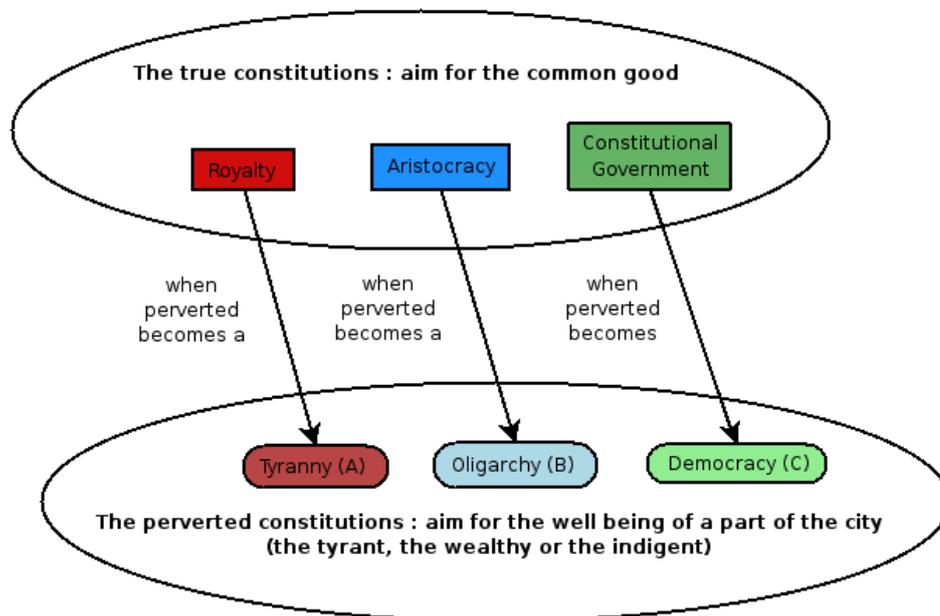


Fig. 1. Government classification by Aristotle.

(<http://upload.wikimedia.org/wikipedia/commons/0/0e/Aristotle-constitutions-2.png>)

¹ The term *polis* (pl. *poleis*, in greco antico πόλις, "città") indicates a city-state in ancient Greece

The first type is the government based on rule by the one, in which like in a coin there are two sides. The good one belongs to the Monarchy, in which a single ruler governs for the benefit of the people and his purpose are: good law, order and social justice.

The other side belongs to the perverse deviation of this form of government and his call Tyranny. In that case the ruler follows an ideological path that drives him to pursue his own benefit and ego, satisfying his lust for power.

The second type of government is based on the rule by the few. Also in this case there is for Aristotle a positive attitude that reflect the role of the Aristocracy, from the Greek words “aristos” excellent and “kratos” power that describes those few people that participate in the governance of the state and are considered the wisest, the most just and honest among the citizens. The perverse form of aristocracy is oligarchy where few people take over the power of government not for the welfare of the community but for their own interest.

The last type of government analyzed by Aristotle is based on rule by the many. He argued that the best form of politics, but maybe the most difficult to achieve is “polity” or political community. A polity occurs when all citizens of the state participate in the decision making process through discussion, compromise and conciliation.

The philosopher comes to this conclusion because he believes the public life is far more virtuous than the private. Connections and network among the citizens create a public amount of knowledge that cannot be reach neither by a single individual nor by an even wise elite.

The perverse form of polity is democracy, the government way that today is common to all what is considered be the develop World. Aristotle stated that in democracy the individuals votes not for the interest of the public, but just following their own goal and a common desire of compromise and conciliation is missing.

1.1.2 A Mediaeval view

Our research on the evolution of the definition of social capital takes us to the contribution of Thomas Aquinas.

In a time, where the societies were established on the rule of the strongest and brutality and oppression of the weaker were the norms, the Aquinas stressed the importance of community governance related to the topic of social justice. His view was certainly unusual for the time, but can be considered a first, important attempt to deviate from an unfair society and give a prominent role to justice.

In distributive justice something is given to a private individual, in so far as what belongs to the whole is due to the part, and in a quantity that is proportionate to the importance of the position of that part in respect of the whole. Consequently in distributive justice a person receives all the more of the common goods, according as he holds a more prominent position in the community. This prominence in an aristocratic community is gauged according to virtue, in an oligarchy according to wealth, in a democracy according to liberty, and in various ways according to various forms of community. Hence in distributive justice the mean is observed, not according to equality between thing and thing, but according to proportion between things and persons: in such a way that even as one person surpasses another, so that which is given to one person surpasses that which is allotted to another. (1265)

1.1.3 A Conservative view

With the rise of the classical theory a huge debate started on the role of the individual, seen by the representative of this theory as purely rational and self-interested.

This environment let of course little space to any kind of improvement reached through cooperation and the role of the community and its improvement find little space in the enlightenment theories.

To defend the value and role of the community born a new political philosophy called Conservatism.

The philosopher and political theorist Burke was a notable exponent of this school of thought, that if one side accepted the idea of Smith in the economic and private property fields on the other consider that these ideas had to remain subordinate to the conservative social ethics and traditions. The value of the community and social harmony over the laissez-faire capitalism and individualism.

Among the father of sociology a huge debate have been made about the value of community in the Homo economicus and laissez faire environment, that drives men toward individualism, transforming social relationship in an irreversible way and developing anomie and alienation in society.

1.1.4 Community Vs. Individualism

The debate of community versus modernization of society and individualism has been one of the most discussed topics among the fathers of sociology.

The attempt is to give a quick view of the main features of most well known contributions on this field.

Spend some time on these theories leads to better understand the role of the individual and is need, that can be more or less amplified by the type of society he lives in, to have a role inside the community, following a common goal.

The first author we decide to mention is Tonnies, a sociologist that studied the distinction between two types of social groups: *Gemeinschaft* and *Gesellschaft*. (1887)

Gemeinschaft, a German word meaning community, is an association in which the individuals take care of the “group” as least as of their own self-interest.

Individuals that take part of the *Gemeinschaft*, share the same values, a common feeling of togetherness and mutual bonds looking at the same goal. They are expression of unity of will.

A family or neighborhood in a pre-modern society is historically exemplified by this kind of association.

Gemeinschaften is characterized by a moderate division of labor, strong personal relationship and simple social institutions. In this kind of society the control is poorer compare to the nowadays society.

The other social group was named by Tonnies, *Gesellschaft*. This German word means society; this kind of relationship arises in an urban and capitalist setting, where individuals pursue their own goals. Individualism and impersonal monetary connections between people are the key characteristics of Tonnies’s *Gesellschaft*.

Gesellschaft emphasize secondary relationships rather than familiar ones. There is less individual loyalty towards society and more control is needed compare to the Gemeinschaft. Class conflict are also much more common in this individualistic and self-interest society.

For Tonnies the distinction between these two types of social groups derives from his assumption that there are two wills that drive the human nature. If a man follows what he defines “essential will” he serves the goal of social grouping, if instead the man follows what is defined “arbitrary will” he sees social grouping, as a way to pursue individual goals.

Grouping formed following the former will, are called Gemeinschaft, instead the one formed with the latter will, are called Gesellschaft.

Moving to another important contribute, Durkheim cannot be forgot.

His works were concerned about, how modern society in an environment of individualism can maintain their integrity and unity.

The importance of social integration is stated by Durkheim as:

For if society lacks the unity that derives from the fact that the relationships between its parts are exactly regulated, that unity resulting from the harmonious articulation of its various functions assured by effective discipline and if, in addition, society lacks the unity based upon the commitment of men's wills to a common objective, then it is no more than a pile of sand that the least jolt or the slightest puff will suffice to scatter.
(1896)

In his Magnus Opera “De la Division du Travail Social” he studied what can hold a society together. He assumed that humans are basically egoistic and selfish by nature, but values, norms and beliefs form a common basis of a society, resulting in social integration.

Especially the values take great importance in the works of Durkheim, that are defines by the French sociologist as collective consciousness that are fundamental for the creation and development of a society and are created through interactions.

The totality of beliefs and sentiments common to the average members of a society forms a determinate system with a life of its own. It can be termed the collective or common consciousness. (1893)

The human being is drive mainly by the collective consciousness, overriding the personal pulse to egoism and selfish behavior.

People act socially, because recognize in the social interactions the responsible way to act. Durkheim suggests that social interactions are the key to form a society.

Another social fact that is of mainly importance for the French sociologist is culture. Groups of people when interacting form a culture, that spread between the individuals and emotions are attached to it.

Durkheim was also interested to the value of cultural diversity, understanding is existence he states that diversity doesn't erodes bonds among people, because is a characteristic inherit in the society and the law and a more general upper system have the role to maintain people together despite these diversities.

A concept of interest for the French sociologist is solidarity studied in a socio-evolutionary approach.

According to Durkheim the society has evolved from mechanical solidarity to organic solidarity and the types of social solidarities are correlated with the types of societies.

Mechanical solidarity derives from a society where the cohesion among individuals derives from the homogeneity of individuals like in education, religion and lifestyle.

This kind of solidarity is typical of traditional and small societies.

In mechanical societies, people are self-sufficient, the options in the life of a person are few, there is not much need of integration and as consequence the use of the force is necessary to hold the society together.

As the society became more complex the solidarity switch from mechanical to organic and the division of labour replaced the collective consciousness.

Organic solidarity derived exactly from this interdependence and interconnection at the base of modern societies. In industrial societies the individuals perform different tasks and have different values, the solidarity comes from the interdependence at the base of this community.

The spontaneity and necessity of this interdependence hold the society together and compare to the rural societies, the use of force to ensure the society together is far less needed.

The Collins dictionary of sociology differentiates the two types of solidarity following four features.

Feature	Mechanical solidarity	Organic solidarity
Morphological (structural) basis	Based on resemblances (predominant in less advanced societies) Segmental type (first clan-based, later territorial) Little interdependence (social bonds relatively weak) Relatively low volume of population Relatively low material and moral density	Based on division of labour (predominately in more advanced societies) Organized type (fusion of markets and growth of cities) Much interdependency (social bonds relatively strong) Relatively high volume of population Relatively high material and moral density
Types of norms	Rules with repressive sanctions	Rules with restitutive sanctions

(typified by law)	Prevalence of penal law	Prevalence of cooperative law (civil, commercial, procedural, administrative and constitutional law)
Formal features of conscience collective	High volume High intensity High determinateness Collective authority absolute	Low volume Low intensity Low determinateness More room for individual initiative and reflection
Content of conscience collective	Highly religious Transcendental (superior to human interests and beyond discussion) Attaching supreme value to society and interests of society as a whole Concrete and specific	Increasingly secular Human-orientated (concerned with human interests and open to discussion) Attaching supreme value to individual dignity, equality of opportunity, work ethic and social justice Abstract and general

Fig. 2. Differences between mechanical and organic solidarity. Collins Dictionary of Sociology pp. 405-406.

One of the main features of the organic, modern society is what has been defines by Durkheim “cult of the individual”.

Thus very far from there being the antagonism between the individual and society which is often claimed, moral individualism, the cult of the individual, is in fact the product of the society itself. It is the society that instituted it and made of man the god whose servant it is. (1893)

The individual became the main holding point that keeps together the modern society. The French sociologist saw population as the key factor explaining evolution. Increase in the population led to an increase in the complexity of the society and in the division of labour. The importance of the individual and the law enforcement increase while the role of solidarity and religion decrease.

Simmel was a sociologist and philosopher that focused part of his studies on the different form of interaction among people and the ability of actors to create social structure.

He defined sociability as all the forms of association by which a mere sum of separate individuals are made into a society.

He was especially interested in the impulse to sociability proper of the individuals. Association is seen as the answer to the solitariness of the individuals and is driven by every kind of impulse such as cordiality, amicability and every kind of attractions.

The kind of sociability described by Simmel is in some way idealistic and designed as an interaction construct over equality, in a spirit of fun and affection that deny any disturbing material intrusion.

Of interest is the definition gives by the German sociologist of the “Stranger” in the last chapter of his book *Soziologie* (1908) in which Simmel discusses how, if a person is close to an actor is considered part of the group and on the other side, a big distance automatically exclude the individual.

The Stranger is close to us, insofar as we feel between him and ourselves common features of a national, social, occupational, or generally human, nature. He is far from us, insofar as these common features extend beyond him or us, and connect us only because they connect a great many people. (1908)

Compare to other forms of social distance, like class or gender, the distance of a stranger as to do with his “origins”.

The stranger is considered extraneous to the group even if in constant relation with it. His distance in the origin is emphasized more than his nearness in the daily life. The stranger is considered as being in the group but not part of it. As consequence of his peculiar condition, he can be elected to role that other individuals of the society are incapable to carry on in a proper way; like being elected as judge using his distance from the local dispute as guarantee of impartiality. (Karakayali, 2006)

His presumed distance from everybody else in the society, bears a certain objectivity and freedom that makes him a valuable member inside the community.

Objectivity may also be defined as freedom: the objective individual is bound by no commitments which could prejudice his perception, understanding and evaluation of the given. (The Stranger, 1908)

As conclusion, the role and opinion of the stranger, if on one side doesn't matter as consequence of his lack of connection with the rest of the community, on the other side the consequence of his position gives him the objectivity and freedom necessary for taking unbiased decisions.

Weber was a sociologist, philosopher and political economist and with Durkheim and Marx was considered one of the fathers of sociology. (Kim, 2007)

Of main importance are some of his works on economic sociology and on the “disenchantment”; term borrowed from Friedrich Schiller to describe the modern

Western society characterized by rational goals and where scientific understanding has greater value than traditional beliefs. (Weber, 1971)

Weber was concerned about understanding how social action comes from the conjunct work of both subjectivity and objectivity.

The understanding or “verstehen” German term, that in the context of philosophy and social sciences means an interpretative and participatory examination of social phenomena, must be based on understanding the subjective purpose at the base of the individual actions.

The principle of “methodological individualism” introduced as a methodological precept for the social sciences by Max Weber and defined as the theory that pursues how social phenomena, can be accurately explained just showing how their origins come from the intentional motivations of individual actors.

In other words, Weber argued that social phenomena can be understand just through models based on the behaviour of individuals. That kind of models are defined by Weber “ideal types”, described as subjective elements in social theory, necessary to build hypothetical concept in abstract needed as based of the sociology research and that distinguish it from natural science.

Ideal types never exist in reality, but provide objective benchmarks against which real-life can be measured.

We know of no scientifically ascertainable ideals. To be sure, that makes our efforts more arduous than in the past, since we are expected to create our ideals from within our breast in the very age of subjectivist culture. (1909)

Weber’s essay “The Protestant Ethic and the Spirit of Capitalism” is an interesting work based on the study of the interaction between various religious ideas and the economic behaviour.

The German sociologist supported the thesis that, the protestant countries like England and Netherland developed better capitalistic economy compare to the Catholic countries like Spain, Italy and French.

The development of the concept of the calling quickly gave to the modern entrepreneur a fabulously clear conscience – and also industrious workers; he gave to his employees as the wages of their ascetic devotion to the calling and of co-operation in his ruthless exploitation of them through capitalism the prospect of eternal salvation. (1905)

Protestantism religion according to Weber help entrepreneurship attitude and through a less blocked society, where people according to their ability can perform an increase in their living standard regardless to the family origin, stimulates the creation of networks that result in better economic performance.

The most important book of Weber related to our topic about social capital, is without doubt “Economy and Society” published in 1922 with his wife Marianne.

Alongside with “The Protestant Ethic and the Spirit of Capitalism” is considered one of his magnus opera.

Weber in his treatise “Economy and Society” started defining sociology as the science that tries to interpret the social actions of agents to reach a formal explanation of the motivations and causes.

The action is defined social when starting from the subjective goals of the individual, take into consideration the behaviour of the others, becoming “guided”.

Weber studies the economy as a social phenomenon. The economy results from the community, where the tangible and intangible goods are distributed.

This distribution result being often unequal and necessarily the power display a fundamental role.

The network created inside and among the different group of a society influenced the creation and distribution of the power and consequently of the resources.

Classes, Status groups and parties are phenomena of the distribution of power within a community. (1922)

Status groups make up the social order, Classes the economic order and Parties the legal/political order.

Power is the “chance of a man or a number of men to realize their will in a social action even against the resistance of others who are participating in the action” (1922)

Power may rest of a variety of bases, and can be of different types:

Economically conditioned power is not identical with “power” as such. On the contrary, the emergence of economic power may be the consequence of power existing on other grounds: Man does not strive for power only to enrich himself economically. Power, including economic power, may be valued for its own sake. (1922)

Class is defined in the economic context. A class exist when a number of people share common economic interest in owning goods and opportunity of earning.

When the conditions of the market prevail, for example in capitalistic economies, the property enforcement is fundamental for the classification of a Class.

Collective actions based on Class situations are determined by the connections between the causes and consequences of the class situation.

Differently from Classes, Status group are determined from the distribution of social honour.

In many case Status situation is the result of an economic stratification:

“Stratification by status goes hand in hand with a monopolization of the ideal and material goods or opportunities” (1922)

In this case the Class situation is predominant respect to the Status situation. Instead:

When the bases of the acquisition and distribution of goods are relatively stable, stratification by status is favoured. (1922)

Technological and economic changes threaten stratification by status, and "push class situation to the foreground... Every slowing down of the change in economic stratification leads, in due course, to the growth or status structures and makes for a resuscitation of the important role of social honor" (1922)

In conclusion there are many factors that help to determine the relations between economy and society according to Weber.

1.1.5 The Role of Social Capital in Human Capital and Society

The aim of this paragraph is to follow the development of the definition of social capital in the field of the creation of human capital and his importance in the nowadays communities.

Jacobs (1961) defined social capital referring to the informal interpersonal relations essential for the correct development of the complex and modern societies.

The American sociologist spends most of his life studying the complexity of the modern community, like New York City.

The city is like a living being that is born, grows, matures, decays and can revive. The elements of the city, “the people, streets, parks, neighbourhoods, the government, the economy” cannot exist without one another and are, like the organs of the human boy, connected with each other. (1961)

In this evolutionary approach streets play an important role: they are the lifeblood where urban dwellers meet each other and where trade and commercial activities take place. The street is the scene a "sidewalk ballet," according to Jacobs, which determines the security, social cohesion and economic development of cities. From this perspective, even taking out the garbage or having a talk with a passer-by is a deed of dramatic expression. These every day acts make a city into a vital city.(1961)

In this view of the city, Jacobs underlines the importance of the connections between the different parts that construct its “body”. The city is human, in the need to survive using networks that absolve the role of connect is different part. The city is alive as consequence of these connections.

Loury (1977) used social capital as instrument for the social analysis. In his studies he asserted that the poverty of the Afro-Americans was inherited by the sons that faced less resources and poorer education compared with the white people. Afro-Americans inherited less economic and human capital.

This didn't explain the entire gap between different races. Another source of discrimination was in the amount of relations within the labour market, showing a far more superficial network of social capital.

Loury stated that if the economic, cultural and social economic resources of the young Afro-Americans condition negatively their capacity of access to the labour market, then the classical economic theories are meaningless focus as they are just on differences in earning and production as result of differences in the personal work ability. The author pointed out how the social context in which the human being mature, is a strong determinant of the differences among individuals with same competences.

Another famous sociologist that popularized the concept of social capital and is relevance in the field of education is Coleman (1966).

In the 1960's Coleman with other prominent scholars were commissioned by the USA Department of Education to conduct a report, one of he largest in history on this field, about the educational equality in the USA.

First is useful to have an in deep look at his use of the concept of social capital inside the theory of sociology that if on one side share with the classical theory the idea of individuals drive by rationality, it deny on the other the individualistic concept of man.

Coleman infect argues that the concept of social capital is a way to insert the role of social structure into a rational actor paradigm as a resource for action.

It defines social capital as:

Not a single entity but a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors, whether persons or corporate actors, within the structure. (1988)

Based on the relation drive by “authority”, “trust” and “norms” Coleman has defined the following forms of social capital:

- “Credit-slip”: is characterized by the control of the social capital network by the “head of the family” and by the possibilities of each member of the family to activate this social capital in his interest;
- “Information channels”: which implies that social networks and connections are conduits for transferring information;
- “Social norms and effective sanctions”: norms that prevent crimes or harm to other people are part of the social capital and are useful to overcome public problems.

Coleman underlay also the importance of “closure” in the theory of social capital. Is through the role of the closure in the social structure that the benefits of a community derived by the social capital can be maintained and the norms can be enforced.

Going back to the report Coleman made for the USA department of education, his study argued that school funding has little effect on student achievement. In other words the socioeconomic background is more important than the school resources in determining educational outcomes.

Coleman also stated that social disadvantaged black students profited from schooling in racially mixed classrooms. This was a boost in the implementation of the “desegregation busing system” that was the practice of assigning and transporting students to schools in such a manner as to overcome racial and residential segregation.

Wellman like Coleman adopted Loury's 1977 definition in developing and popularising the concept.

His main areas of interest are community sociology and social network analysis. Before his study the community question, concerning the extent to which the organization and content of primary and interpersonal ties are affected by the large-scale division of labour associated with modern urban society, was handicapped.

According to Wellman (1979), there are three basic points of views on this.

The earliest considered urban society profoundly disruptive or communal solidarity. This community lost perspective considers urbanities to be “limited members of multiple social networks, sparsely knit and loosely bounded, their social ties are weak and, narrowly defined and disorganized; and they are bound to the city only by “webs of secondary” affiliations.” (Tsai and Sigelman, 1982)

On the other hand the so-called “community saved” perspective argued that the community lost perspective is too pessimistic and contends that urbanities “primary ties have not withered away... for the inherent gregariousness of human nature presents an effective counterpoise to any such tendencies”. (Tsai and Sigelman, 1982)

Close primary ties as a result continued to flourish in the city. The third perspective, the so-called “community liberated” perspective argues that the community is liberated in the sense that city dwellers are no longer restricted to their immediate kinship groups or neighbourhoods in developing intimate ties. Rather, their close relationship may come to encompass the entire urban area or even the whole nation. (Fisher, 1976)

Wellman (1979) conducted an intensive study of intimate interpersonal network ties; his findings supported the “community liberated” perspective compare to other two alternatives.

The social capital spreads in the nowadays society far more than in the past, that allowed the individual to enrich themselves of contact and connection that were impossible at the start of the 20th century.

In the late 1990s the social capital studies gained popularity serving at the focus of a World Bank research programme and the subject of several mainstream books.

Here we mention two authors and their relative books. The first one analysed is Putnam's *Bowling Alone: America's Declining Social Capital* (1995). Putnam underlines in his essay the decline of social capital in the United States since the 1950 noticing the reduction of interpersonal relationships upon which Americans used to found, educate and enrich the fabric of their social lives.

It is emphatically not my view that community bonds in America have weakened steadily throughout our history—or even throughout the last hundred years. On the contrary, American history carefully examined is a story of ups and downs in civic engagement, not just downs—a story of collapse and of renewal. (1995)

He believes that this change in society are dangerous, not only from an economic point of view but mostly from a democratic point of view. A strong democracy needs engagements and trust.

Participations in politics is increasingly based on the checkbook, as money replaced time.

Explanatory of this disengagement is the loss of membership of many civic organizations, where individuals don't move to others, they simply quit. This thesis is confirmed by data of the General Social Survey used by Putnam.

To illustrate why the declines in Americans' membership in social organizations is problematic to democracy, Putman uses bowling as a similitude. Even if the number of people who bowl has increased in the last 20 years, the number of people who bowl in leagues has decreased. If people bowl alone, they do not participate in social interaction and civic discussion that might occur in a league environment.

Putnam then pass to the question: Why is US social capital eroding? (pp.35). He believes the movement of women into the workforce (pp.36) and the other demographic changes have made little impact on the number of individuals engaging in civic associations. Instead the greatest source of detachment from civic associations have to be find on the modernization of the society through television and Internet that tend to alienate the human being.

Associations create social capital that is the base of every democratic society and its decline is a source of worries. Solutions have to be found and Putman emphasized the importance of discovering how the Unites States could reverse the trend of social capital decay.

A possible answer at the question posed by Putman about how to end the atrophy of American's civic vitality has been give by Feldstein, Professor of public policy at Harvard.

Describing through a good number of examples Feldstein points out how America in his history have been a nation of helpers, joiners, and good citizens bent on building community in a big diverse, modern nation.

This ability has earned the respect and admiration of international observers at least since Alexis de Tocqueville's famous insight in the 1830's that "American of all ages, all conditions and all dispositions constantly form associations".

Civic culture cannot be restored without deliberate effort. Even if this changing is massive, their prices can be in nowadays values far less than the damage caused continuing this trend. Modest investment in social capital generates impressive long-term return, creating a "virtuous circle".

To solve our civic crisis, we need a change in the institutions that structure our private, professional, social and public life. Many of our institution fail to accommodate changes in the way we live our lives.

To boost the engagement process and increase their rewarding, it is up to the single person to change the organization with which we are affiliated. State, local government,

local government, employers, universities, museums, human-services agencies, youth groups, schools and even family will have to try new approaches.

We need not only more civic engagement but also better civic engagement.

Feldstein in his studies suggested four principles for building social capital that are applicable across categories of organizations:

- **Social Capital Impact Principle.** Social Capital is not only a resource, but is also a lens for evaluating institutions, programs and individual behavior. Looking through a Social Capital lens can both prevent civically harmful decisions and guide us toward civically beneficial choices.
- **The Recycling Principle.** Unlike financial capital, social capital has an interesting and valuable property: It is not expected when it is drawn upon. Instead drawing upon our stock of social capital usually generates even more.
- **The Bridging Principle.** One important way to categorized Social Capital is through the degree to which the connections reinforce similarities among individuals. Alliances between people that are more alike than they are different are called “bonding” social capital. Connections between people who are different along some important dimension, like races, socioeconomics status, or gender are referred to us as “bridging” social capital. Research shows that building connections across groups is valuable for everything from getting a job to securing important social and political rights.
- **The “C2C” principle.** In the emerging language of the “dot com” world, C2C refers to communications that occur “consumers to consumers”. We expand that definition to mean “citizen to citizen” and “community to community”. Vertical communication between “experts” and “laymen” has come to characterize too much of our interconnections and has legitimized the notion that regular folks

don't have much to offer one another. Effort to build social capital must strengthen horizontal communication and reciprocity among peers.

1.1.6 The Social Capital of Structural Holes

Here we examine the contribution of Burt (2001) that is an important insight in the theory of social capital. The sociologist compared two network structures that have been argued to create social capital. The first one is the closure structure that is created by a network of strongly interconnected elements. The other structure is the structural holes one, where social capital is created by a network in which people can broker connections between otherwise disconnected elements.

Burt analysed the two structures to find which one displayed better connections.

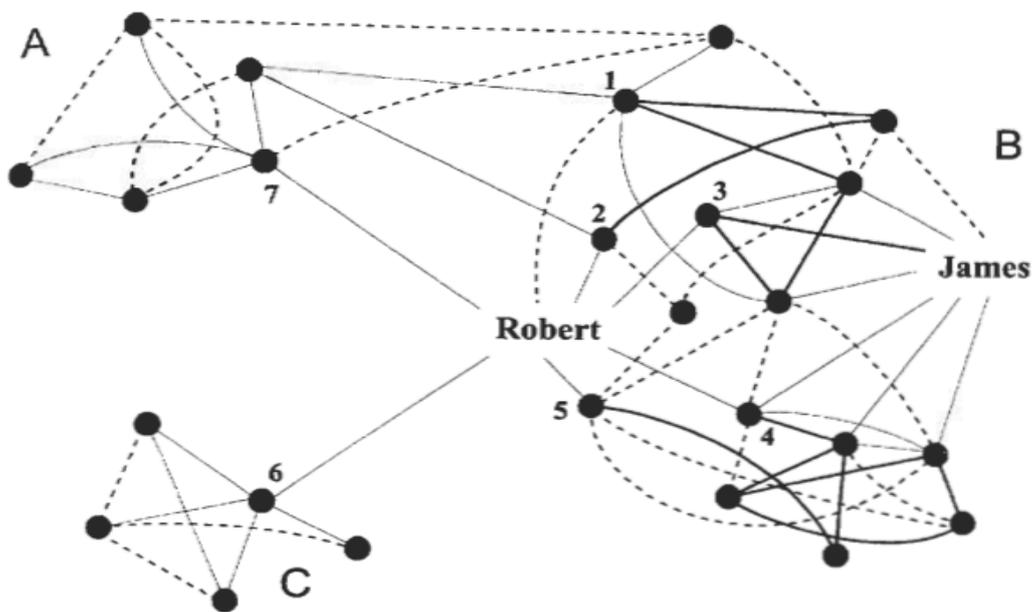


Fig. 3. Table of networks around Robert and James. (Burt, 2001)

Figure 3 is a generic sociogram and density table description of a network. People are dots. Relationships are lines. Solid (dashed) lines connect pair of people who have a strong (weak) relationship.

Selecting the best exchange requires having information on available goods, seller, buyers and prices. This is the point at which network mechanism enter in the analysis.

The structure of relationships among people and organizations in a market can affect, or replace, information. Replacement happens when market information is so ambiguous that people use network structure as the best available information.

For example, transaction could be so complex that available information cannot be used to make a clear choice between sellers, or available information could be ambiguous such that no amount of it can be used to pick the best exchange.

White (1981) argues that information is so ambiguous for producers that competition is more accurately modelled as imitation. Producers in White's model deal with the ambiguity of market information by focusing instead on their position relative to other producers. Markets emerge as separate small group of interdependent producers.

More generally, presumptions ambiguous market information underlie social contagion explanations of firms adopting policies in imitations of other firms (Greve, 1995; Davis and Greve, 1997, Strang and Soule 1998), or people more likely to undertake an entrepreneurial venture if people they know are doing so (Abell, 1996).

Zuckerman's (1999) market model is an important development, in that the model goes beyond predicting where producer conformity is more likely to describe penalties that producers pay for deviating from accepted product categories, and the audience that enforce penalties.

Information quality is also the problem addressed in Podolny's concept of status as market signal. Podolny (1993) describes how investors, not able to get an accurate read on the quality of an investment opportunity, look at an investment bank's standing in the social network of other investment banks as a signal of bank quality. Banks higher in status are able therefore to borrow funds at lower cost and enjoy higher margins.

Network contagion and prominence are both advantages in social capital. The former facilitates the transmission of beliefs and practices between certain people and

organizations. The latter represents an advantage for people and organizations and is often discussed in contemporary economics and sociology as reputation or status.

Information can be expected to spread across the people in the market, but generic research findings demonstrate that it will circulate within groups before it circulate between groups.

The result is that people are not simultaneously aware of opportunities on all groups. Even if information is of high quality and eventually reach everyone, the fact that diffusion occurs over an interval of times means that individuals informed early or more broadly have an advantage.

Participation in, and control of, information diffusion underlies the social capital of structural holes. The argument describes social capital as a function of brokerage opportunities, and draws on network concept that emerged in sociology during the 1970s., most notably Granovetter (1973) on the strength of weak ties and Cook and Emerson (1978) on the benefit of having exclusive exchange partners. More generally, sociological ideas on the autonomy generated by conflicting affiliations are mixed in the hole argument with traditional economic ideas of monopoly power and oligopoly to produce network models of competitive advantages.

The weaker connections between groups in Figure 3 are holes in social structure of the market. These structural holes create a competitive advantage for an individual whose relationships span the holes. The structural hole between two groups does not mean that people in the groups are unaware of one another. Simply means that people are focused on their own activities regardless to what happen among people in the other group.

Structural holes are an opportunity to broker the flow of information between people, and control the projects that bring together people from opposite sides of the hole.

Structural holes separate nonredundant source of information. There are two indicators of redundancy: cohesion and equivalence. Cohesive contacts (contacts strongly connected to each other) are likely to have similar information and therefore provide redundant information benefits. Structurally equivalent contacts (contacts who link a manager to the same third parties) have the same source of information and therefore provide redundant information benefit.

Robert and James in Figure 3 have the same volumes of connections (six strong and one weak ties), but Robert has something more. James is linked to people of group B and is well informed about cluster B activities. Robert is also tied with people within group B, but in addition, his strong relationship with person “7” is a conduit for information on group A and his strong relationship with “6” is a conduit for information on group C. The relationship with “7” is for Robert a network bridge, in fact this connection is the only direct one with group A. His relationship with person “6” instead meets the graph-theoretic definition of a network bridge. Breaking that relationship and there are no more connections between group B and C. Robert is a broker of the network.

Robert’s bridge connections to other groups give him an advantage with respect to information access. He reaches a higher volume of information because he reaches more people indirectly. Further, the diversity of his contacts across the three separate groups means that his higher volume of information contains fewer redundant parts. Robert is positioned at the crossroads of social organization so he is early to learn about activities in the three groups. Moreover, his more diverse contacts mean that he is more likely to be a candidate for inclusion in new opportunities. Robert is more attractive as a contact than the other people because of this benefit.

There is also a control advantage to point out. Robert is in a position to bring together otherwise disconnected contacts, the holes between his contacts mean that he can broker communication while displaying different beliefs and identities to each contact.

Simmel and Merton introduced the sociology of people who derive control benefits from structural holes: The ideal type is the “*Tertius gaudens*”², a person who benefits from brokering the connection between others. Robert, in Figure 3 is an entrepreneur in the literal sense of the word, brokering connections between others. Structural holes are the setting for *tertius* strategies and information is the substance. Accurate, ambiguous or distorted information is strategically moved between contacts by the *tertius*. The information and control benefits reinforce one another at any moment and cumulate together over time.

² “*Tertius gaudens*” is a Latin word that means literally the third who benefits.

Individuals with contact networks rich in structural holes are the individuals who know about and exercise control over more rewarding opportunities. The behaviour by which they develop the opportunities are many and varied, but the opportunity itself is at all times defined by a hole in the social structure. Entrepreneurs are people skilled in building the interpersonal bridges that span structural holes. They monitor information more effectively and faster than bureaucratic control. To these benefits of faster, better solutions, add cost reductions; entrepreneurial managers offer inexpensive coordination relative to the bureaucratic alternative. Speeding the process towards equilibrium, individuals with networks rich in structural holes operate building bridges between disconnected parts of a market where it is valuable to do so.

In conclusion, Robert compared to James is the one that hold more social capital. His network across structural holes gives him faster access and control over information.

To support the thesis of structural holes, three categories of evidence show achievement and reward associated with brokerage.

Lab experiments with small-group exchange network show the resources accumulate by people with exclusive exchange relations to otherwise disconnected partners (Cook and Emerson, 1978).

Census data on economic transactions have been used to describe how producer profit margins increase with structural holes in network of transactions with supplier and costumers. Burt (1983) described the association in 1967 with profits in American manufacturing markets defined at broad and detailed levels of aggregation and extended the results to include nonmanufacturing through the 1960s and 1970s. Later, Burt refined the nonlinear form of the model to more accurately describe the association between performance and market network.

Survey data on interpersonal relations have been used to describe the career advantage of having a contact network rich in structural holes.

A widely known study, is Granovetter's (1995) demonstration that white-collar workers find better job faster through weak ties that bridges otherwise disconnected social groups.

In particular, organizations have been a fruitful site for network studies of social capital. Burt (2000) and Baron (1997) present survey evidence from probability sample of managers in two high-technology electronics firm showing that senior managers with network richer in structural holes are more likely to get promoted early. Moreover they present evidence from a French chemical firm of salary increasing with the industrial holes in a manager's network, and of higher bonus compensation to investment officers with networks richer in structural holes.

Mehra, Kilduff and Brass (2000) find that supervisors in a small high technology company give higher performance evaluations to employees whose networks bridge otherwise disconnected parts of their organization. Mizruchi and Sterns (2001) studying loan officers in a large commercial bank, show that the officers those networks span structural holes in the firm are more likely to be successful in bringing a deal to closure. Hansen (1999) studied new-product teams in one of American's leading electronics and computer firm, a firm segmented by geography and product lines into 41 divisions. The network data are aggregate, in that Hansen asked the R&D manager in each division to describe the extent to which people in his or her division had frequent and close working relationships with other division. Team performance is calculated by the relative speed with which a team move from initiation (first employee dedicated to the project) to completion (product released to shipment). Faster solutions are to be expected from teams with the social capital of bridge relationships that span the structural holes between divisions, and Hansen found that teams reached completion more quickly when they were in divisions with frequent and close relations to other divisions.

Hansen, Podolny and Pfeffer study the interpersonal networks around the teams. Each team member was asked to name intra-division contacts from whom he or she had regularly sought information and advice, then asked about relations between the contacts. Teams more quickly completing their assigned task contained people with more non-redundant contacts beyond the team.

Suggestive results come from research in which networks beyond the team are inferred from the demography of the people within the team. Ancona and Caldwell (1992)

provide a study of this type describing 409 individuals from 45 new-product teams in five high-technologies companies. Teams were distinguished by managerial ratings of innovation, member reports on the volume of the communications outside the teams, functional diversity (members from multiple functions) and tenure diversity (members vary in their length of time with the firm). Structural holes are implicit in the boundaries between corporate divisions and the boundaries between cohorts of employees in that each division or cohort is presumed to have its own unique perspectives, skills or resources. A team composed of people from diverse corporate functions spans more structural holes in the firm, and so as faster access to more diverse information and more control over the meaning of the information than a team composed of people from a single function. For tenure diversity, replace the control advantages of access to more functionally diverse information with the same advantages stemming from access to information that differs between employees long with the firm who are familiar with how things have worked before and newer employees more familiar with procedures and techniques outside the firm.

More innovative solutions are to be expected from teams with the social capital of bridge relationships that span the structural holes between divisions, and Ancona and Caldwell report higher managerial ratings of innovation for teams with more external communication.

Tenure diversity has the opposite effect. Ancona and Caldwell report some benefits of tenure diversity associated with higher evaluations of team performance, but the aggregate direct effect of tenure diversity is lower performance. Presumably, people drawn from widely separated employee cohorts have more difficulty with communication and coordination with the team.

The negative association between performance and tenure diversity could have been positive if the density of communication within the team had been held constant. Tenure diversity can be disruptive because of the difficulties associated with communicating and coordinating across different perspectives, but when communication is successful, team performance is enhanced by the timing and control advantage of the team having access to more diverse information.

On the other side Coleman (1988, 1990) view of social capital is focus on the risk associated with being a broker. The key idea is that network with closure are the source of social capital. Network closure does two things for people in the closed network. First, it affects access to information:

An important form of social capital is the potential for information the inheres in social relations...A person who is not greatly interested in current events, but who is interested about being informed about important developments can save the time required to read a newspaper if he can get the information he wants from a friend who pay attention to such matters. (1988)

Second, and this is the benefit more emphasized by Coleman, network closure facilitates sanctions that make it less risky for people to trust one another:

Without a high degree of trustworthiness among the members of the group, the institution could not exist. (1988)

For example, one could not image a rotating-credit association operating successfully in urban areas marked by a high degree of social disorganization or lack of social capital.

Summarizing the concept just mentioned, Coleman stated:

The consequences of this closure is, as in the case of the wholesale diamond market or in other similar communities, a set of effective sanctions that can monitor and guide behaviour. Reputation cannot arise in an open structure, and collective sanctions that would ensure trustworthiness cannot be applied. (1988)

The effect of closure can be seen especially well by considering a system involving parents and children. In a community where there is an extensive set of expectations and obligation connecting the adults, each adult can use his drawing account with other adults to help supervise and control his children. (1988)

Coleman's closure argument is prominent to respect to social capital, but it is not alone in predicting that dense networks facilitate trust and norms by facilitating effective sanctions.

In sociology, Granovetter argues that the threat of sanctions makes trust more likely between people who have mutual friends.

My mortification at cheating a friend of long standing may be substantial even when undiscovered. It may increase when the friend become aware of it. But it may become even more unbearable when our mutual friends uncover the deceit and tell one another. (1985)

There is an analogue argument in economics: Mutual acquaintances observing two people a) make behaviour between the two people public, which b) increases the salience of reputation for entry for future relations with the mutual acquaintances, c) making the two people more careful about the cooperative image they display, which d) increases the confidence with which each can trust the other to cooperate.

In conclusion the closure theory comparing people like James and Robert, will elect James as the person with more social capital. Strong relations among his contacts give James more reliable communication channels and protect him from exploitation because he and his contacts are more able to act in concert against someone who violets their norms of conduct.

1.2 Conceptualisation of Social Capital

1.2.1 Theory of the Conceptualisation

Through the conceptualisation of Social Capital we aim to simplify the complexity of the social world to better understand its dynamics and structures.

To be of relevance, conceptualisation has to facilitate the understanding but not lose the complexity necessary to be of scientific relevance.

As seen in the previous chapter, social capital does not have a clear unique definition, but its characterization adopted in a study depends mostly on the discipline and the level of investigation. (Robinson, 2002)

Because of these difficulties in defining Social Capital, authors tend to discuss the concept, its intellectual origin and its diversity of origin and some of its unresolved issues before adopting a school of thought and adding their own definition. (Adam and Roncevic, 2003)

As a consequence nowadays in the Social Capital theory still present a considerable amount of unknowns surrounding our knowledge in this field.

We know that various relationships exist between determinants, structural elements and manifestations but their connections and interactions are at the moment largely unknown.

The main purpose of the conceptualization work is to give an appropriate operationalization to Social Capital understanding the process, that starting from the determinants brings us to the outcomes.

Determinants → ? → Consequences/Outcomes

Our attempt is to take into consideration factors like casual relationship, specific contexts, externalities, levels and feedback loops as link between determinants and outcomes in the social capital process.

The literature identified a large number of determinants that we can divide in three classes:

- Family/Society: social class, environment, mobility, family, institutions;
- Human Capital: education, values;
- Interactions: civil society, associations, networks, social norms.

These factors play an important role in determine the characteristic of the social capital structure, what they fail to explain is how casual factors and functional relationship work. In other words, what miss is a multi level, multi dimensional study of social capital.

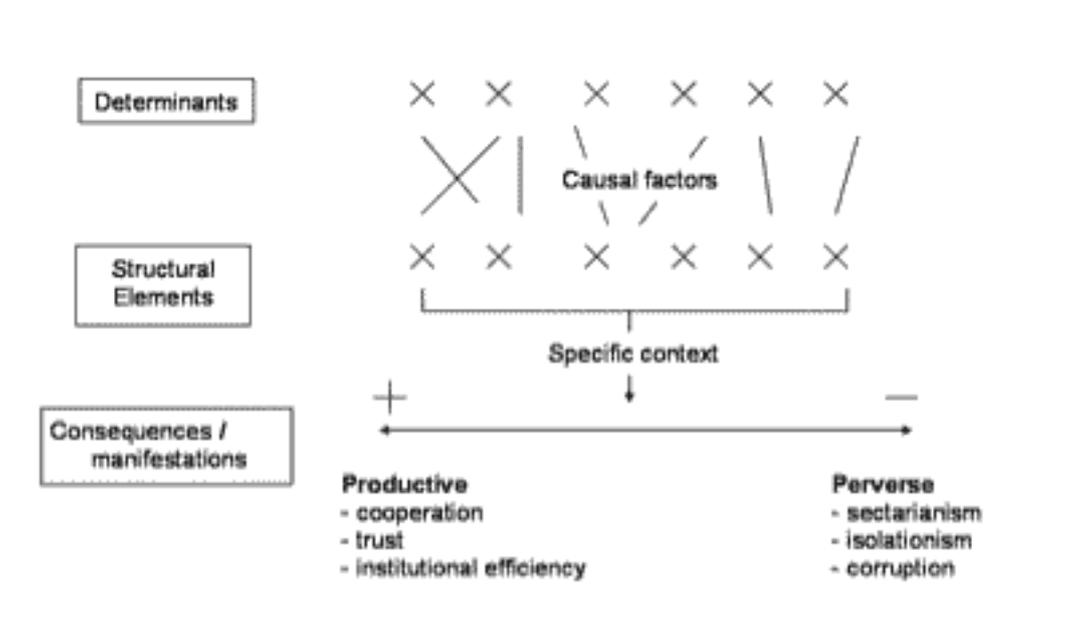


Fig. 4. The links between determinants, structural elements and consequences.

(<http://www.socialcapitalresearch.com/conceptualisation.html>)

Figure 4 shows us how social capital is built, mixing different components. The consequences cannot be understood simply referring to the determinants but an in-depth study of the whole structure is necessary.

The role of the causal factors is determinant in the definition of the structural elements. These latter, inside a specific context, lead to the social capital consequences. Social capital is a dynamic relationship between its components that evolves constantly on spatial and temporal scales. Every social interaction between actors has wide-ranging and unpredictable outcomes. Similar structures shape in different contexts lead to different externalities, that Figure 13 shows us a continuum line that goes from the more productive outcomes such as cooperation and trust, to the perverse ones: isolationism and corruption among others.

Starting from the determinants is fundamental to identify the role played by the causal factors and the specific contexts in the determination of the consequences/manifestations.

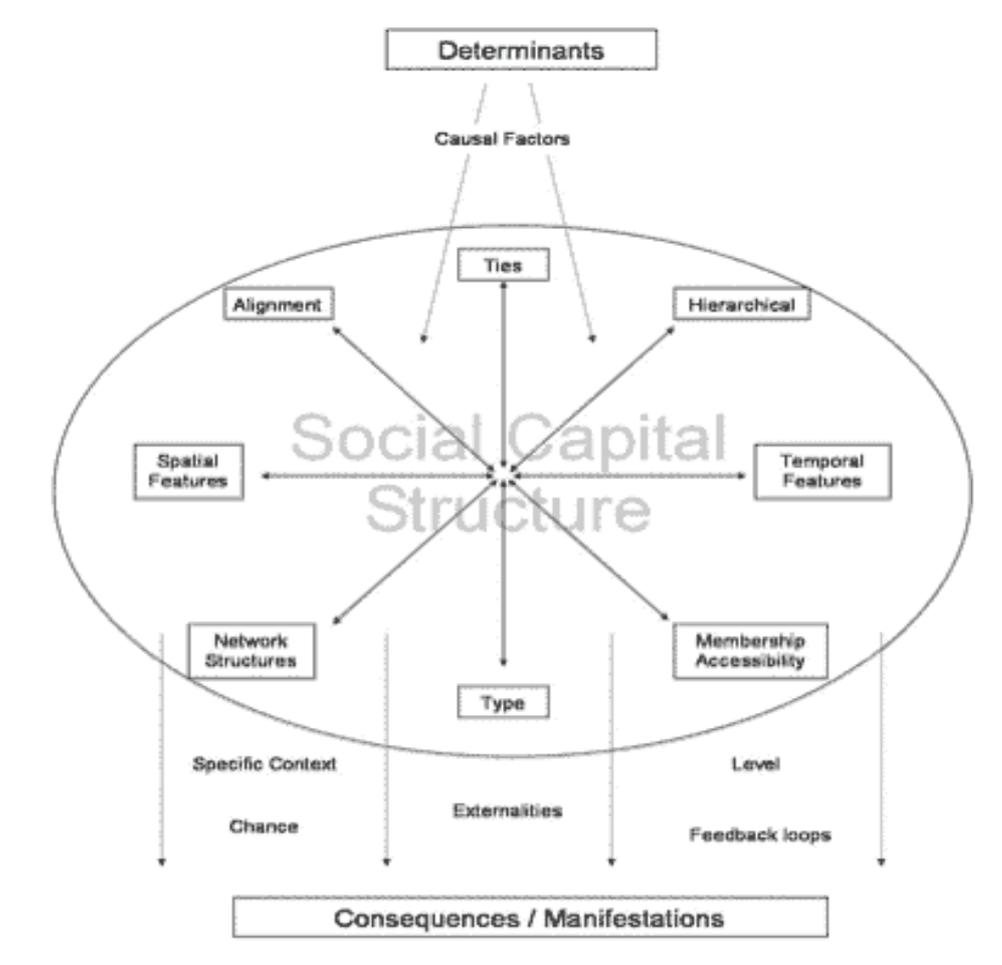


Fig. 5. Conceptualisation of the social capital structure

(<http://www.socialcapitalresearch.com/conceptualisation.html>)

Figure 5 shows us various elements of the social capital structure. These elements then insert in a specific context leads to the final consequences.

We want now to better describe the single elements:

- Ties: defines as elements that link people together with others who are primarily like them along some key dimension.
- Hierarchical: refers to the distribution of vertical and horizontal ties.

- Temporal features: are identified as a component as time has a considerable impact on other components of social capital. Social capital displays significant changes over time.

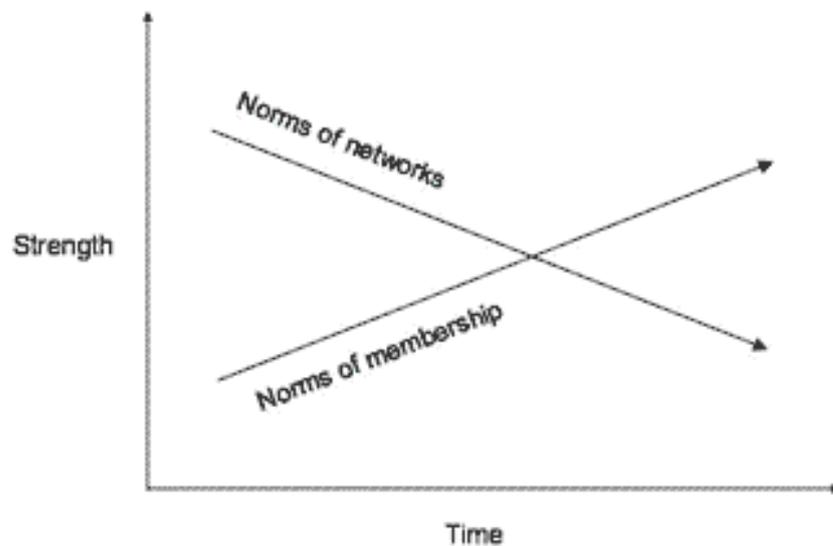


Fig. 6. Norms of networks and norms of membership in a Strength/Time diagram
<http://www.socialcapitalresearch.com/conceptualisation.html>

Figure 6 hypothesizes the possible temporal change of different norms over time. Norms of networks, associated with ties, are expected to decrease over time with decreased expected future returns. Instead the norms of membership are likely to increase over time as one develops reminiscence and therefore increased strength of norms of trust and reciprocity towards other members whether a network tie existed or not.

- Membership accessibility: relates to whether there is group inclusion or exclusion and so strongly determines the nature of the externalities.

- Type: refers to the distinction made in literature between structural and cognitive and between bonding and bridging social capital.

- Network structure: the network theories that are relevant to social capital structure.

- Spatial features: interact to determine the nature and impacts of social capital structure. Geographic proximity has an important role in the formation of social interactions and reciprocity. This effect is consequences of the strength of the relationship that the sense of belonging and membership amplify.

Emails and SMS have been increasingly utilized in communication, because they are cheap and they offer a fast communication that reduced spatial distances. Both of these technologies have different impact on social capital because of the lack of personal contact of face-to-face interactions. Infact the type of social capital that is produced from this interaction is significantly different from that found in traditional relations. These new technologies if on one side they facilitate the day-to-day life on the other side they contribute to social isolation.

Whereas in the past, social networks were commonly based on proximity, they are now based more on work and interest groups. The strength of networks based on proximity has decreased because people know few of their neighbours, particularly in medium to high-density areas and where there is high residential mobility. The result is limited opportunity to repeated interaction, which is fundamental to the equilibrium concept for social capital generation.

- Alignment: refers to the interests, beliefs and views of individual or groups.

People can be aligned to groups or communities for various reasons, and this membership results in a range of social capital manifestations

All the elements we have described above have dynamic relationship with a series of factors identified in Figure 14 that are: specific context, level, externalities, chance and feedback loops.

The externalities and manifestation that results from the social capital structure are strongly related to circumstances and context. The presence and form of the social capital is shape by the environment that represents the *condicio sine qua non* for its manifestation.

The level at which social capital is located is another important feature of the conceptualization work. Different components of social capital operate at different levels. A useful example is to look at the role of ties in the society. At a first look these connections operate at the individual level, but this is partly incorrect, because they also operate at the meso and micro levels. Meso levels look at the group, but these groups are made of individuals that have networks with the group member and members of other outside group.

It is important to identify that different outcomes of social capital are evident at different levels. At the micro level the main outcomes relate to norm of reciprocity and information flows and the individual not “owns” the social capital that exists between them. At the meso level instead the individuals have a level of ownership and control of the social capital by choosing ties and membership.

Another factor of interest is the role played by chance. Chance meeting and chance events both play an important role in the structure of social capital, but also in realizing the manifestations of social capital. For example, and individual can meet a colleague outside the work place, transforming the pre-existing weak tie with a stronger one based on reciprocity and mutual interest.

The feedback loops operate within the dynamic relationship between the components of social capital. For example, a community network created to build social capital has initial benefits in terms of information flows, norm of reciprocity and trust, however, network closure results in norm that restrict the behaviour with a high likelihood of negative externalities that can bring loss of memberships. The existence of feedback loops is also supported by authors like Biox and Prosner (1998), that consider social

capital theories as an equilibrium concept, although as equilibrium in terms of expected returns.

I would be more appropriate to think of social capital as an equilibrium caused by limits and determinants, particularly in terms of beneficial manifestation.

As conclusion of this paragraph, it can be see that social capital involves complex interactions between its determinants, structure and manifestations. The structure of social capital is marked by dynamic relationships between its components with the roles of chance, feedback loops and externalities that determine the outcomes. These relationships are further complicated by the level of investigation, components infect operate at different levels and there is a considerable interaction between components operating at different level simultaneously. This complexity highlights the need for research to determine the various casual factors involved.

1.2.2 Problem with Conceptualization of Social Capital

The proliferation of competing definition, analytical methods and applications associated with the terms is perhaps only dwarfed in volume by the literature critical of its theoretical ambiguity, ambitious conceptual scope and practical over versatility.

(McHugh and Prasetyo, 2002)

As seen in the previous chapter conceptualisation of social capital is one of the biggest challenges of this field of study. At present there is a lack of rigorous conceptualization of social capital (Krishna and Uphoff, 2002) and the danger is that the term most of the time is used without a rigorous and scientific specification. Fine (1999) pointed out that social capital is taking over explanations of economic development, growth and prosperity, he also suggests that social capital had other possibilities before being turned against the other by economics. Hean and Cowley (2003) made the observation that the accumulation of literature on social capital has begun to obscure the understanding of the concept. The inappropriate measurement techniques that have been implemented have caused problems for understanding social capital at the conceptual level and led to debate over whether the concept is relevant or appropriate. (Stone, 2001)

Collier (1998) provided a good starting point for conceptualization, identifying that a conceptual model for social capital should identify the concept within the complexity of the social world, as defined by dynamic relationship between its component, rather than what at present often appear to be a desperate collection of circumstantial variables.

Paxton (1999) identified the complexity of social capital framework in terms of micro (individual), meso (group) and macro (societal) scales with the interaction of negative externalities in the form of exclusion and negative ends such as crime.

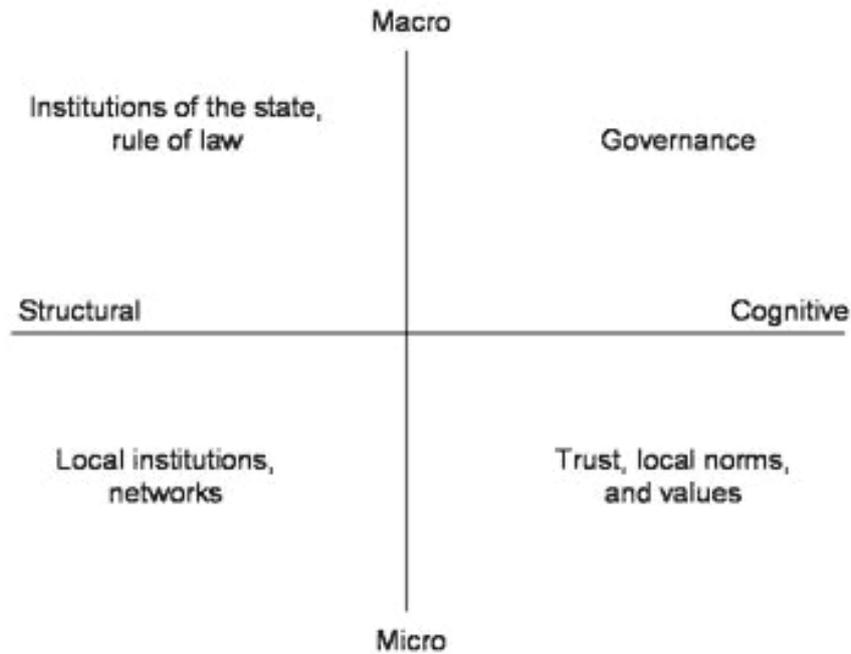


Fig. 7. Conceptualisation of social capital by Grootaert and Van Bastelaer (2002)

A good conceptualization of the different level concerning social capital has been made by Grootaert and Van Bastelaer (2002) built on the work of Uphoff (1999). This graph also shows the continuum from cognitive to structural dimension.

In conclusion social capital is a theory full of complexity and the lack of rigorous law that define its definition and implementation create a risky environment in which is easy to fail in misspecification and unprofessionalism errors.

2. The Emotions

Emotions are defined as a set of subjective and conscious experiences that are characterized primarily by psychophysiological expressions, biological reactions and mental states. Emotions enter in the modern formulation of economic theory just recently, but with great emphasis, establishing an important branch named behavioural economics. This sector of economics, study the effects of social, cognitive and emotional factors on the economic decision of individuals and institutions, and the consequences for market prices, returns and resource allocation.

Even apart from the instability due to speculation, there is the instability due to the characteristic of human nature that a large proportion of our positive activities depend on spontaneous optimism rather than mathematical expectations, whether moral or hedonistic or economic. Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as the result of animal spirits – a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities. (Keynes, 1936, 36)

2.1 A first intuition

Emotions are a fundamental aspect in the life of a man and they help to classify and evaluate his experiences.

The word emotion derive from “*emovus*” that is the past tense of the Latin verb “*emovere*” that means to move, to separate. Define the etymology of the term is quite easy, far more difficult is to understand its meaning. Everybody in life experience emotions and know what they are at a hypothetic level, the problem arise trying to give a clear definition.

Emotions have been described as discrete and consistent responses to internal or external events that have a particular significance for the organism. Emotions are brief in duration and consist of a coordinated set of responses, which may include verbal, physiological, behavioural and neural mechanisms.

James (1890) one of the first psychologist studying emotions, asserted that the explanation of emotions have to be find in the perceptions of the human states. Being the number of perceptions of human body infinite, there will be an unlimited number of emotions to describe.

Oatley stated that:

Emotions are mental states that own coherent psychological functions and they can be recognized through theoretical and empirical criteria. (1992)

For Oatley emotions are mental states that can be analysed and described with scientific criteria. The use of these scientific tools avoids the problem concerning heterogeneity and ambiguity.

Reisenzein (1983) studied emotions as a complex set of answer, defined as: “multidimensional reactive syndrome”. Under this set we can find:

1) Physiological answers: that refers in particular to the activation of the central nervous system, autonomous nervous system and of the endocrine system that produce physiological answer; like for example the increase or decrease of the cardiac frequency and of the blood pressure or salivation.

2) Tonic-posture answers: the tension or relaxing of the body.

3) Instrumental answers: for example: bite, run, beat even when these reactions are not yet performed but just started.

4) Expressive answers: this group would have technically to include also manifestation like the liberalization of chemical substances, among the other the secretion of pheromone, but due to their relevance the main considerations goes to facial mimic and vocalization.

5) Subjective experimental component: is relative to the part of our reactions that is not possible to describe, as consequences of its subjective essence: like our strictly personal reactions to fear, happiness or surprise.

The subjective component that we experience with the emotions can be analysed following different aspects:

1) Intentionality: prerogative of the emotional experience is the experiencing situation, always linked to a phenomenon or situation.

At the same time is possible to experience happiness or fear without knowing the cause. This latter specification is the key of distinctions between human beings and is considered by Lewis and Michalson (1983) a pre-requirement of the emotional competence.

2) Attention: the emotional process implied different cognitive process, like the attention one. Emotions leads to an increment of the information that arrive to the brain and this emotional state is equivalent to what is called attention.

3) Perception: another process activated during emotions is the perception one that transforms the reality around us along with our feelings.

4) Recycling: is a mnemonic process that let us remember situations in which we have experienced similar emotions.

The different components of the emotions are correlated between them by a set of complex interdependent relationships.

The emotion seen as a multidimensional reactive syndrome is one of the most developed reaction of the human body.

2.2 Ancient Greek and Middle Ages theories

Theories and study over emotions date back to the Ancient Greek and China. In the latter philosophers questioned over the worthiness of emotions. It was believed that excess of emotion caused damage at the qi³, which in turn damage vital organ. In the Western world from Plato to the Middle Ages, emotions were viewed as unhealthy and immoral. Even William Shakespeare, those writing are full of passion, cautioned against emotional excess. Despite these attitude, caused by a total lack of scientific investigation on the human brain theories and model were developed. These investigations consisted of a good dose of imagination and poetic expedients.

A first attempt drive us back to the Ancient Greek, were philosopher were not only interested in discover what the world was made of, but also how the behaviour of men work.

According to a theory developed by the Greek philosopher Hippocrates of the four humours⁴, the human body consisted of four basic elements: blood, phlegm, black bile and yellow bile (Arikha, 2007). These elements correspond to four basic substances that were presumed to make up the world. The proportions of the four humours in the human body were thought to fluctuate with the four seasons, but also as a function of physical and mental health. Thus, according to Hippocrates, both physical and mental illness were the result of imbalances among the four humours. Further elaboration of these theories belongs to Galen of Pergamon who used the four humours as a framework for classifying human traits and personalities. He proposed for example, that rosy cheeks and round body were the reflection of high level of blood, resulting in a “sanguine” personality. If one accepts the notion that the four humours represent a metaphor for

³ In traditional Chinese culture, “qi” is an active principle forming part of any living thing. Qi is frequently translated as “life energy”, “life force”, or “energy flow”.

⁴ Humour is the tendency of particular cognitive experiences to provoke laughter and provide amusement. The term derives from the humoral medicine of the Ancient Greeks.

hormones, it is not easy to see how imbalances among humours would be responsible not only of physical illness but also of mental dysfunction.

While the theory of the four humours focused on understanding the physical sources of personality and mental illness, other thinkers focused on trying to understand the “spiritual” underpinnings of emotions. Among these Plato who was primary interested in defining abstract ideal forms of the world.

Plato proposed, taking advantage of the three classes⁵ of citizens described in the “Republic”, that the human psyche consisted of three parts: the “rational soul” corresponding to the ruling class of the philosopher, the “spirited soul” corresponding to the military and the “appetitive soul”, corresponding to the workers, farmers and businessmen who provided sustenance for the state’s citizens.

Aristotle later elaborated the theory of Plato: He believed that if on one hand emotions were undesirable and evil on the other they were a concrete part of life. To reconcile these two views, he proposed the concept of “predisposition to feel emotions”. This concept allowed him to propose that it was not the absence of emotions but rather the ability to regulate them that defines the perfect moral man.

Some aspects of these old theories, even if mostly based on philosophical concepts rather than scientific, still represent the base of the nowadays studies on this field.

As example, the theory of the tripartite structure described by Plato and Aristotle served as model for modern thinkers like Freud with his psychosexual structure of personality (superego, ego and id) and can be considered a metaphor for the key components of brain processing (crystallized intelligence, behavioural control and emotions or drive).

In medieval times in Europe the love of Christ was the only emotion allowed by the Christian rule and all other emotions were viewed as irrational and subversive.

⁵ The three classes of citizens described by Plato were:

- 1) the ruling class, composed of wise philosopher
- 2) the middle class, composed by the military
- 3) third class, consisting of workers, farmers and businessmen that generate the state’s economic well being.

Aquinas shared the view of Aristotle towards emotions, especially with negative feelings: considered evil and cause of deleterious effects on people. Positive feelings on the other side were described as a rational state equivalent to the one belonging to God and the angels. Rationality was intended as happiness.

Machiavelli along with his magnum opus "The Prince" made some astute observations about the role of emotions in motivating behaviour. He recommended that emotions like fear and envy, to be exploited in military pursuits. He introduced the notion of publicly recognized heroes as an a priori manipulation of soldiers into desiring glory and participation in combat (Schmitter, 2006).

In summary, emotions were judged in the Middle Ages as evil and immoral, an idea already introduced in antiquity, and were considered to be appropriate only in the service of God or in politics.

2.3 19th and 20th century theories

This paragraph has the purpose to analyse some of the main theories concerning emotions belonging in the 19th and 20th centuries. These theories in the positivistic milieu where only those phenomena, that lent themselves to direct observation were deemed worthy of study.

Darwin was the first to explicitly point out the adaptive nature of the emotions. Rather than pointing out, how excesses of emotions can make one physically ill or morally weak, he stated that emotions help individuals to communicate and are fundamental for survive.

His essay “The expression of the emotions in man and animals” (1872), detailed the virtues of experiencing emotions, as well as the parallel between emotions experienced by animals and those experienced by humans. This latter point, open the door for animal research that have been fundamental for discover much of the brain functioning.

It is not the conscience which raises a blush, for a man may sincerely regret some slight fault committed in solitude, or he may suffer the deepest remorse for an undetected crime, but he will not blush... It is not the sense of guilt, but the thought that others think or know us to be guilty which crimson the face. (1872)

Describing laughter: the sound is produced by a deep inspiration followed by short, interrupted, spasmodic contractions of the chest, and especially the diaphragm... the mouth is open more or less widely, with the corners drawn much backwards, as well as a little upwards; and the upper lip is somewhat raised.(1872)

After the Darwin's work, the importance of emotions as part of human experience comes to be recognized and accepted. Emotions became an important topic of scientific

interest, and researchers were interested in linking emotions to what was known at the time about the working of human body.

Of strong presence were the theories belonging to the somatic way to investigate over emotions. These theories claimed that bodily responses are fundamental to investigate emotions.

The first modern attempt in this field belonged to William James and Carl Lange that produced the James-Lange theory.

In this study, James proposed that perception of what he called an “exciting fact” led directly to a physiological response, and the cognitive interpretation of such a response was the phenomenon known as emotion. To account for different types of emotional experiences, James proposed that different emotions reflected our interpretations of differentiated physiological states.

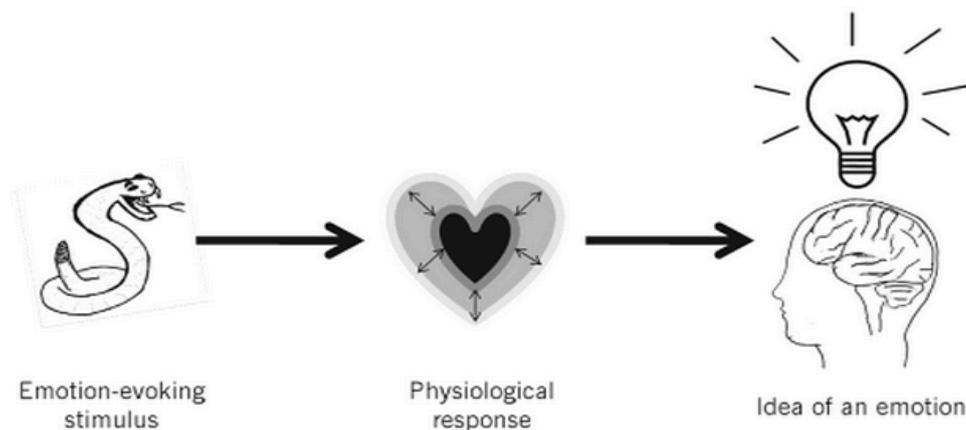


Fig. 8 According to the James-Lange theory of emotion, an emotion-evoking stimulus triggers a physiological response, which is then interpreted as a particular emotion. This interpretation equals the experience of emotion. (Suchy, 2011)

Although mostly abandoned in its original form, Dalgleish argues that most contemporary neuroscientists have embraced the components of the James-Lange theory of emotions.

The James-Lange theory has remained influential. Its main contribution is the emphasis it places on the embodiment of emotions; especially the argument that changes in the bodily concomitants of emotions can alter their experienced intensity. Most contemporary neuroscientists would endorse a modified James-Lange view in which bodily feedback modulates the experience of emotions. (2004)

Taking as base the James-Lange theory, Walter Cannon developed with the help of his student Phillip Bard his own theory. Unlike James and Lange, Cannon did not believe that physiological responses alone could explain subjective emotional experiences. He argued that physiological responses were too slow and often imperceptible compared to the rapid and intense subjective awareness of emotion.

He also believed that the richness, variety, and temporal course of emotional experiences could not stem from physiological reactions that reflected fairly undifferentiated fight or flight responses⁶. In conclusion Cannon argued that was not automatically possible for sensory events to cause a physiological response prior to triggering conscious awareness.

⁶ The fight or flight theory of Cannon stated that animals react to threats with a general discharge of the symphatetic nervous system, priming the animal for fighting or fleeing. The response was later recognized as the first stage of a general adaptation syndrome that regulates stress responses among organisms.

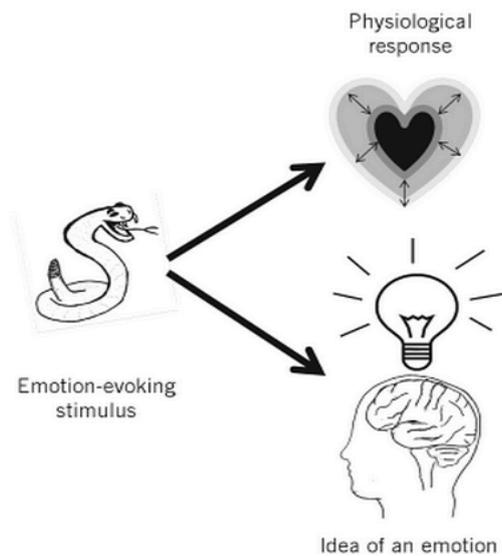


Fig. 9 According to the Cannon-Bard theory of emotion, an emotion-evoking stimulus triggers simultaneously both a physiological response and a conscious experience of an emotion. (Suchy, 2011)

A theory of surely interests in the field of emotions, that firstly incorporated cognition is the one developed by Stanley Schachter (Schachter and Singer, 1962) called “the two factor theory of emotion”. Core of the theory is the idea that emotions were a result of a two-step process: first, physiological arousal in response to a stimulus, and second, cognitive elaboration of the context in which the stimulus occurred.

Schachter benefit from the research conducted from Gregorio Maranon. Interested in testing the James-Lange theory, Maranon injected 200 hospital patients with epinephrine and subsequently asked them how they felt and the vast majority responded with statement like: “I feel as I am afraid, but I am not”. In the absence of an emotion-evoking stimulus, most patients were unable to interpret their physiological arousal as genuine subjectively experienced emotions.

To test his theory, Schachter along with his student Jerome Singer conducted a famous study. As part of this experiment they invited undergraduate volunteers to participate in a study that presumably examined the effect of vitamins on visual acuity. Under the appearance of being given a vitamin shoot, the participants were injected epinephrine or

placebo. Following the injection, while waiting for the presumed vision test take place, the participants were asked to fill out some questionnaire. A confederate of the experimenters, masquerading as another volunteer, joined and produced to act either as though he was angry or amused by the questionnaire. The naïve participants followed his attitude, alternately laughing or cussing at the questionnaire. In support of Schachter and Singer's hypothesis, the results of the study showed that those participants who had been injected with epinephrine reported higher level of angry or happiness in response to angry or happy confederate. In other words, undifferentiated arousal, combined with a particular context, resulted in context-specific emotional experiences.

With the two-factors theory now incorporating cognition, several theories began to argue that cognitive activity, in the form of judgments and evaluations, was entirely necessary for an emotion to occur.

One of the main promoters of this view was Richard Lazarus who argued that emotions must have some cognitive intentionality. At the heart of Lazarus's theory was what he called appraisal, a theory that stated that emotions are extracted from our evaluations (appraisals) of events that cause specific reactions in different people. Essentially our appraisal of a situation causes an emotional response that is going to be based on that appraisal. An example of this is going on a first date. If the date is perceived as positive, one might feel happiness and joy, because they have appraised this event as one that could have positive long-term effects. On the other hand is perceived negatively, then our emotions, as a result might include bad feelings.

Trying to conceptualize the theory of Lazarus, emotion is a disturbance that occurs in the following order.

- 1) Cognitive appraisal – the individual assesses the event cognitively, which cause the emotion. (Example: Mr Rossi sees a snake. Cognition allows him to understand that is a danger)

2) Physiological changes – the cognitive reaction starts biological changes. (Mr Rossi's brain activates adrenaline gland that pumps adrenaline through the blood, resulting in increasing heartbeat.)

3) Action – the individual feels the emotions and chooses how to react. (Mr Rossi screams and runs away)

After the affirmation during the 20th century of the theories related with cognition, recently the somatic theories regained popularity, especially with the works of Joseph E. LeDoux and Antonio Damasio.

LeDoux's research interests are mainly focused on the biological underpinnings of memory and emotion, especially the mechanisms of fear. Taking advantage of the studies made by Edouard Claparede on women affected by amnesia, a deficit that cause the impossibility to forming new memories. The experiment consists in repeating every day the same introduction: Claparede presented himself to the woman and shake her the hand. One day Claparede decide to vary the routine. He introduced himself to the woman as usual, but when he reached to shake her hand for the first time, he concealed a pin on his palm. With this unfriendly behaviour Claparede faced a great discover; infect when the next day he repeated the usual welcome, (notice that the woman had no memories of yesterday at all) arrived at the time to shake the hand, the woman refused. She was incapable of forming new memories, but a subconscious sense of danger rose on her.

LeDoux replicate this study on fear conditioning but on rats, discovering that conditioned fear turns to be one of the essential techniques to increases the survival possibilities. The problem was to discover how this mechanism took place. It was clear that learning to be afraid involved different mechanism compared to memorize common notions or facts LeDoux discovered a connection to the amygdala, an almond-shaped

region in the forebrain long associated with emotional states. If the amygdala is removed the rat failed to learn.

The key insight that emerged is that facing a danger situation, like a snake, before that the eyes transmitted the information to the brain to realize that what actually we are facing is a snake, our body has frozen and our heart beat has accelerated. The key difference between the two paths is time. The semiotic impulse is faster than the cognitive one.

In conclusion, Claparède's patients lacked the ability to form declarative memories, but she had a functioning amygdala that kept the memory alive, albeit unconsciously. If you had a past encounter with a snake and you felt actively threatened, a trace of that memory would have been stored by the amygdala.

The same process happened to many local residents in downtown Manhattan after the 11th September, experiencing a conditioned fear response to that event, making hard for them to work in tall building. LeDoux suspects those traumatic memories will persists in the brains of New Yorkers. The treatment possibilities are not about eliminating the memories so much as retraining the amygdala to respond differently when those memories are triggered

Damasio formulated the somatic marker hypothesis, a theory about how emotions and their biological underpinnings are involved in decision-making.

When individuals make decisions, they must evaluate the incentive value of the choice available to them, using cognitive and emotional processes. When the individuals face complex and conflicting choices, they might be unable to decide using only cognitive processes.

In these cases, somatic markers can help decide. Somatic markers are associations between stimuli that induce an associated physiological affective state. These somatic markers associations can recur during decision-making and bias our cognitive processing. When we have to make complex and uncertain decisions, the somatic markers created by the relevant stimuli are summed to produce a somatic state. This

overall state directs our decisions of how to act. Damasio proposes that somatic markers direct attention towards more advantageous options, simplifying the decision-making process.

Damasio defined emotions as changes in the in both body and brain states in response to stimuli. Physiological changes occur in the body and transformed in the brain into emotions that tells the individual something about the stimulus they have encountered. Over time emotions and their corresponding body change become associated with particular situation and their past outcomes.

When making decisions, these physiological signals (somatic markers) and their emotions are consciously or unconsciously associated with their past outcomes and bias decision-making.

These psychological studies are at the base of the behavioural economic theories that refuse the axiom of perfect rationality and emotions-free condition of the human beings in economic decision-making.

2.4 Behavioural Economics

In this chapter we want to analyse the role played by the emotions in economic choices. The branch of study that tries to understand this connection is called: behavioural economics.

According to the classical economic theory, human decision-making is emotion-free and involves logical reasoning based on cost-benefit calculations. This theory assumes that individuals have unlimited time, knowledge and information processing power and can therefore make perfect decisions. In contrast the behavioural economic theory proposes that emotions play a critical role in our ability to make fast, rational decisions in complex and uncertain situations.

Behavioural economics highlights inefficiencies such as under or over reactions to information as causes of market trends. Such reactions have been attributed to limited investor attention, overconfidence, overoptimism.

Other key observations include: the asymmetry between decisions to acquire or keep resources and loss aversion.

One of the first attempts to give a role to psychology and irrationality in economic matters belonged to Adam Smith.

How selfish soever man may be supposed, there are evidently some principles in his nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it except the pleasure of seeing it. (Smith, 1759)

How many people run themselves by laying out money on trinkets of frivolous utility? What pleases these lovers of toys is not so much, as the aptness of the machines which are fitted to promote it. All their pockets are stuffed with little conveniences... of which the whole utility is certainly not worth the fatigue of bearing the burden. (Smith, 1759)

This quotes showed that Smith did not have a simple-minded view of human nature. He did not have of course a theory of decision in the modern sense, but he did express a vision of human nature, which is remarkably multifaceted.

Smith's homo economicus...was a man with a temporal sense, a man with loyalties, a man who clearly understood that he was part of a larger social collective. What Smith's man wanted and needed was the responsibility for making his own decisions and accepting the consequences of those decisions. This

Responsibility had to be understood as existing in concert with the twin principles of self-love and sympathy, for all were combined on the Smithian calculus. In brief, in modern parlance what was to be maximized by Smith's man was the right of self-determination, while still allowing a place for both moral and social sensibilities and even expression of altruism. (Perlman and McCann, 1998)

Reading the classical economists' philosophical and economic psychology, several contemporary authors have gone so far as suggesting that Smith identified and discussed some of the phenomena that now occupy behavioral economists.

Of interest are the insights of Jevons that explicitly built his economic view on the foundation of hedonic psychology, that is, an account of individual behavior according to which individuals seek to maximize pleasure and minimize pain.

Pleasure and pain are undoubtedly the ultimate objects of the Calculus of Economics. To satisfy our wants to the utmost with the least effort... in other words, to maximize pleasure, is the problem of Economics. (Jevons, 1871)

Behavioral economics has also been applied to intertemporal choice, largely considered inconsistent. (Ainslie, 1975)

In 1979, Kahneman and Tversky wrote “Prospect theory: an analysis of decision under risk”, an important paper that used cognitive psychology to explain various divergences of economic decision making from neo-classical theory. Prospect theory is an example of generalized expected utility theory. Although not a conventional part of behavioural economics, generalized expected utility theory is similarly motivated by concern about the descriptive inaccuracy of expected theory. The prospect theory says that people make decisions based on the potential value of losses and gains rather than the final outcome, and that people evaluate these outcomes with different weights. The model is descriptive: it tries to model real-life choices, rather than optimal decisions.

2.5 Robots that have emotions

The last paragraph of the chapter dedicated to emotions, describes an interesting paper of Parisi and Petrosino call: “Robots that have emotions” that deal with the possibility of introducing emotions in robots and the relative increase in their performance.

This experiment is underlay by two hypothesis: 1) to construct robots that have emotions it is first necessary to construct robots that have many different motivations that compete one another for the control of the robot behaviour so that the robot has to decide which motivation should control its behaviour at any given time; 2) the robot will have emotions if the neural network that controls the robot behaviour includes a special emotional circuit which allows the robot to take faster decisions that improve its life.

The decision making process is executed at a two-stage level. First, is necessary a mechanism for deciding which of the different motivations should control the behaviour of the agent; this level of functioning is call strategic or motivational level.

Once a particular motivation has been chosen at the strategic level, the agents will execute the behaviour that satisfies the motivation. This second level of functioning is call tactical or cognitive level. To ensure the survival of the agents both levels must function properly.

Parisi and Petrosino assume a simple, implicit mechanism for deciding which particular motivation will control the robot behaviour: all the robot motivations have a quantitative level of intensity and win the motivation with the highest level of intensity.

As said, deciding correctly which motivation should control the animal behaviour at any given time is critical for the survival.

Our hypothesis about emotions is that emotions are felt states of an animal's body/brain that increase the correctness and effectiveness of the motivational decisions of the animals by influencing the current intensity of the different motivations. (2010)

Emotions tend to emerge in complex animals that have to choose among a large number of different motivations or have to decide quickly. These animals can make errors in their motivational decisions or they can be slow in deciding and this can compromise their survival and reproductive chances.

Experiments evidenced the improvement of the behaviour of robots with emotions. All the three abilities tested in the paper: 1) approaching the food, 2) flying away from predator 3) shifting from approaching food to flying away from predator displayed better results by robots with emotional system.

The hypothesis of Parisi and Petrosino is that emotional states are an evolved mechanism for making the strategic of behaviour more effective, less subject to error and faster.

3. The Netlogo Simulation

3.1 Introduction

3.2 The Project

3.3 Code of the Program

3.4 Experiments – Rational Model

3.5 Experiments – Behavioural Model

3.6 Results of the experiments

3.1 Introduction

The simulation has the purpose to help understand the dynamic at the base of the behaviour of agents in an environment with networks.

In nowadays societies interconnections and interrelations among agents are fundamental features of the creation of wealth.

The goal of this simulation is to investigate how agents create network, metaphor of economic value, choosing with who and when to collaborate and how emotions might have a role, amplifying or not these procedures.

3.2 The Project

A good starting point is to describe the work environment. For this simulation we choose to distribute randomly our agents using all the space give us by Netlogo.

Agents are one of the fundamental features in Netlogo, they represent beings that follow the instructions that we assign them through the code.

The agents can represent people, firms, animals or every kind of physical entity. In my simulation they represent economic agents those goal is to increase their income. We choose to distribute randomly the agents in the Netlogo's world. The number of economic agents is decided directly by the operators that use the program, through the use of a slider. The slider is a very useful command in Netlogo that allow the users to modify the value of a global variable associated with it between a min and a top value. Moreover I choose to distribute my agents randomly, this instruction of Netlogo let our agents to be set in our world regardless to their position allowing the necessary independence and causality of a real simulation.

The agents are characterized by some specific features that they own: “turtles-own”. In the model there are a total of five variables. Three of them: “reputation”, “ability to attract business”, “optimism” and “trust” represent the core of our simulation, and are variables that explain the networks and the creation of values in the model.

We choose to divide our simulation in two macro-areas: rational and emotional. On the rational side, we have:

- Reputation: describe what all the other agents in the world think about a specific agent.
As the reputation level of the agent increase, it connects more easily with the other members;
- Ability to attract business: a higher value of this variable leads like in the case of the reputation to better performance of the individual in establish networks in our simulation.

On the Emotional side, we have:

- Trust/optimism: on one side (trust) it defined the level of fiduciary attitude belonging to each actor and on the other (optimism) is a mental attitude or tendency to look on the more favorable side of events or conditions and to expect the most favorable outcome. As this value increases the probability of connection among agents increase too;

The first two variables are set randomly, receiving values between 1 and 9. Optimism/trust instead, is set on one side randomly like the other variables but we

decide to implement its formulation multiplying its value with the “general economic situation”. This had as result of linking this agent variable to a global variable.

Along with these characteristic belonging to the agents, the simulation take into account also two environmental variables:

- General economic situation: is set at the start of the simulation and the interactions among agents modify time to time his value.
- Rule of law: defines the law enforcement level of the society.

Moving on at the “setup phase” the agents also receive an initial endowment that we set through a slider call “initial endowment”. This is the amount of resources that the agents hold and their purpose is to increase this value.

The simulation start pressing the “go” button, making run the model continuously. If the agents hold an endowment equal or greater at the “initial endowment” (requirement that at least is satisfy at the first tick⁷, being the endowment = “initial endowment”) the agents displayed the “search partner” command, starting to move randomly. At every tick this requirement is check. Moreover every time that the agent moves it “consumes” part of its endowment defined by the “consume of endowment” slider.

The principal action that defines my simulation is the creation of links, metaphor of economic value that increase the total amount of resources of each agent.

In the rational part of the simulation, the agents to “create links”, first they look at the “Rule of the law” level (that goes from 0 to 2). If the level is less than 1, the agents will create links with other agents with these characteristics.

1) The distance between the agents has to be less or equal to the number set through the “length” slider.

⁷ Tick: is the time counter of Netlogo.

2) The reputation value given randomly has to be equal or greater than the relative break-even value set with the slider.

3) The ability to attract business has to be equal or greater than the relative break-even value set with the slider.

When all these three conditions are satisfied then the links are created.

If instead the “Rule of the law” level is more than 1, the agents will create links with other agents with these characteristics.

1) The distance between the agents has to be less or equal to the number set through the “length” slider.

2) The reputation value given randomly has to be equal or greater than the relative break-even value set with the slider divided by the amount set by the “Rule of the law”.

3) The ability to attract business has to be equal or greater than the relative break-even value set with the slider divided by the amount set by the “Rule of the law”.

The differences in point 2) and 3) are to be intended as a sort of “punishment” that a worst law enforcement situation cause reducing the economic exchange as result of a more insecure business environment.

A higher general level of the law enforcement, increase the probability that networks occur, lowering the minimum rational requirements.

The next step is being able to count the number of links created by each agent. This mission is solved by the command: “count links” that we will see more in detail later.

When the agents create networks among each other, they receive a “money premium” to sum to their initial endowment. This premium is a figurative simplification of the positive result of a business, for computational purpose.

The endowment of the agent increase by a factor proportional to the number of link owned.

The links created own a life's value that is set, first looking at the endowment of the agents at the two ends of the link and choosing the lower endowment. Second, this value is divided by the consume of endowment that is the necessary as fuel of our model.

If the energy value lower under 0 the link die.

The agents are also influenced in their research of economic partnership by their emotional side that redefines the "go" part of our simulation. We decide to call it "go-behavioural". This second simulation implemented the features of the rational model with two behavioural variables, one specifically of the agents and another defined globally. The agents' own variable "optimism/trust" is defined differently respect to the rational conditions seen before. Its value if on one side is defined randomly between 1 and 2 on the other is linked to the general economic situation. This second part of its computation is the fundamental difference between the rational model: one characteristic of our agents is now affected by an environmental variable.

Also the general economic situation present some differences compared to the rule of the law variable. Instead of being set by the controller like the latter, the former is defined inside the simulation and as the program run its value gets modify. Its formulation is composed of two parts, the first one take into account the past value at t_{-1} of the general economic situation, the second one defined how this variable increase/decrease along with the development of the simulation. In detail two elements play the role of define its modification: a multiplier, named "alfa" which value is defined by the operator and the division between "total links" and "total endowment". This latter part lets the simulation being able to modify the value of the general economic situation according to increase/decrease of the number of links and the total wealth. This leads to a more realistic simulation were the agents take into account how the rest of the world act. The general economic situation is not fix, but its value change during the simulation as the agents create network, improving their wealth. The goal is to see how introducing emotions change the result of the simulation.

The increase of the level of optimism/trust of the agents is reflected by the procedure links' creation proper of the "go behavioural".

As in the rational part, the first thing to look for in order to create networks is the level of the rule of law level. If this level is less than 1 the agents will create links if the following characteristic are satisfied.

1) The distance between the agents has to be less or equal to the number set through the "length" slider.

2) The reputation value given randomly multiplied for the optimism/trust level has to be equal or greater than the reputation break-even level set in the slider.

3) The ability to attract business value given randomly multiplied for the optimism/trust level has to be equal or greater than the ability to attract business break-even level set in the slider.

If instead the rule of the law level is more than 1. The conditions to be satisfied are the following.

1) The distance between the agents has to be less or equal to the number set through the "length" slider.

2) The reputation value given randomly multiplied for the optimism/trust level has to be equal or greater than the reputation break-even level set in the slider divided by the amount set by the "rule of the law".

3) The ability to attract business value given randomly multiplied for the optimism/trust level has to be equal or greater than the ability to attract business break-even level set in the slider divided by the amount set by the "rule of the law".

As before, the differences between point 2) and 3) have to be intended as a “punishment” for a lower level of the law enforcement.

The other procedures are same of the rational part. A good quantity of experiments is then possible, analysing different situations.

3.3 Code of the Program

Following suit the code of the program with comments.

```
globals [total-endowment total-links]
```

- We utilize the global command to define a set of variables accessible from all the agents and they can be executed all-over in the program.

```
links-own [energy]
```

- With this command we defined the variables proper of the links in the simulation. Energy is a counter that we use as life status of the links.

```
turtles-own [reputation ability_to_attract_business optimism/trust endowment  
howmanylinks]
```

- The turtles-own' command is used to define the variables own by our agents. In our simulation are: reputation, ability to attract business, optimism/trust, endowment, howmanylinks.

```
to Setup
```

```
clear-all
```

```
set-default-shape turtles "person"
```

```
create-turtles number_of_agents
```

```
ask turtles [setxy random-xcor random-ycor
```

```
set color blue set reputation random 10 set ability_to_attract_business random 10
```

```
set optimism/trust random-float 2 * general_economic_situation set endowment  
(initial_endowment)]  
set general_economic_situation 1.0  
reset-ticks  
end
```

- Here is described the setup phase that represent the static starting point of the simulation.

The first command to appear is clear all, that has the purpose of literally cleaning the program environment.

Set default- default-shape turtles “person” is just a graphic command that modify the image of our agent, from turtles to people.

Create turtles number_of_agents has the goal of introduce the population in the simulation. The number of agents is decided by the namesake slider.

The ask turtles procedure gives a set of orders to our agents. First to set randomly in our world, then to set the colour equal to blue. Next, is the turn to define numerically the variable own by the agents. The reputation and ability to attract business variables are set randomly out of 10. The optimism/trust variable is instead defined on one side randomly (in this case from 0 to 2) and on the other is proportional to the general economic situation level.

Set endowment, refers to the number of agents in the simulation. The number is decided by the operator through the namesake slider.

Set general economic situation, referred to the environmental variable and set it equal to 1.

Reset ticks, reset the tick counter of the simulation.

to go

search-partner

create-links

count-links

```

update-links-energy
die-links
tick
count-endowment
end

```

- This procedure is activated by the “go” command and run our simulation, that pass from be static to be dynamic. They will be described more in detail later.

```

to search-partner
ask turtles with [endowment >= initial_endowment] [lt random 360 fd 1 set endowment
(endowment - consume_of_endowment)]
end

```

- The search partner procedure is the key of the movements of our agents. The agents move to search networks if the endowment is equal or greater than the initial endowment. In this case, they will turn randomly and move of one unit. Move implies for the agents the use of endowment. This consume can be decided ex-ante through the slider.

```

to create-links
  ifelse rule_of_law <= 1 [ask turtles [create-links-to other turtles in-radius lenght with
[reputation >= reputation_break-even and
  ability_to_attract_business >= ability_to_attract_business-break-even
  ]]]
[ask turtles [create-links-to other turtles in-radius lenght with [reputation >=
reputation_break-even / rule_of_law and
  ability_to_attract_business >= ability_to_attract_business-break-even /
rule_of_law]]]
end

```

- This is the procedure used by the agents to create links. The first condition they check is the rule of the law level. If less than 1 they will perform the first part of the program, creating links with other agents that are enough near and with a level of reputation and ability to attract business equal or greater to the two break-even's value set ex-ante. If instead the level of the rule of the law is greater than 1, the agents will perform the second part of the command, where the two break-even values set for reputation and ability to attract business are lowered, dividing their level by the rule of the law.

to count-links

```
ask turtles [set howmanylinks count links with [end1 = myself or end2 = myself]]
end
```

- This command count the number of links hold by every agents.

to count-endowment

```
ask turtles[ if howmanylinks > 0 [set endowment (endowment + howmanylinks)]]
end
```

- This procedure count the endowment that every agents hold. The endowment at every tick is calculated summing the endowment $t-1$ plus the number of links holds.

to update-links-energy

```
ask links [ifelse [endowment] of end1 <= [endowment] of end2 [set energy
([endowment] of end1 / consume_of_endowment)]
[set energy ([endowment] of end2 / consume_of_endowment )]]
end
```

- This command updates the energy/life of the links. At every tick the link will check the endowment of the agents at both its end choosing the smaller value. This value will

be also divided by the consume of endowment. The final result is the energy holds by the links.

to die-links

ask links [if energy < 0 [die]]
end

- This command decies how the links died. This circumstance happen when the energy of the links is less than 0.

to go-behavioral

search-partner-behavioral
create-links-behavioral
count-links-behavioral
update-links-energy-behavioral
die-links-behavioral
tick
count-endowment-behavioral
count-total-endowment
count-total-links
*set general_economic_situation (general_economic_situation + alfa * (total-links / total-endowment))*
update-optimism/trust
end

- This procedure activated by the “go behavioural” button redefined our simulation, introducing the emotional features in the program. Being some parts just a repetition of the rational simulation, we will focus just on the differences.

Of interest here the command that set the general economic situation. This environmental variable displayed a value that is not fixed during the simulation like the

one related to the rule of the law's level. The model is now dynamic being able to change according to the increase/decrease of the economy. More in details, the general economic situation at t is equal to the general economic situation at t_{-1} plus α , that is a multiplier, multiplied by a ratio defined by the total links divided by the total endowment.

to create-links-behavioral

```

ifelse rule_of_law <= 1 [ask turtles [create-links-to other turtles in-radius length with
[reputation * optimism/trust >= reputation_break-even and
    ability_to_attract_business * optimism/trust >= ability_to_attract_business-break-
even
    ]]]
[ask turtles [create-links-to other turtles in-radius length with [reputation *
optimism/trust >= reputation_break-even / rule_of_law and
    ability_to_attract_business * optimism/trust >= ability_to_attract_business-
break-even / rule_of_law ]]]
end

```

- This is the procedure used by the agents to create links implemented with the behavioural features. The first condition they check is the rule of the law level like in the rational simulation. If less than 1 they will perform the first part of the command line, creating links with other agents that are enough near and with a level of reputation and ability to attract business multiplied by the optimism/trust variable equal or greater to the two break-even's value set ex-ante. The difference is the implementation of a behavioural feature. As in the rational model if instead the level of the rule of the law is greater than 1, the agents will perform the second part of the command, where the two break-even values set for reputation and ability to attract business are lowered, dividing their level by the rule of the law.

to count-total-endowment

```
ask turtles [ set total-endowment sum [endowment] of turtles]
end
```

- This procedure counts the total endowment, summing at every tick the endowment of all the agents.

```
to count-total-links
  ask turtles [set total-links count links]
end
```

- Like the procedure described just over, it sums at every tick all the links created.

```
to update-optimism/trust
  ask turtles [set optimism/trust random-float 2 * general_economic_situation]
end
```

- This procedure simply repeat the command use to defined the optimism/trust level, making this variable dynamic instead of fix and set ex-ante.

3.4 Experiments – Rational Model

This part is dedicated to a set of experiments with the goals of understanding how modifying variables in the program gives different outputs.

This first chapter is dedicated to the experiments related with the rational side of our simulation.

These are the experiments we want to try.

A.1/2 – increase/decrease the number of agents.

Goal of this experiment is to see if a numerical change affects the output of our simulation. As expected the experiments will confirm our prevision about a positive correlation between number of agents and wealth.

B.1 – increase the Rule of Law's level

In this experiment we want to modify the environmental variable that define the level of law enforcement in our simulated world. As expected the experiments will confirm a positive correlation between this global variable and wealth.

C.1/2 – increase/decrease the length

Modifying the length, leads to an increase or decrease of the radius around in which the agents can find an economic partner. The results are in line with our expectation: increasing the length increases the creation of networks, while a decrease leads to the opposite result.

D.1/2 – increase/decrease the initial endowment

In this experiments we want to analyse the effect of changing the initial quantity of wealth of every agents. The results will show a positive correlation towards these changings.

E.1/2 - increase/decrease the reputation break-even

In this experiments we will modify the break-even level. The results are in line with our expectations: an increase of the break-even limit shows a decrease in the creation of wealth, while decreasing the reputation break-even leads to better results.

F.1/2 – increase/decrease the ability to attract business break-even

As in the experiment E, we will modify a break-even limit. While the decrease of this limit leads to results in line with our expectations, the increase of such limit instead of bring us a situation opposite to the one expected.

G. 1/2 - increase/decrease the consume of endowment

In this experiments we want to analyse the effect of changing the consume of wealth spend by every agents moving. The results will show a negative correlation towards these changings.

We choose to start from what we consider the basic situation. These are the characteristics:

Number of Agents: 25

Rule of Law: 1.0

Length: 8

Initial Endowment: 7

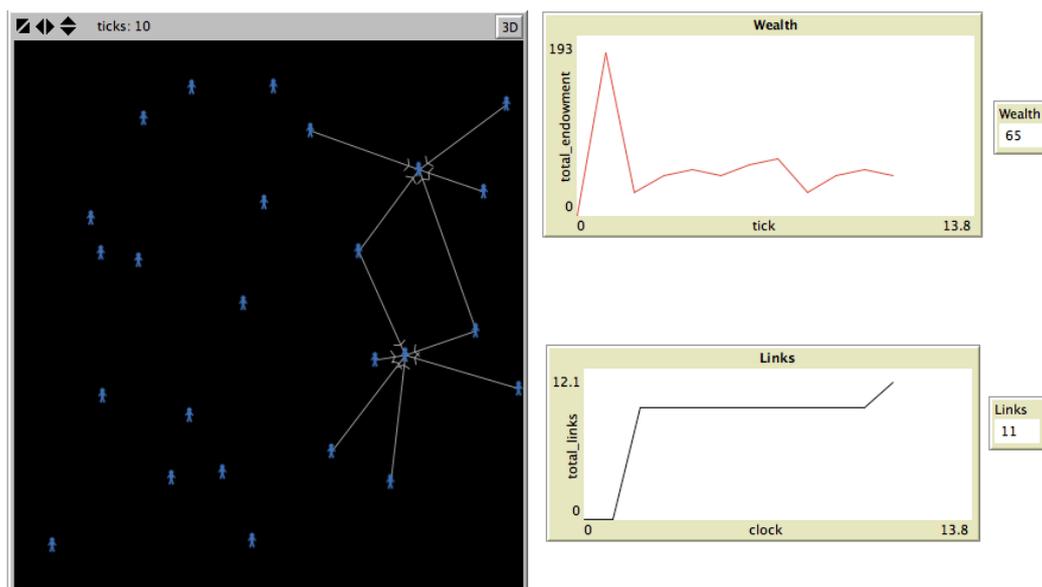
Reputation break-even: 6

Ability to Attract Business break-even: 6

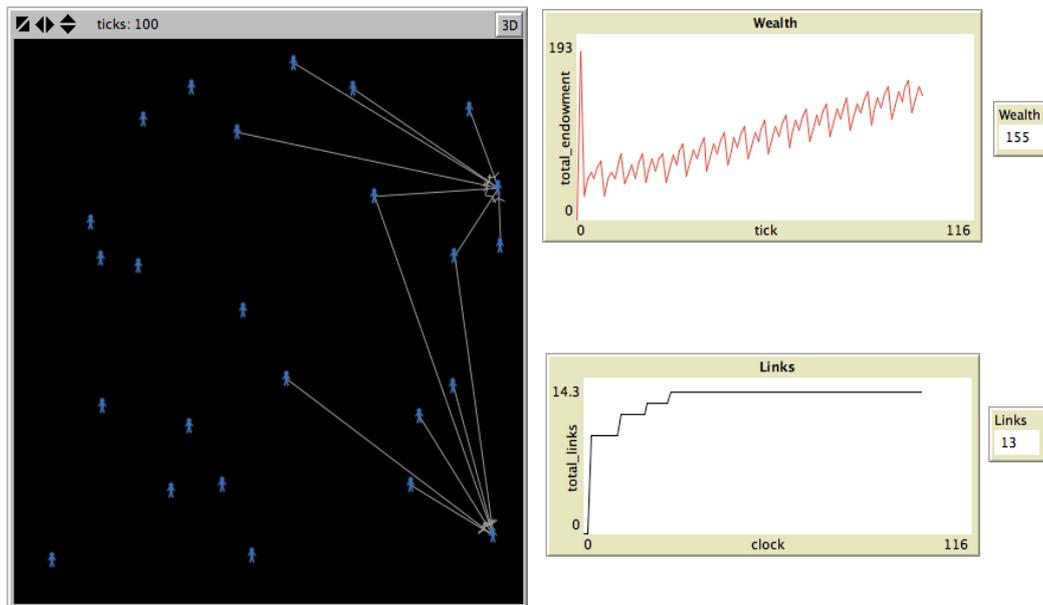
Consume of Endowment: 6

Moreover we choose to observe the results at two different time: at the 10^o and at the 100^o ticks to have a more complete and clear view of the changings.

At the 10^o tick:



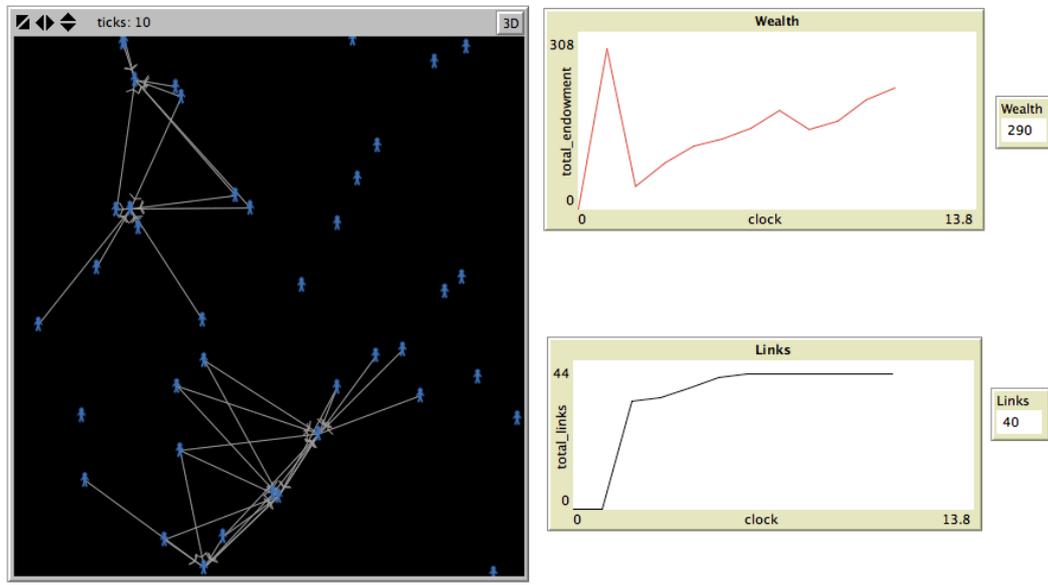
At the 100° tick:



We can observe how in the “basic situation” at the 10° tick the simulation displays 11 links and an amount of wealth equal to 65. At the 100° tick both this value have increase. We can notice that from the 4° tick on the wealth’s plots follows a recurrent movement. Instead the links’ plot shows a stabilization around the 26° tick, at the final value of 13.

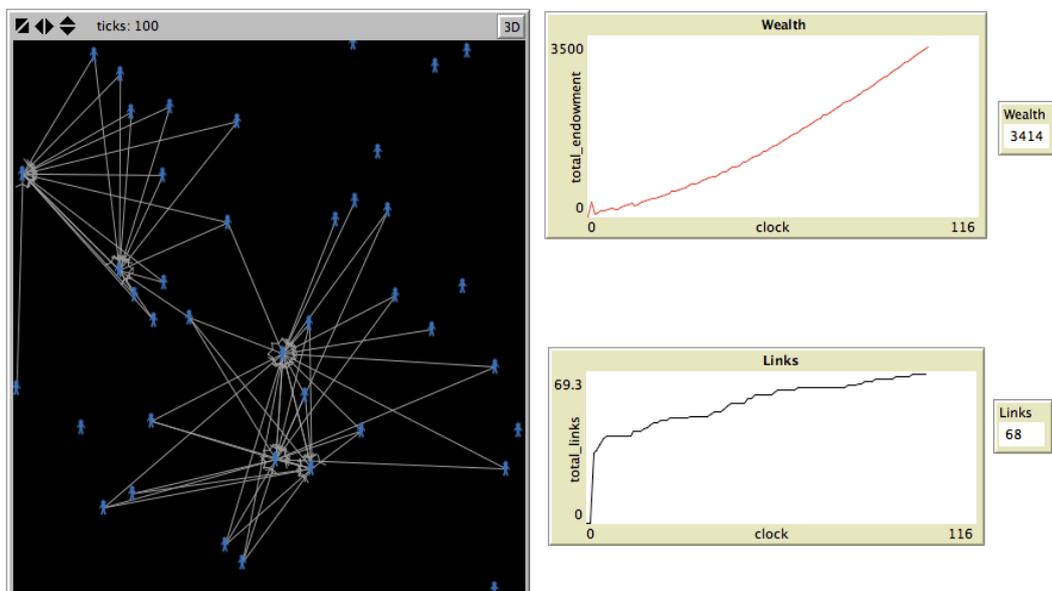
A.1 – Increase in the number of agents (from 25 to 40).

At the 10^o tick



A.1 – Increase in the number of agents (from 25 to 40).

At the 100^o tick

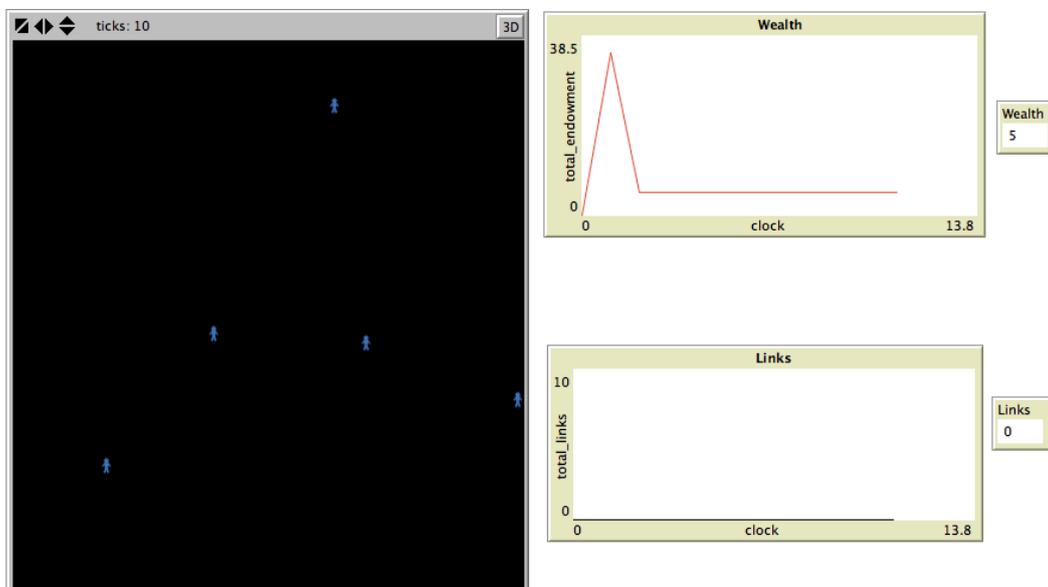


A.1 – Increase in the number of agents (from 25 to 40).

We can see how letting all the other variables untouched the wealth level and the number of links increased exponentially compared to the “basic situation”. This result is of easily prevision, because as the number of agents increase, also the probability of find an economic partner follows the same way. Practically, the search partner command became more effective. To notice how at the 10° tick both the statistics are higher compared to the 100° tick of the “basic situation”.

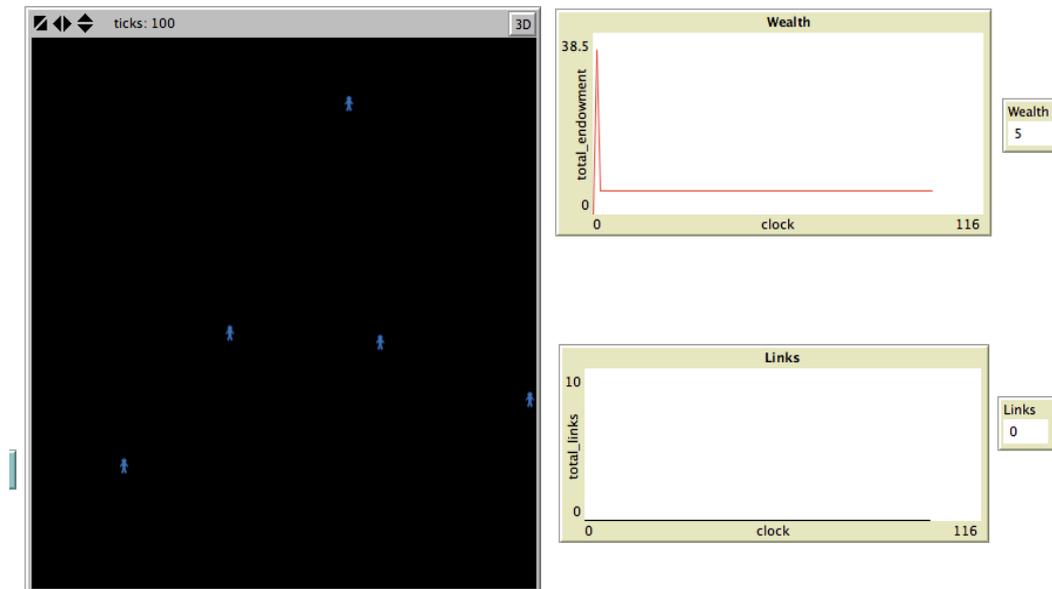
A.2 – Decrease in the number of agents (from 25 to 5).

At the 10° tick



A.2 – Decrease in the number of agents (from 25 to 5).

At the 100^o tick



A.2 –

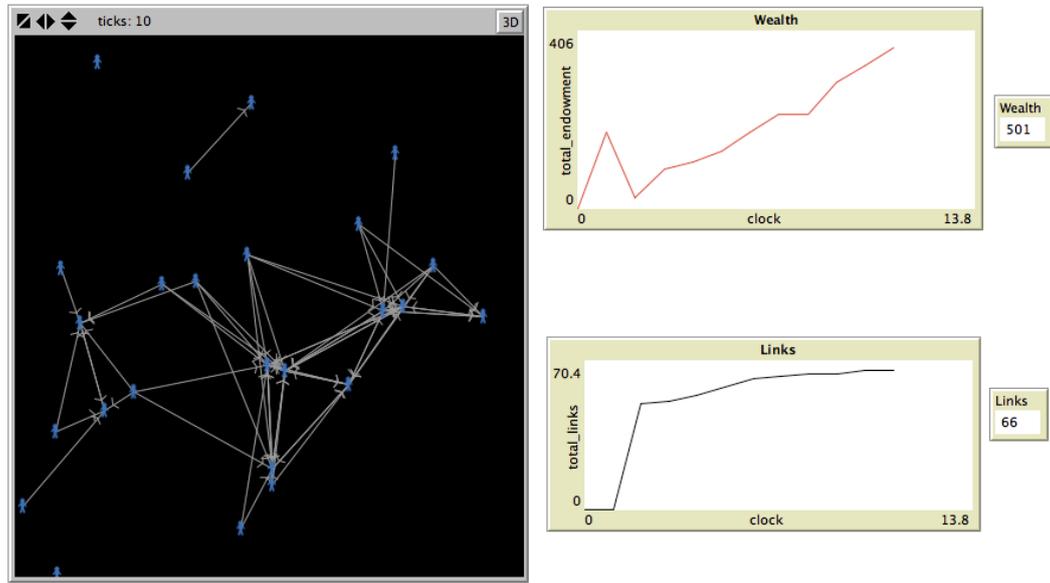
Decrease in the number of agents (from 25 to 5).

The result of the decrease of agents is the impossibilities, along with the other restrictions, of creating economic value through links. We can notice how the wealth at the 1^o tick was higher, this is the consequences of the consume of endowment that occurred at every movement. After the 1^o tick the endowment is lower than the initial endowment, and the agents cannot move.

B.1 – increase the Rule of Law’s level (from 1.0 to 2.0).

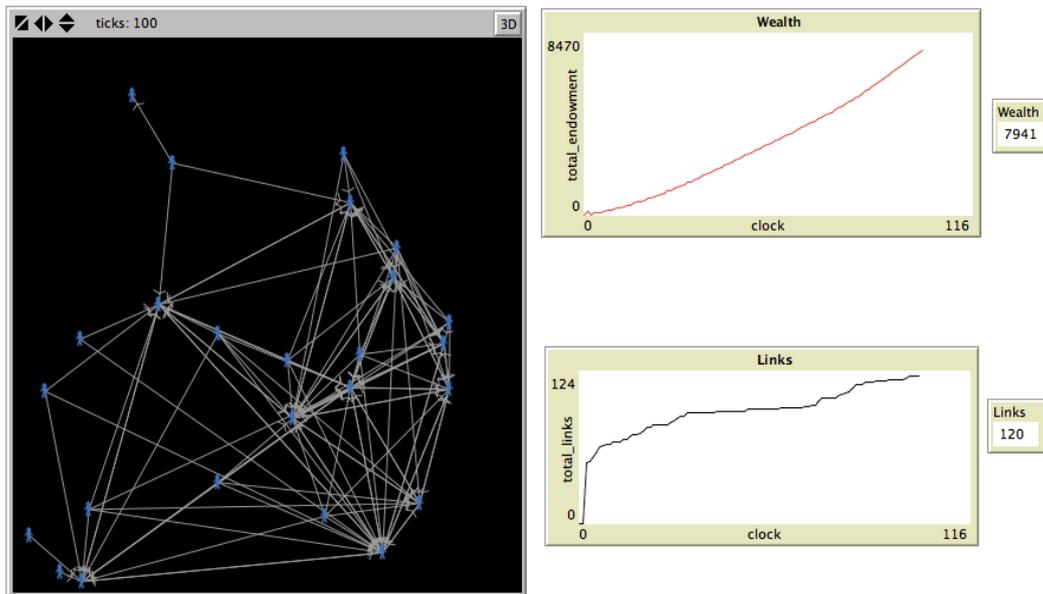
(A decrease instead will not change the simulation, because changing the Rule of Law level from 0 to 1.0 don’t affect the simulation)

At the 10° tick



B.1 – increase the Rule of Law’s level (from 1.0 to 2.0).

At the 100° tick

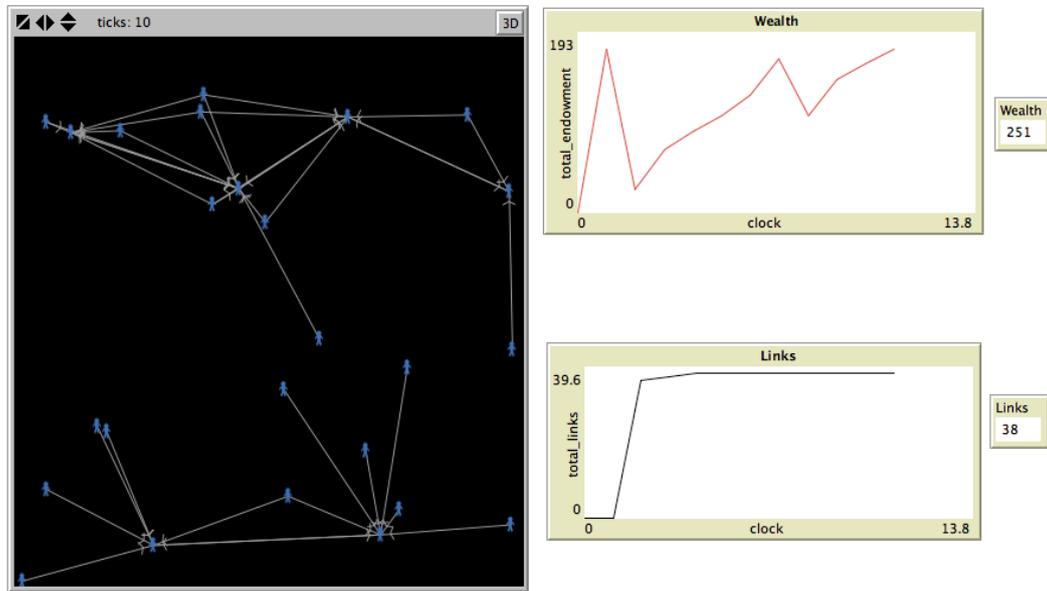


B.1 – increase the Rule of Law’s level (from 1.0 to 2.0).

As easy to foresee, increasing the level of the Rule of law increased the percentage of links created, because the reputation and ability to attract business break even are now divided by the level of the Rule of the law. The consequence is similar to a direct decrease of these two barriers. We will then compare this experiment with the E.2 and F.2 ones, expecting lower results in terms of wealth and number of links by the latter two.

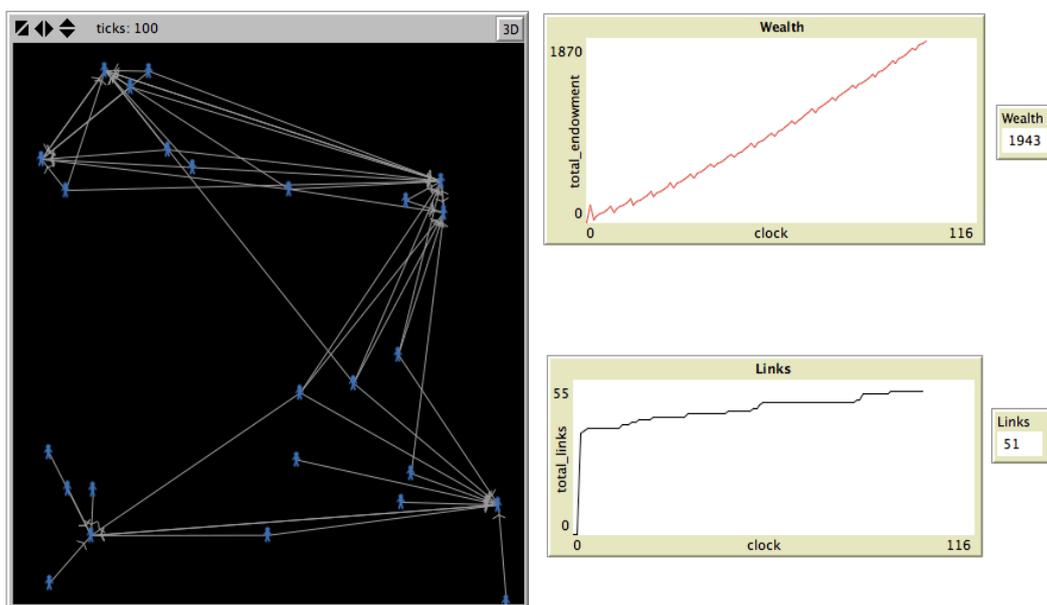
C.1 – increase the length (from 8 to 12)

At the 10° tick



C.1 – increase the length (from 8 to 12)

At the 100° tick

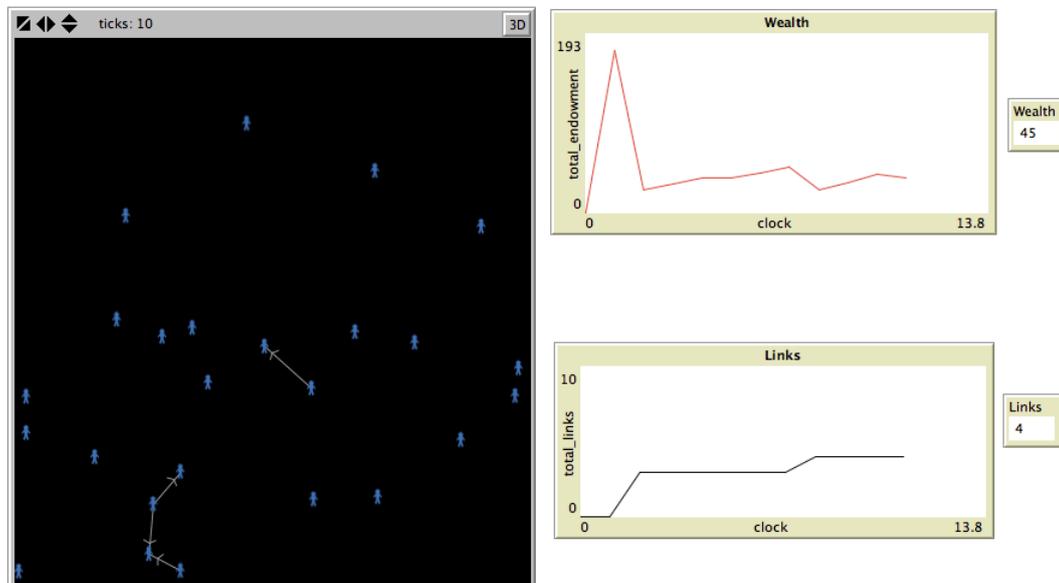


C.1 – increase the length (from 8 to 12)

We can observe how compare to the “basic situation”, at the 10° tick the simulation displays 38 links and an amount of wealth equal to 251. At the 100° tick both this value have increase respectively to 51 and 1943. The results show on both time lags a large improvement respect to the “basic situation”. The reason is in the increase of the radius in which the agents can create networks.

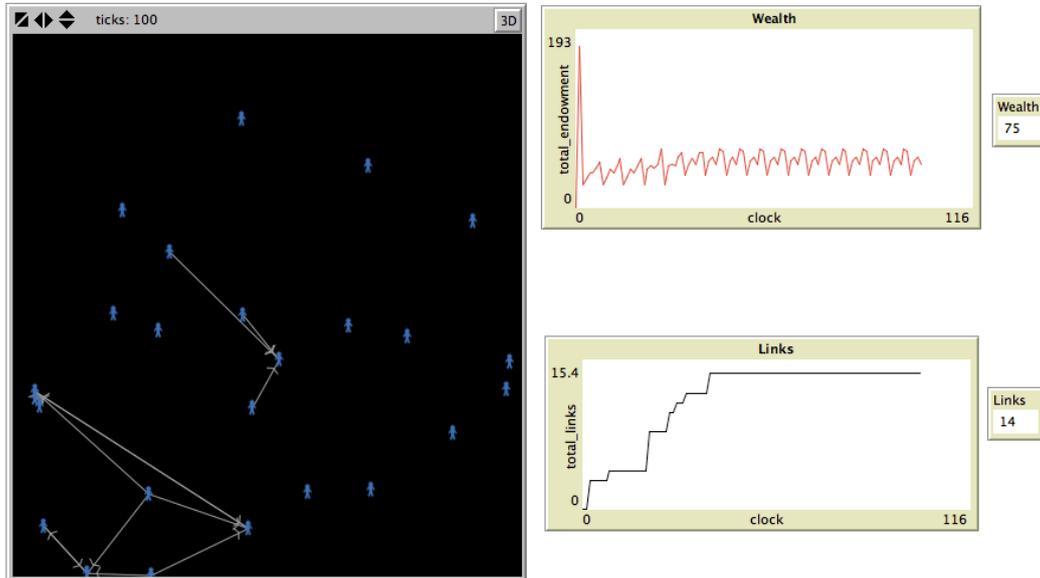
C.2 – decrease the length (from 8 to 4)

At the 10° tick



C.2 – decrease the length (from 8 to 4)

At the 100° tick

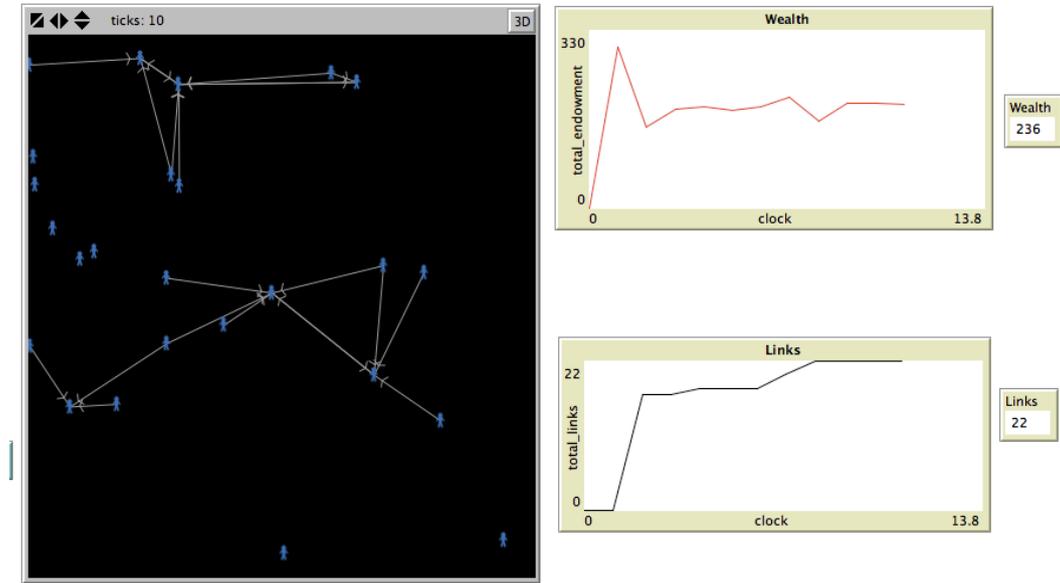


C.2 – decrease the length (from 8 to 4)

We can observe how compare to the “basic situation”, at the 10° tick the simulation displays 4 links and an amount of wealth equal to 45. At the 100° tick both these values have increase respectively to 14 and 75. The results show with exception of the number of links at the 100° tick, a decrease in the performance. To notice is that comparing this decrease with the increase of the experiment C.1, the latter displays a larger differentiation on the results. These results can make us point the doubt that increase and decrease of a same amount the length, don't bring to equally proportional outputs.

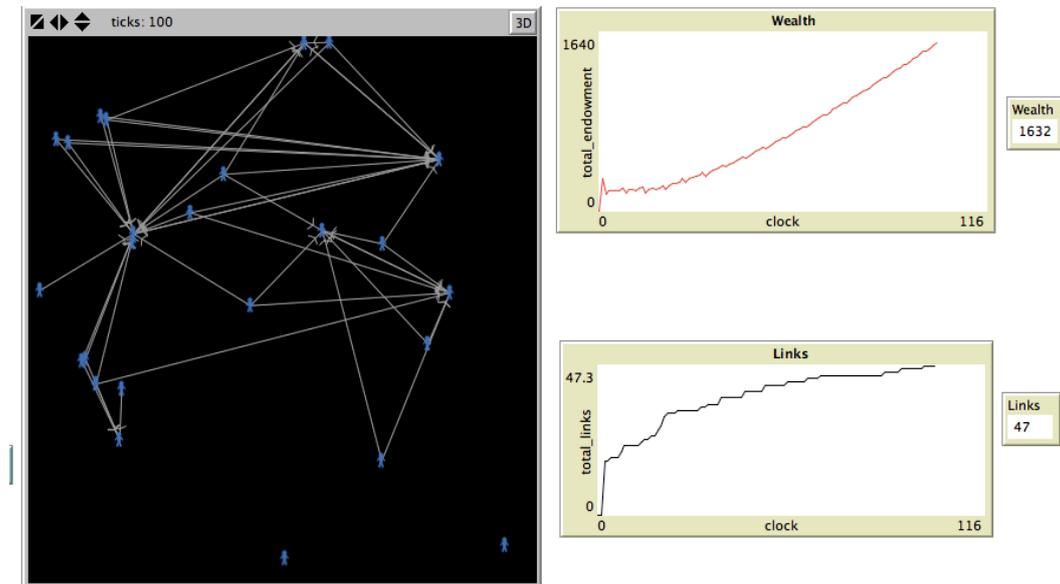
D.1 – increase the initial endowment (from 7 to 12)

At the 10^o tick



D.1 – increase the initial endowment (from 7 to 12)

At the 100^o tick

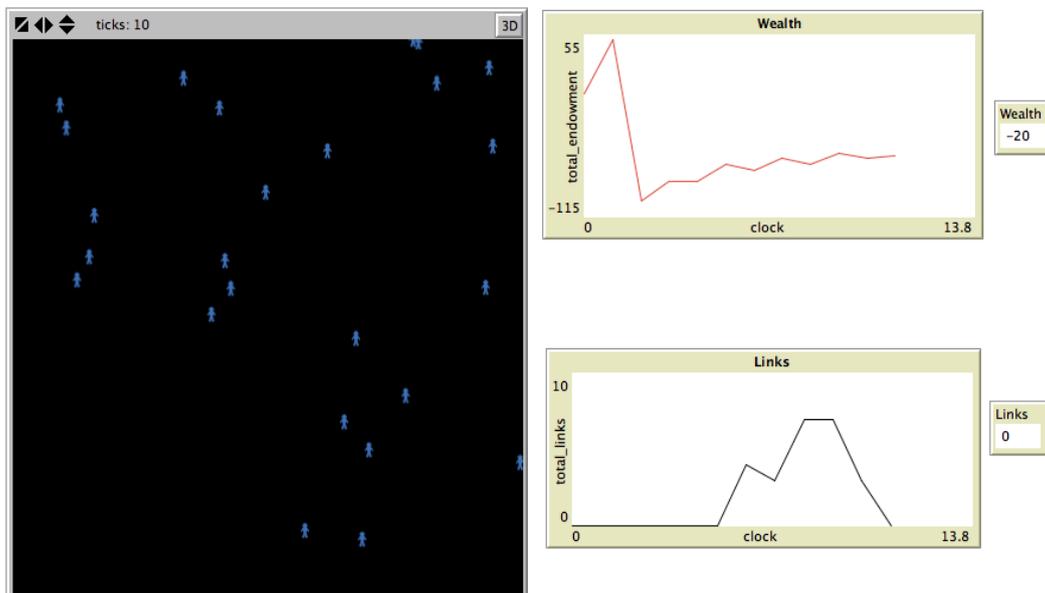


D.1 – increase the initial endowment (from 7 to 12)

We can observe how compared to the “basic situation”, at the 10° tick the simulation displays 22 links and an amount of wealth equal to 236. At the 100° tick both this value have increase respectively to 47 and 1632. The result shows as expected and increase on both parameters as consequences of a higher initial endowment that let higher possibilities of movements to the agents.

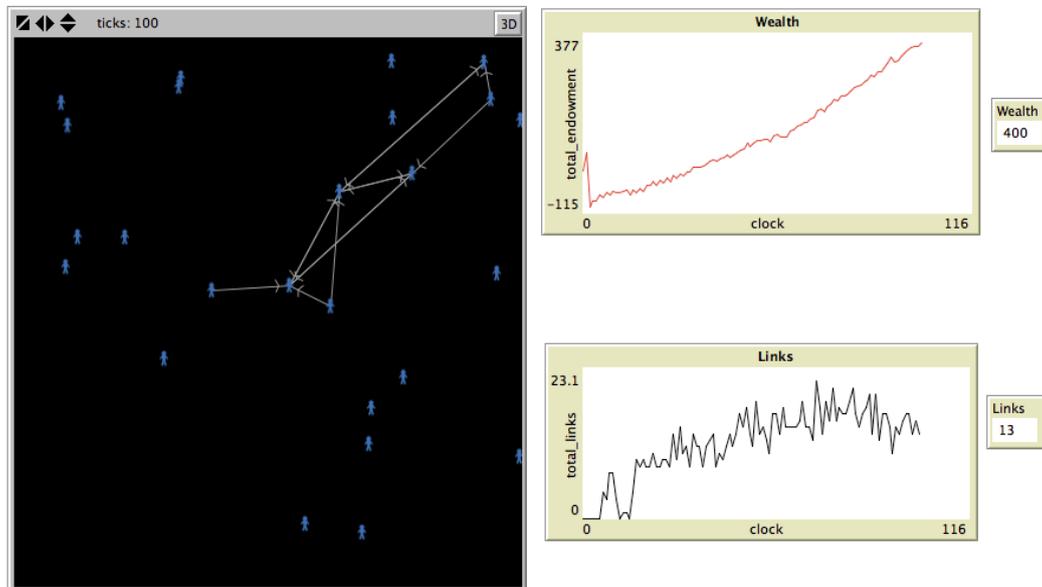
D.2 – decrease the initial endowment (from 7 to 2)

At the 10° tick



D.2 – decrease the initial endowment (from 7 to 2)

At the 100° tick

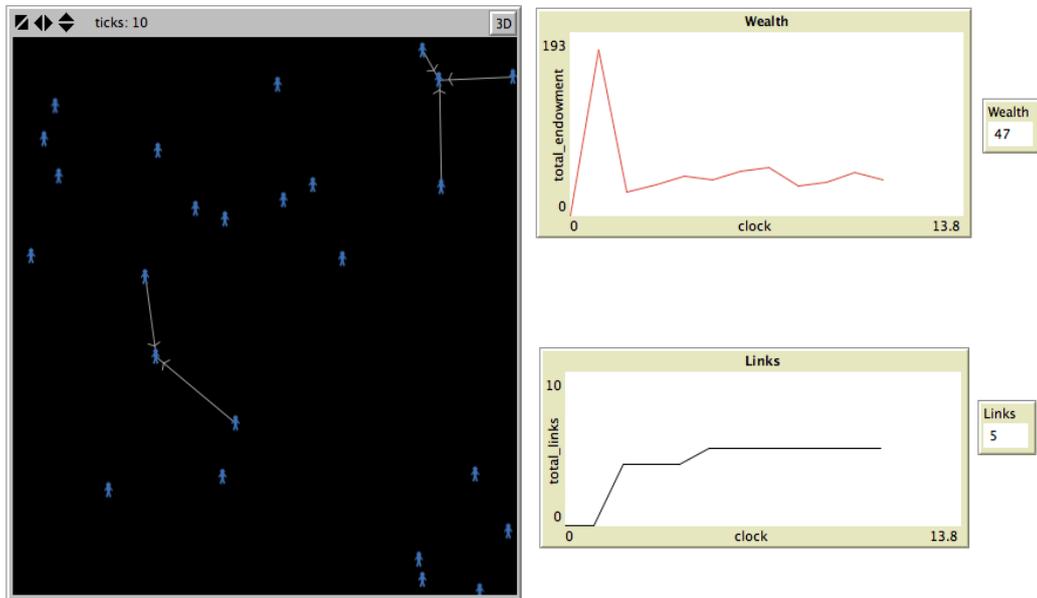


D.2 – decrease the initial endowment (from 7 to 2)

This simulation leads to a curious situation. At the 10° tick the counters show values for wealth and the number of links in line with our expectations. In particular the wealth value is under 0 because of the higher value of the consume of endowment compared to the initial endowment. What can be a surprise, is instead the result that we face at the 100° tick, where both links and wealth are positive. Why? The answer is in the position of the agents, that even if in difficulties at the start, as consequences of the law initial endowment, they have the possibility of create links with they neighbour in quantity sufficient to restart the “engine” of the movements.

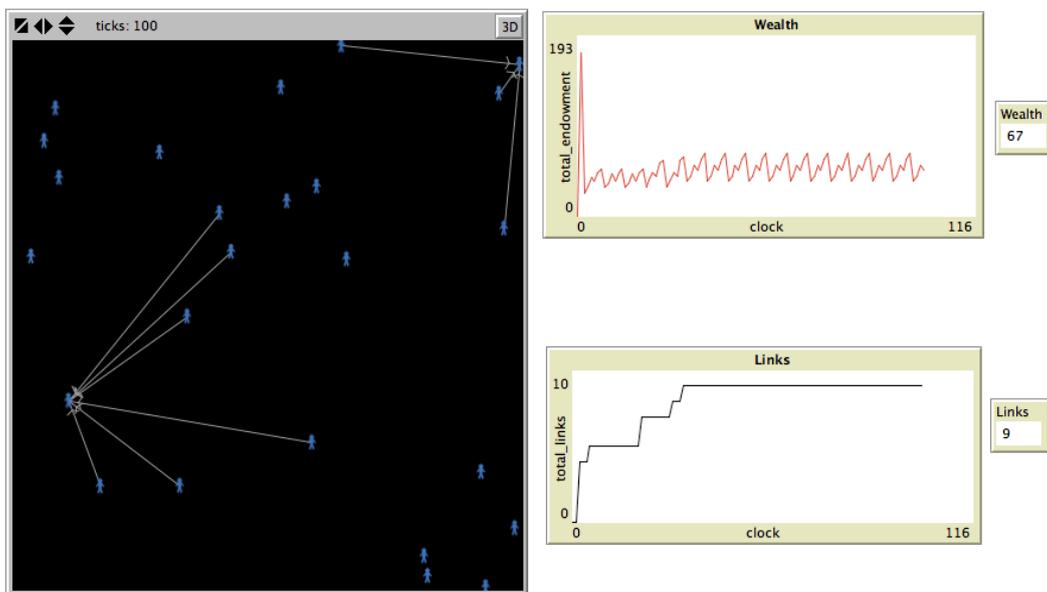
E.1 - increase the reputation break-even (from 6 to 9)

At the 10° tick



E.1 - increase the reputation break-even (from 6 to 9)

At the 100° tick

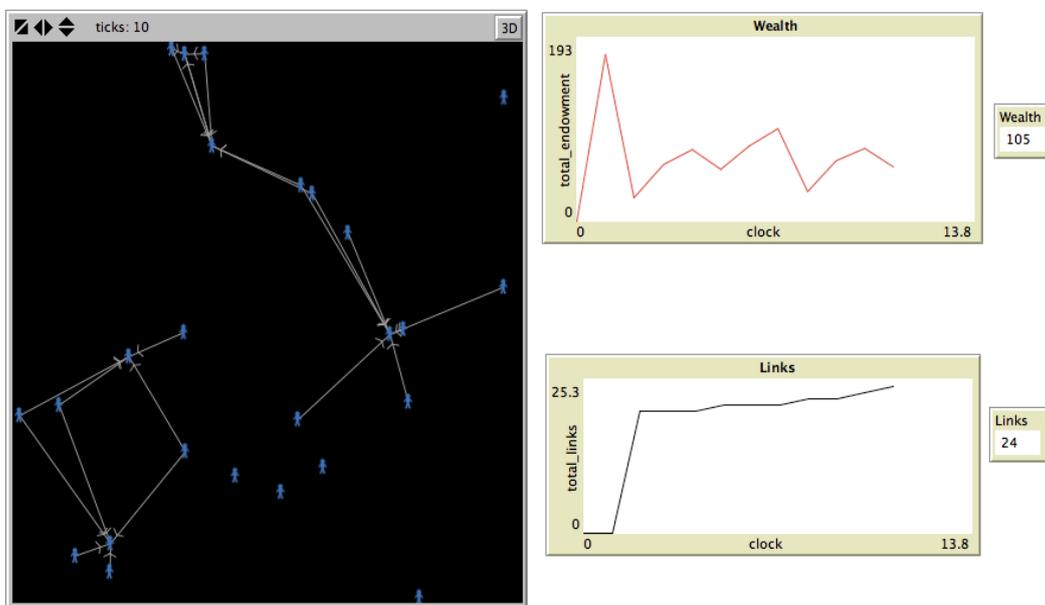


E.1 - increase the reputation break-even (from 6 to 9)

We can observe how compare to the “basic situation”, at the 10° tick the simulation displays 5 links and an amount of wealth equal to 47. At the 100° tick the values are respectively 9 and 67. As expected compare to the “basic model”, at the 10° and 100° tick the situation is worst, as consequences of a higher barrier of reputation requirement. Of interest is to see how the wealth level from around the 3° tick followed a recurrent movement and instead the links counter stabilized around the 25° tick.

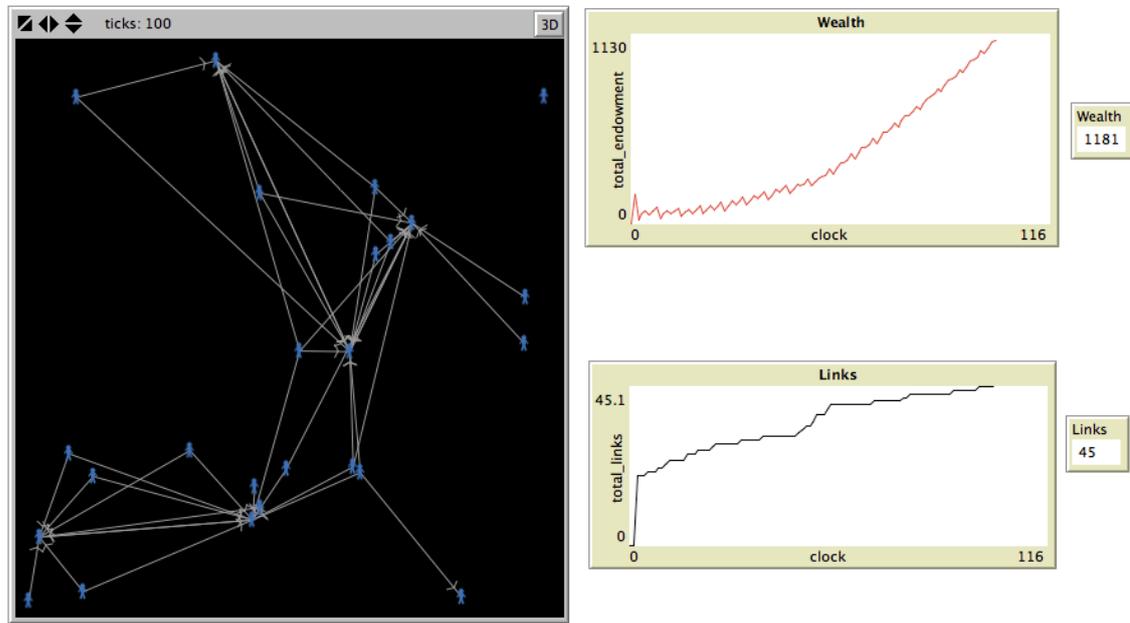
E.2 - decrease the reputation break-even (from 6 to 3)

At the 10° tick



E.2 - decrease the reputation break-even (from 6 to 3)

At the 100° tick

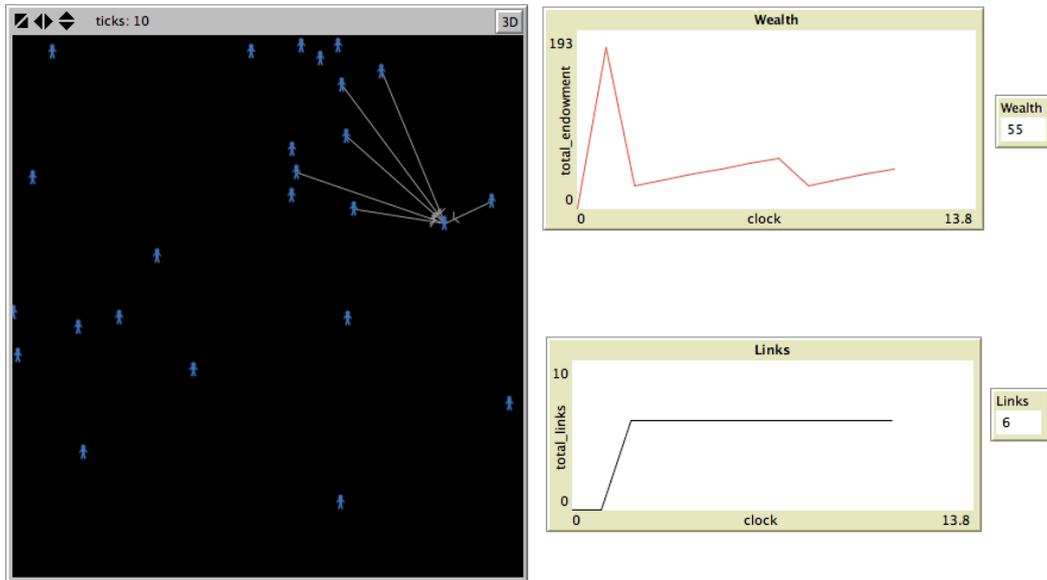


E.2 - decrease the reputation break-even (from 6 to 3)

As expected a decrease in the reputation break-even increase the possibilities for the agents to create networks. Both the wealth and links counters displayed values higher than in the “basic situation”. As point out before these values, even if higher, remain lower compared to the effect that follow the increase in the Rule of Law variable. The reason is simple, here just one break-even variable have been affected.

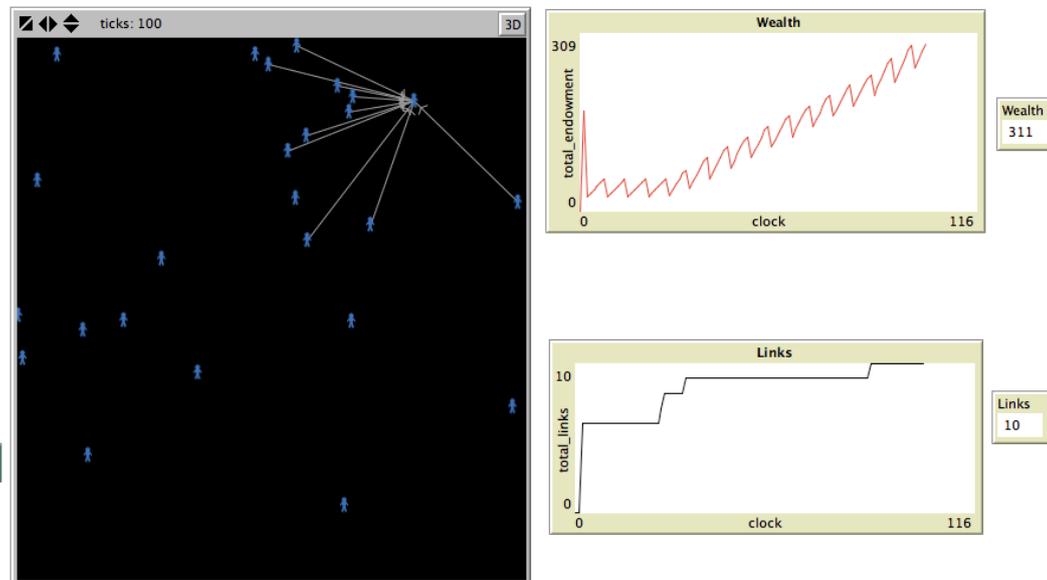
F.1 – increase the ability to attract business break-even (from 6 to 9)

At the 10° tick



F.1 – increase the ability to attract business break-even (from 6 to 9)

At the 100° tick



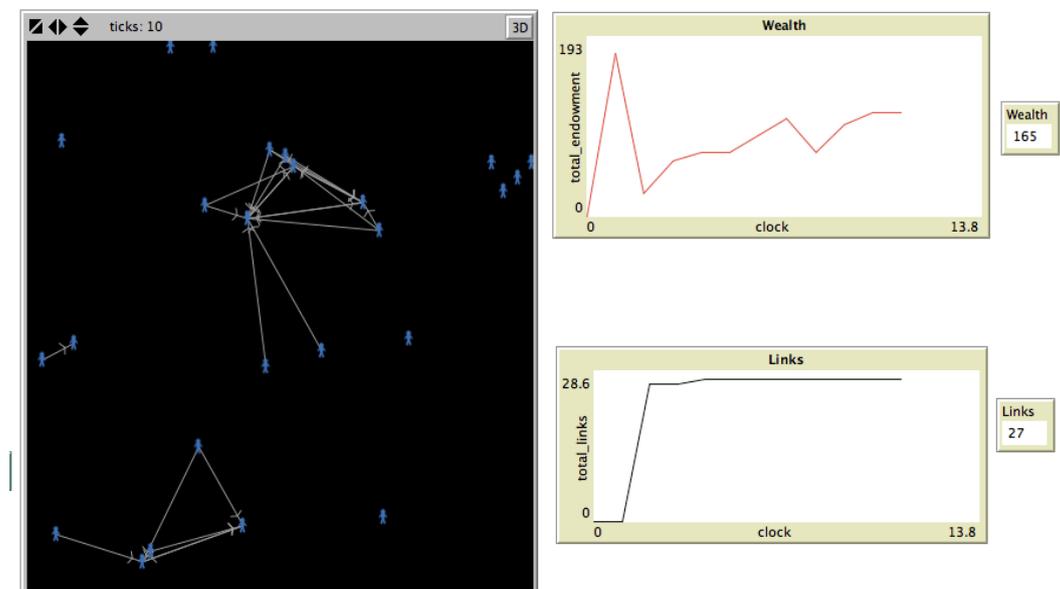
F.1 – increase the ability to attract business break-even (from 6 to 9)

Respect to the “basic situation”, as expected, at the 10^o tick both values are lower as result of higher requirement for creating networks.

At the 100^o tick instead the situation is overturned, with values higher compared to the 100^o tick of the “basic situation”. These results can be explained by the important role assumed by the distribution of the agents in our simulation. The distribution can affect the expected results.

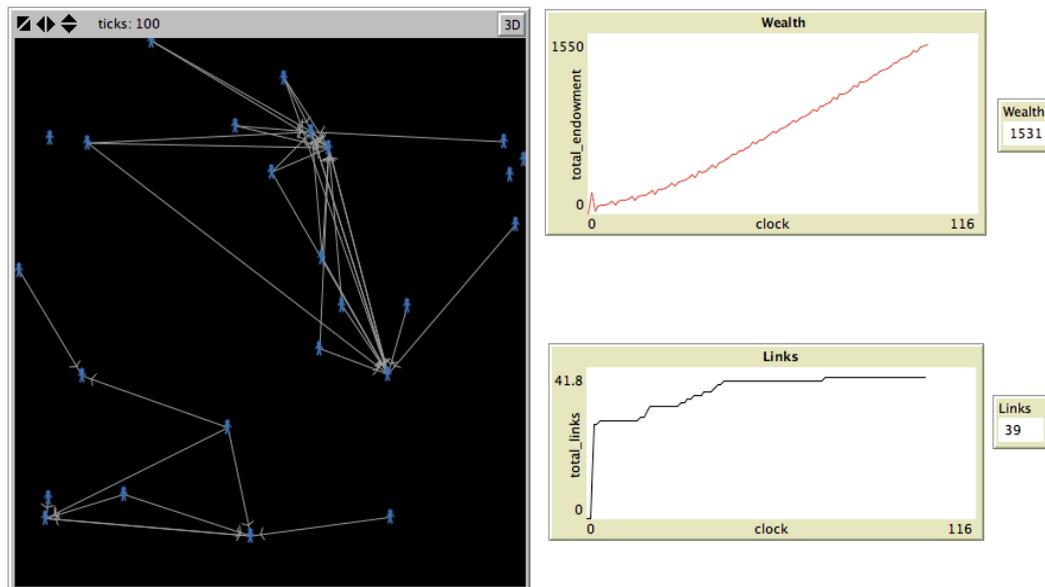
F.2 – decrease the ability to attract business break-even (from 6 to 3)

At the 10^o tick



F.2 – decrease the ability to attract business break-even (from 6 to 3)

At the 100° tick

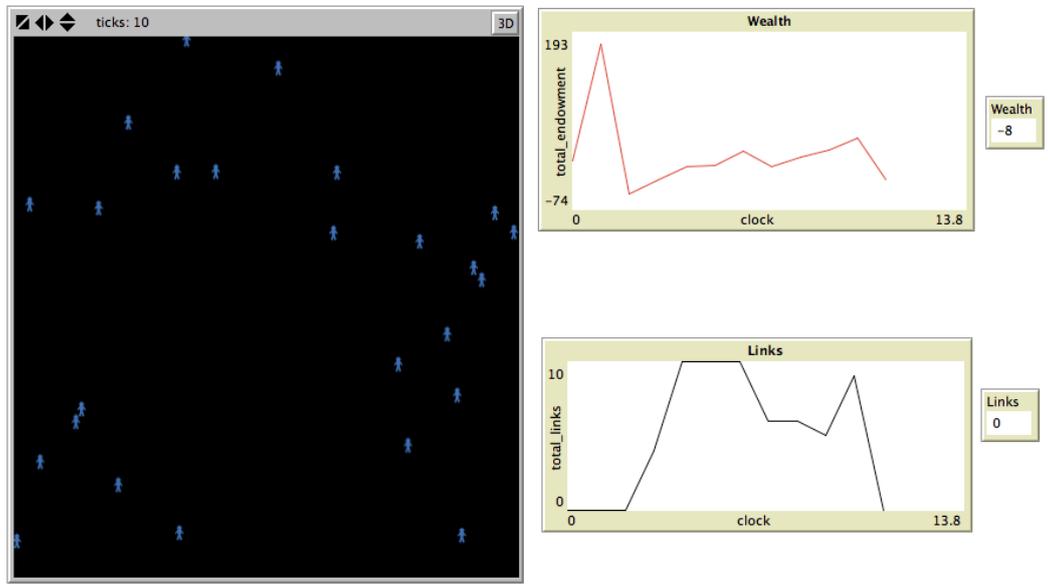


F.2 – decrease the ability to attract business break-even (from 6 to 3)

As expected a decrease in the ability to attract business break-even increase the possibilities for the agents to create networks. Both the wealth and links counters displayed values higher than in the “basic situation”. Compared to the decrease in the reputation break-even, as expected: been the effects of the variables of the same magnitude, the value of wealth and the number of links are similar.

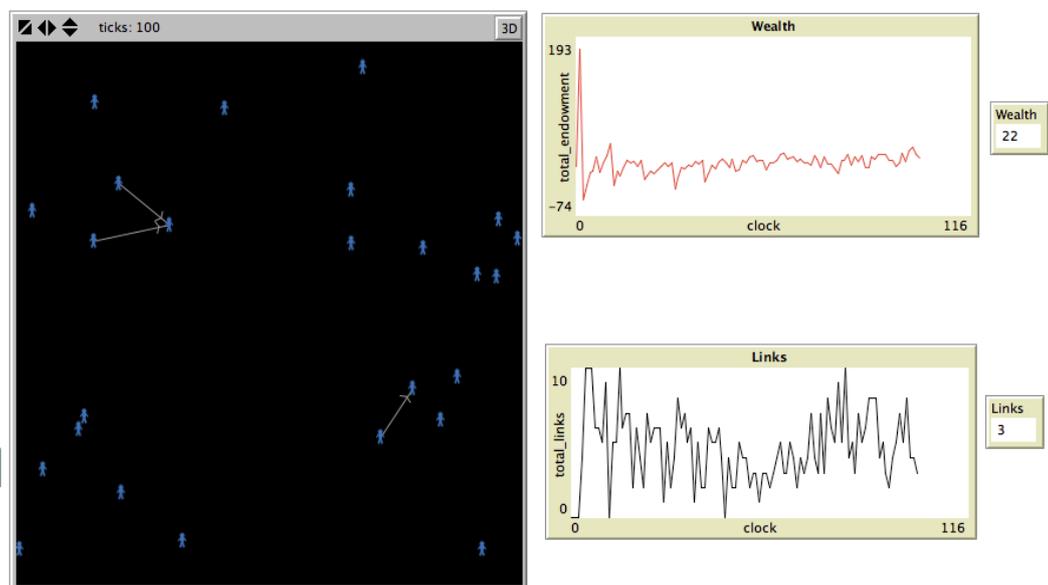
G. 1 - increase the consume of endowment (from 6 to 9)

At the 10° tick



G. 1 - increase the consume of endowment (from 6 to 9)

At the 100° tick

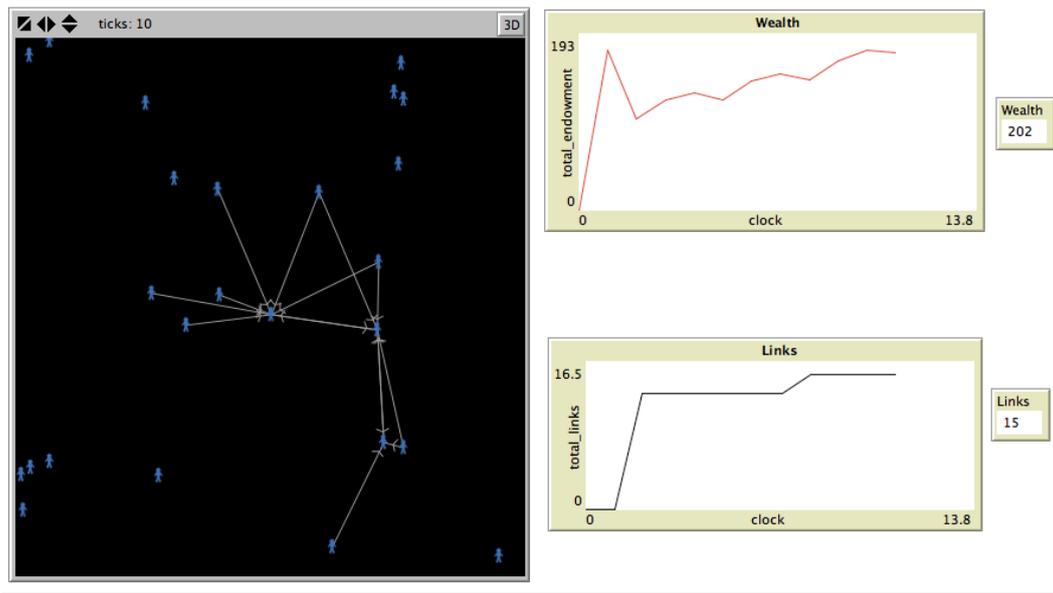


G. 1 - increase the consume of endowment (from 6 to 9)

Both value at the 10° and 100° tick are lower than in the “basic situation” mirroring the great handicap that every agents occured trying to find a commercial partner.

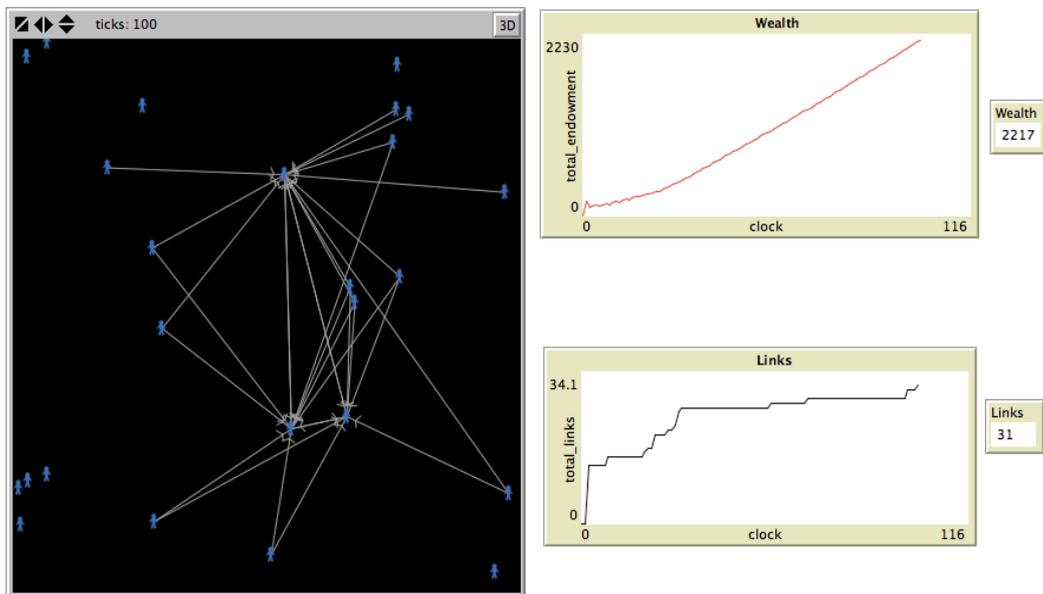
G. 2 – decrease the consume of endowment (from 6 to 3)

At the 10° tick



G. 2 – decrease the consume of endowment (from 6 to 3)

At the 100^o tick



G. 2 – decrease the consume of endowment (from 6 to 3)

As expected, decreasing the consume of endowment, increase the level of wealth and the number of links created, pushing the agents to search and create networks.

3.5 Experiments – Behavioural Model

This second chapter of experiments is dedicated to experiments related with the behavioural side of our simulation.

This is the plan of the experiments:

A.1/2 – increase/decrease the number of agents

Goal of this experiment is to see if a numerical change affects the output of our simulation. As expected the experiments will confirm our prevision about a positive correlation between number of agents and wealth.

B.1 – increase the general economic situation level

In this experiment we want to modify the environmental variable that define the level of general economic situation in our simulated world. As expected the experiments will confirm a positive correlation between this global variable and wealth.

C.1 – increase the rule of law's level

In this experiment we want to modify the environmental variable that define the level of law enforcement in our simulated world. As expected the experiments will confirm a positive correlation between this global variable and wealth.

D.1/2 – increase/decrease the length

Modifying the length, leads to an increase or decrease of the radius around in which the agents can find an economic partner. The results are in line with our expectation: increasing the length increases the creation of networks, while a decrease leads to the opposite result.

E.1/2 – increase/decrease the initial endowment

In this experiments we want to analyse the effect of changing the initial quantity of wealth of every agents. The results will show a positive correlation towards these changings.

F.1/2 - increase/decrease the reputation break-even

In this experiments we will modify the break-even level. The results are in line with our expectations: an increase of the break-even limit shows a decrease in the creation of wealth, while decreasing the reputation break-even leads to better results.

G.1/2 – increase/decrease the ability to attract business break-even

As in the experiment E, we will modify a break-even limit. While the decrease of this limit leads to results in line with our expectations, the increase of such limit instead of bring us a situation opposite to the one expected.

H. 1/2 - increase/decrease the consume of endowment

In this experiment we want to analyze the effect of changing the consume of wealth spend by every agents moving. The results will show a negative correlation towards these changings.

I.1/2 – increase/decrease alfa

In this experiment we want to analyse the effect of changing the value of the multiplier alfa. As expected increasing alfa leads to better performance, while decreasing alfa lower the performance.

As in the experiments related with the rational side, we choose to start from a basic situation. These are the characteristics:

Number of Agents: 25

General Economic Situation: 1.0

Rule of Law: 1.0

Length: 8

Initial Endowment: 7

Reputation break-even: 6

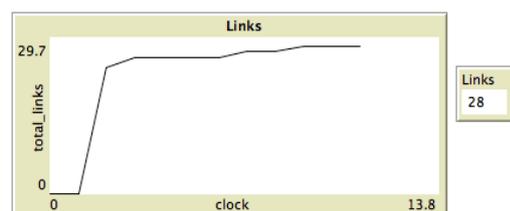
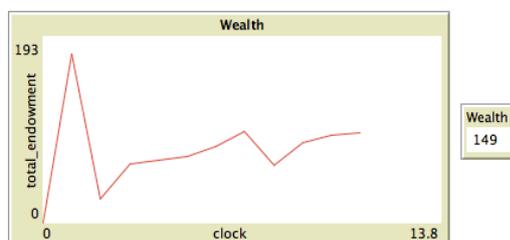
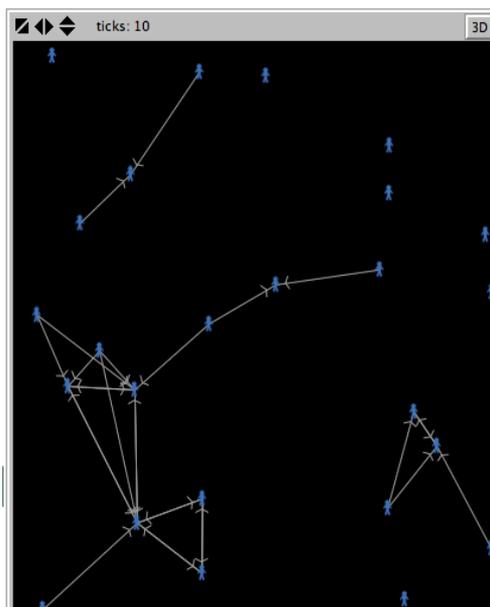
Ability to Attract Business break-even: 6

Consume of Endowment: 6

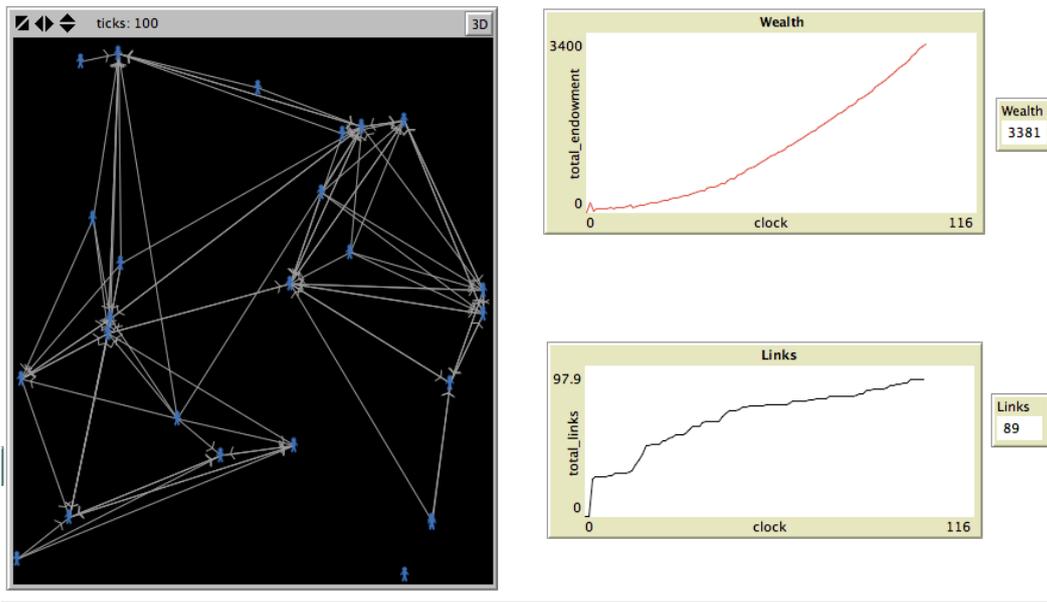
Alfa: 0.2

Like in the experiments of the previous chapter, we choose to observe the situation at two time lags: the 10^o and 100^o ticks.

At the 10^o tick



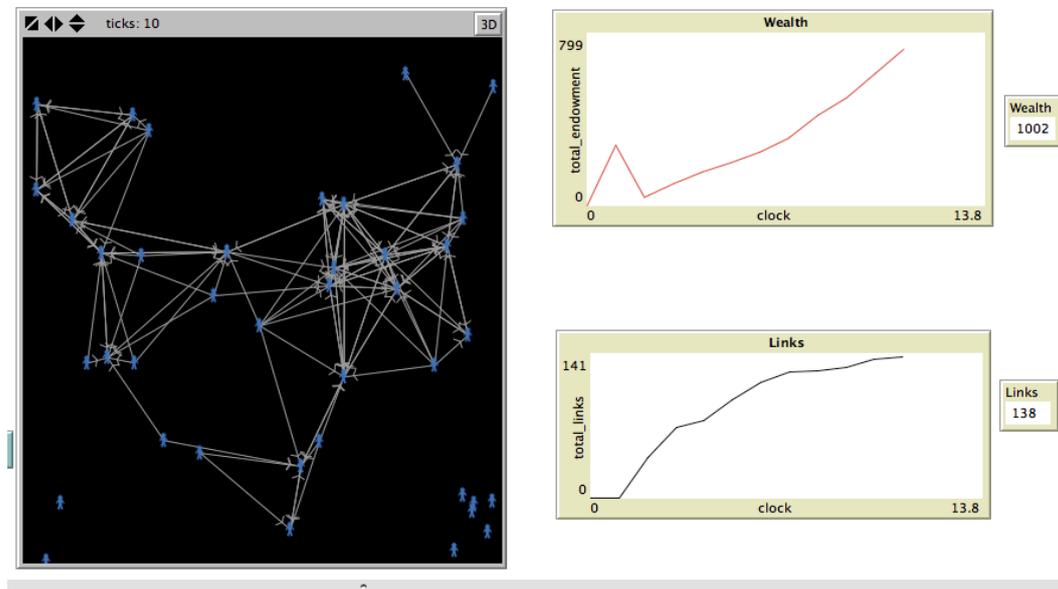
At the 100° tick



We can observe how in the “basic situation” at the 10° tick the simulation displays 28 links and an amount of wealth equal to 149. At the 100° tick both this value have increase, respectively to 89 and 3381.

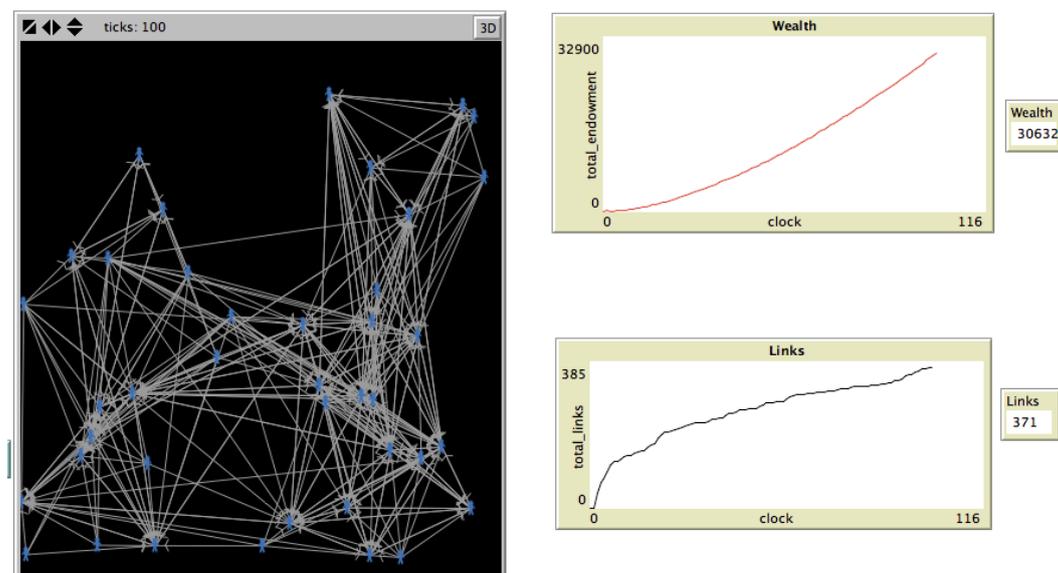
A.1 – Increase in the number of agents (from 25 to 40)

At the 10° tick



A.1 – Increase in the number of agents (from 25 to 40)

At the 100° tick

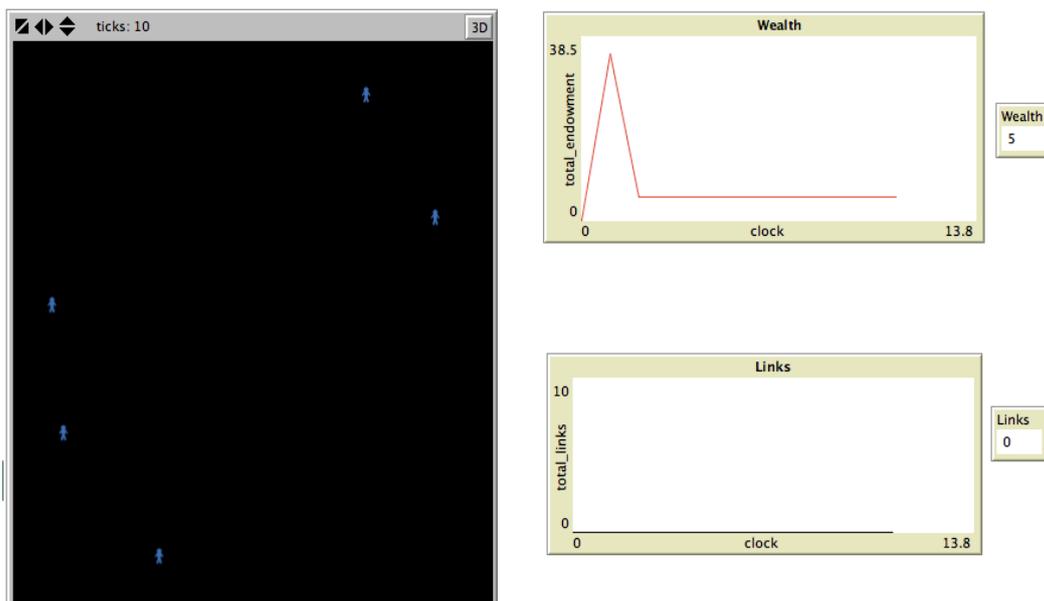


A.1 – Increase in the number of agents (from 25 to 40)

We can see how letting all the other variables untouched the wealth level and the number of links increased exponentially compared to the “basic situation”. The values are higher than in the rational model. At the 10^o tick the general economic situation displayed a value of 1.41, at the 100^o tick the value displayed is 2.04.

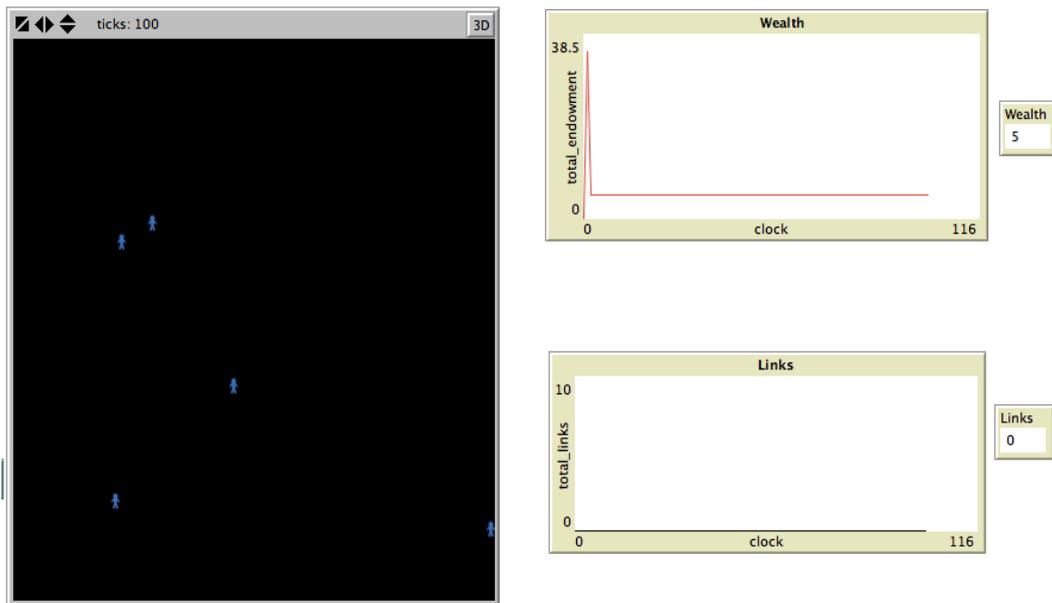
A.2 – Decrease in the number of agents (from 25 to 5)

At the 10^o tick



A.2 – Decrease in the number of agents (from 25 to 5)

At the 100° tick

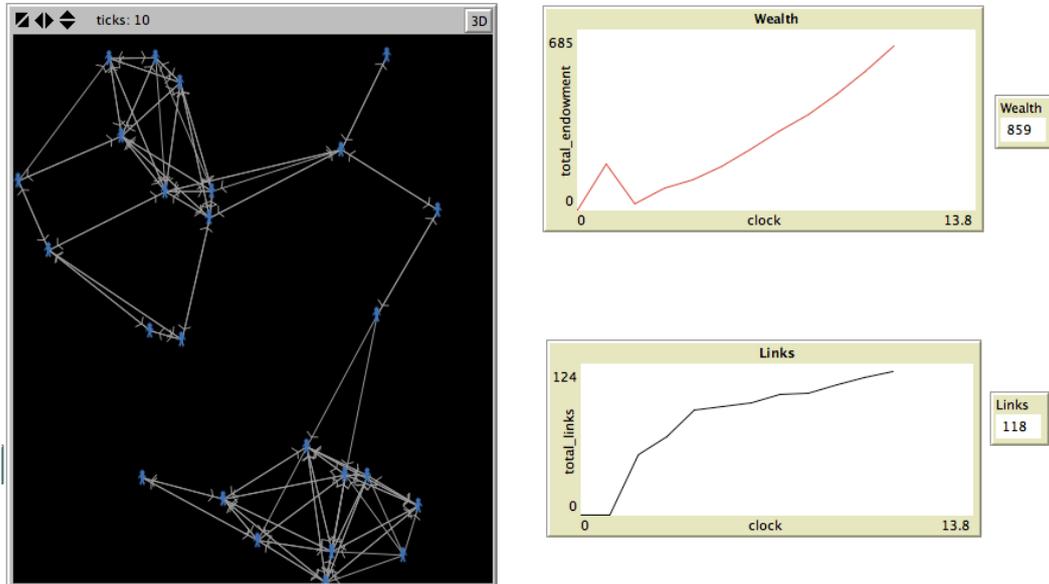


A.2 – Decrease in the number of agents (from 25 to 5)

The result of the decrease of agents is the impossibilities, along with the other restrictions, of creating economic value through links. The results are the same of the rational experiments. The general economic situation level remain the same at the 10° and 100° tick.

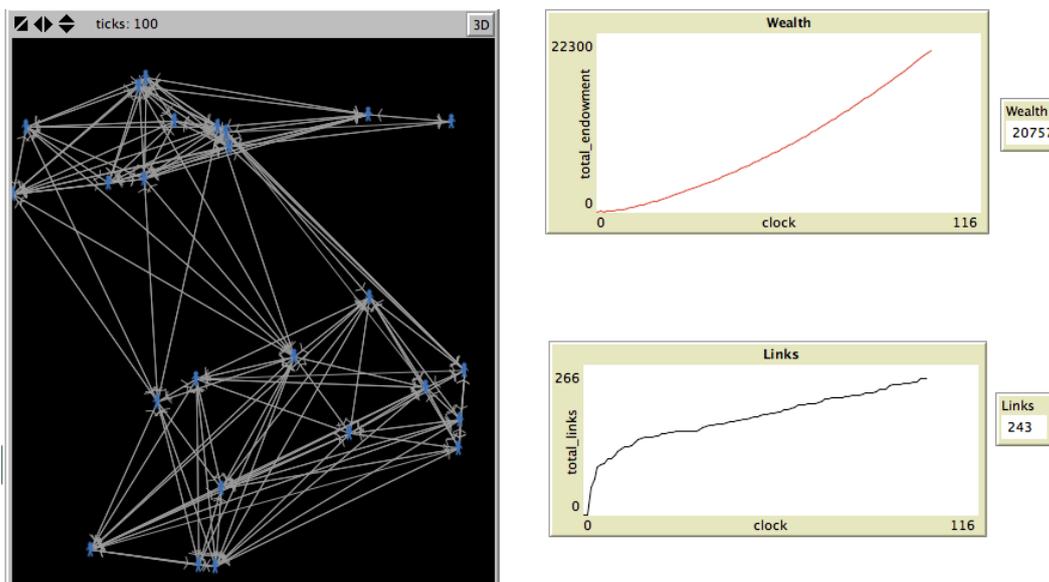
B.1 – Increase the general economic situation (from 1.0 to 3.0)

At the 10° tick



B.1 – Increase the general economic situation (from 1.0 to 3.0)

At the 100° tick



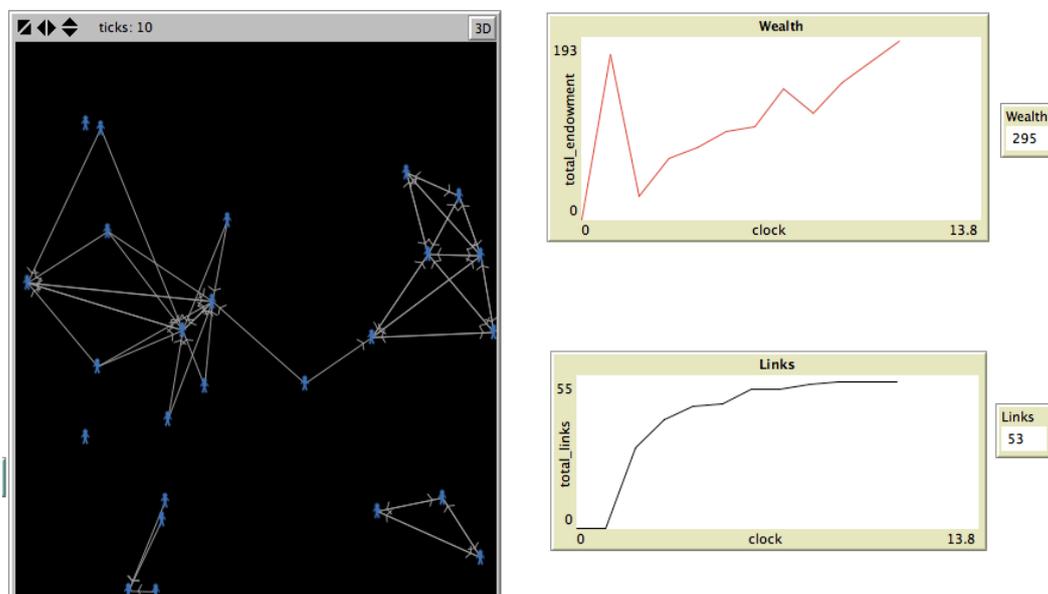
B.1 – Increase the general economic situation (from 1.0 to 3.0)

As expected, being the optimism/trust variable a determinant in the creation of economic networks and being the general economic situation inside its computation, an increase of the latter leads to better performances of both counter: number of links and wealth.

The general economic situation level pass from 3.4 at the 10° tick to 4.0 at the 100° tick.

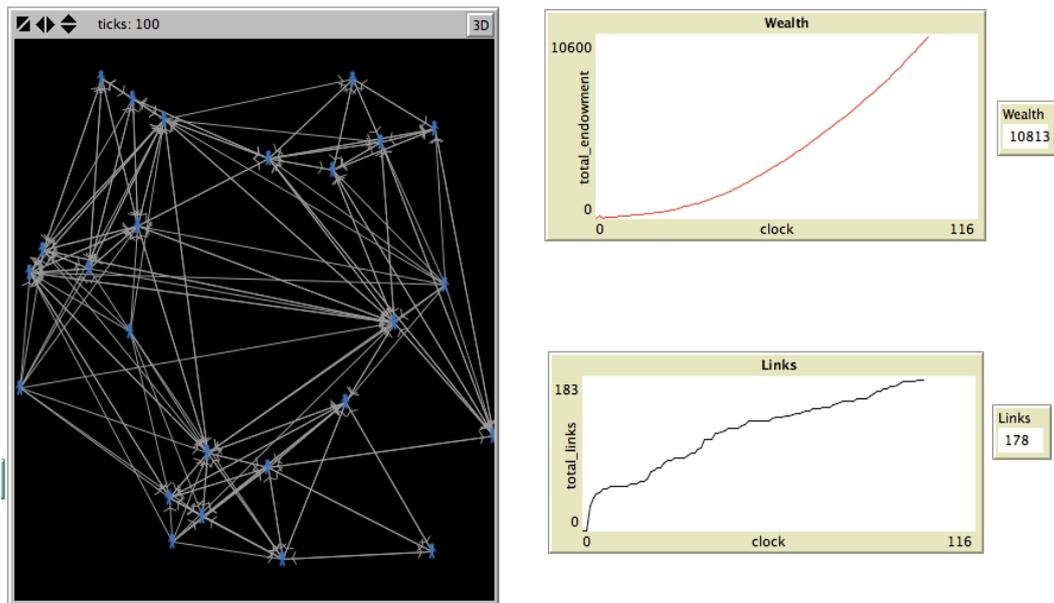
C.1- Increase of the rule of the law level (from 1.0 to 2.0)

At the 10° tick



C.1- Increase of the rule of the law level (from 1.0 to 2.0)

At the 100^o tick

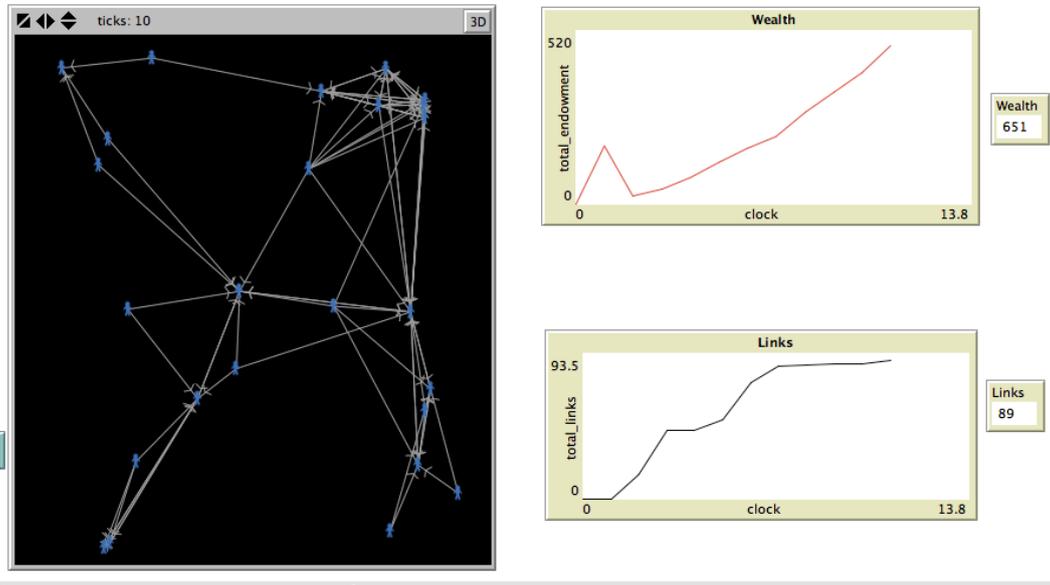


C.1- Increase of the rule of the law level (from 1.0 to 2.0)

As easy to foresee, increasing the level of the Rule of law increased the percentage of links created, because the reputation and ability to attract business break even are now divided by the level of the Rule of the law. The consequence is similar to a direct decrease of these two barriers. The general economic situation level passed from a value of 1.48 to a value of 2.5.

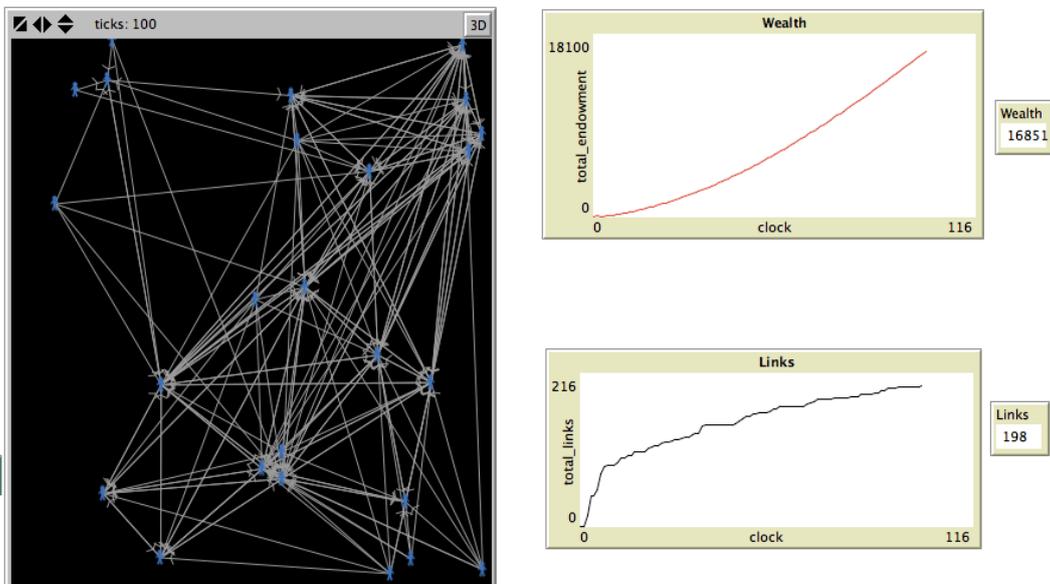
D.1 – increase the length (from 8 to 12)

At the 10° tick



D.1 – increase the length (from 8 to 12)

At the 100° tick

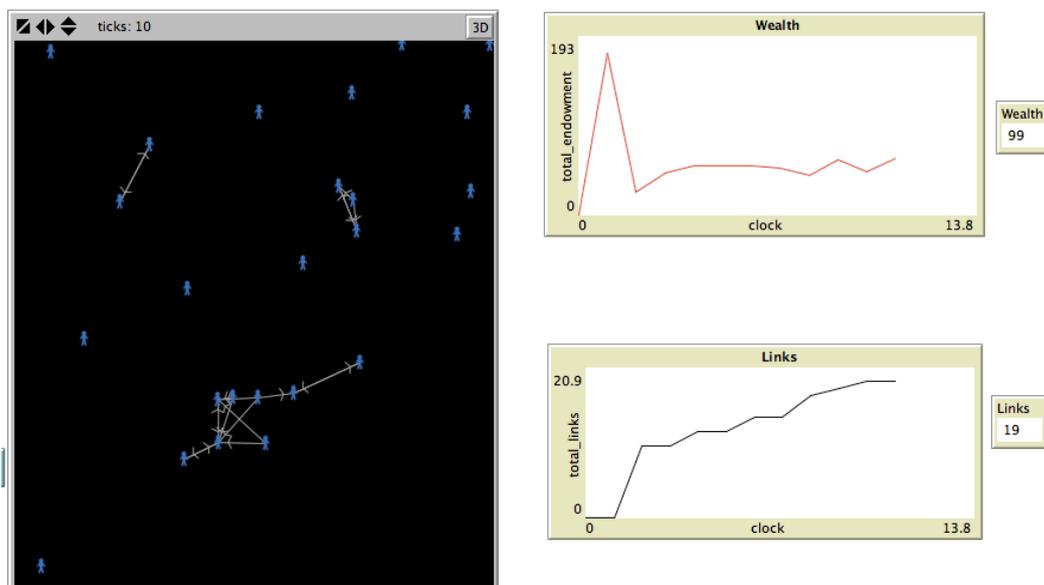


D.1 – increase the length (from 8 to 12)

As expected, increasing the radius in which the agents can create the networks increase the number of links created and consequently the wealth. Both at the 10° and 100° tick the simulation displayed better results than the “basic situation”. At the 10° tick the simulation displayed 89 links and a level of wealth equal to 651 at the 100° tick the links are 198 and the wealth is equal to 16851. The general economic situation passed from 1.44 to 2.07.

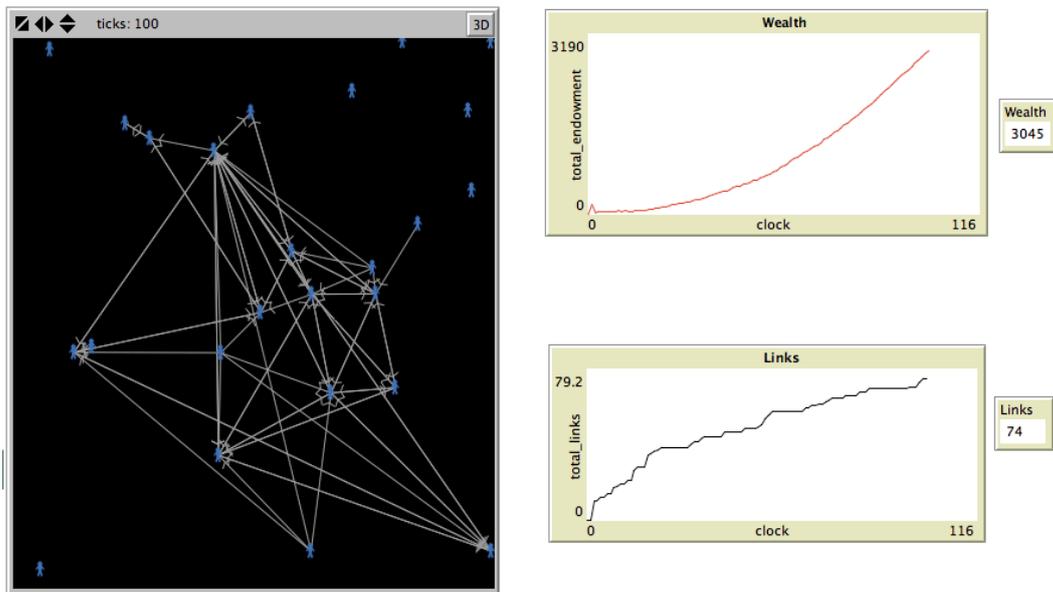
D.2 – Decrease the length (from 8 to 4)

At the 10° tick



D.2 – Decrease the length (from 8 to 4)

At the 100° tick

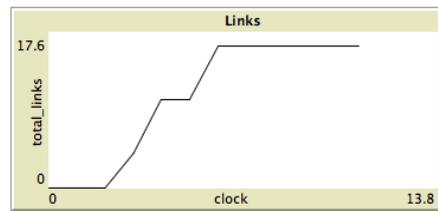
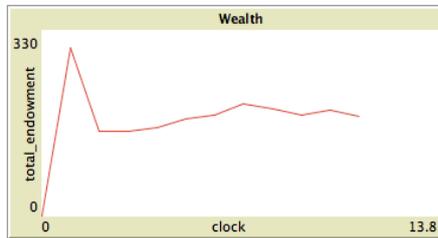
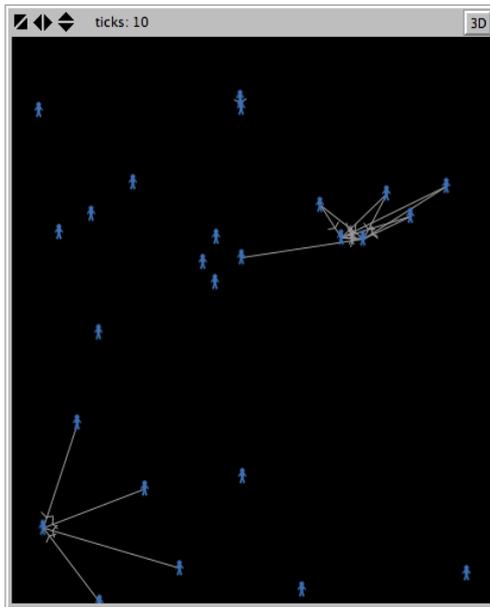


D.2 – Decrease the length (from 8 to 4)

We can observe how compare to the “basic situation”, at the 10° tick the simulation displays 19 links and an amount of wealth equal to 99. At the 100° tick both these values have increase respectively to 3045 and 74. The results show a decrease in the performance. The general economic situation value passed from 1.37 to 2.88.

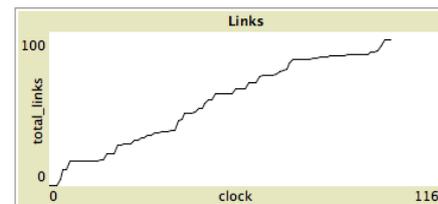
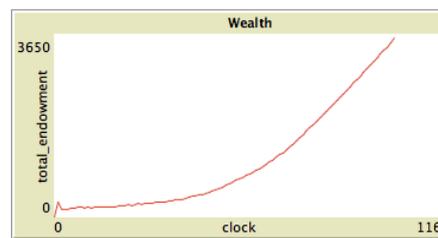
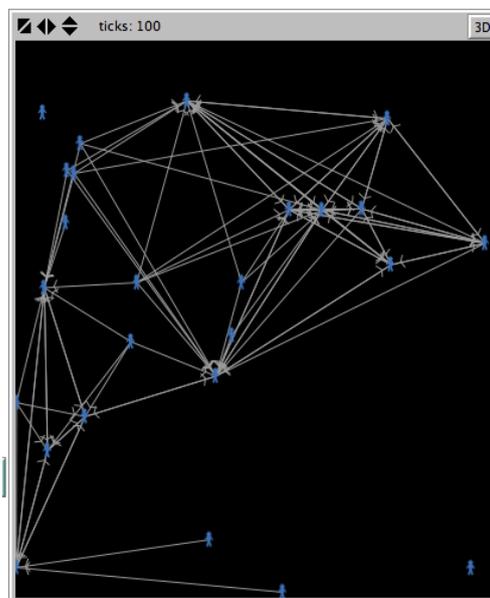
E.1 – Increase the initial endowment (from 7 to 12)

At the 10° tick



E.1 – Increase the initial endowment (from 7 to 12)

At the 100° tick

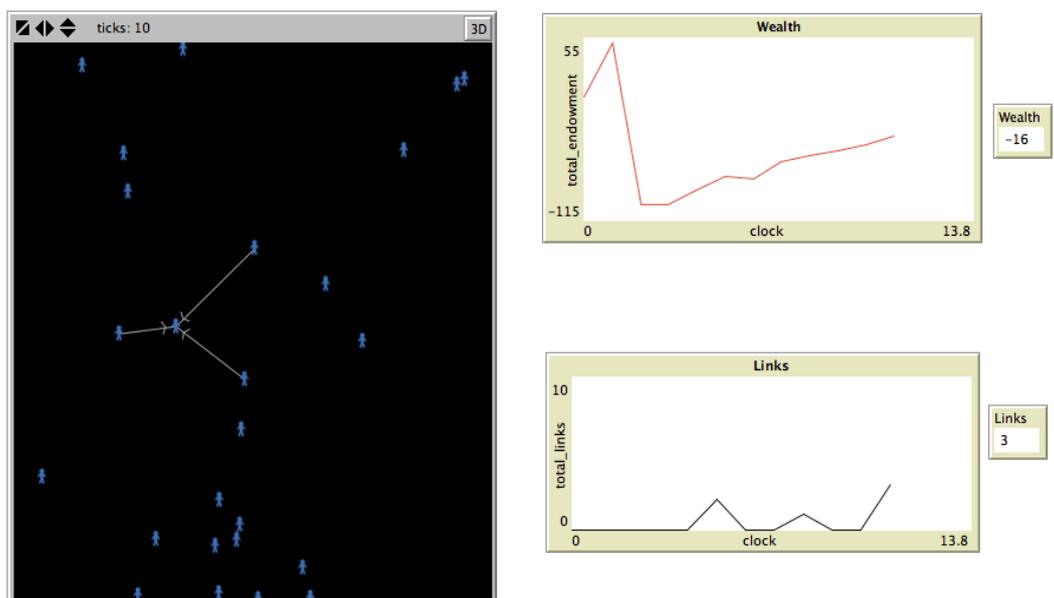


E.1 – Increase the initial endowment (from 7 to 12)

We can observe an increase in the performance respect to the “basic situation” expect for the number of links at the 10° tick. The number in details are: at the 10° tick, 16 links and a level of wealth equal to 210 and at the 100° tick, 95 links and a level of wealth equal to 3762. The general economic situation level passed from 1.11 to 2.27.

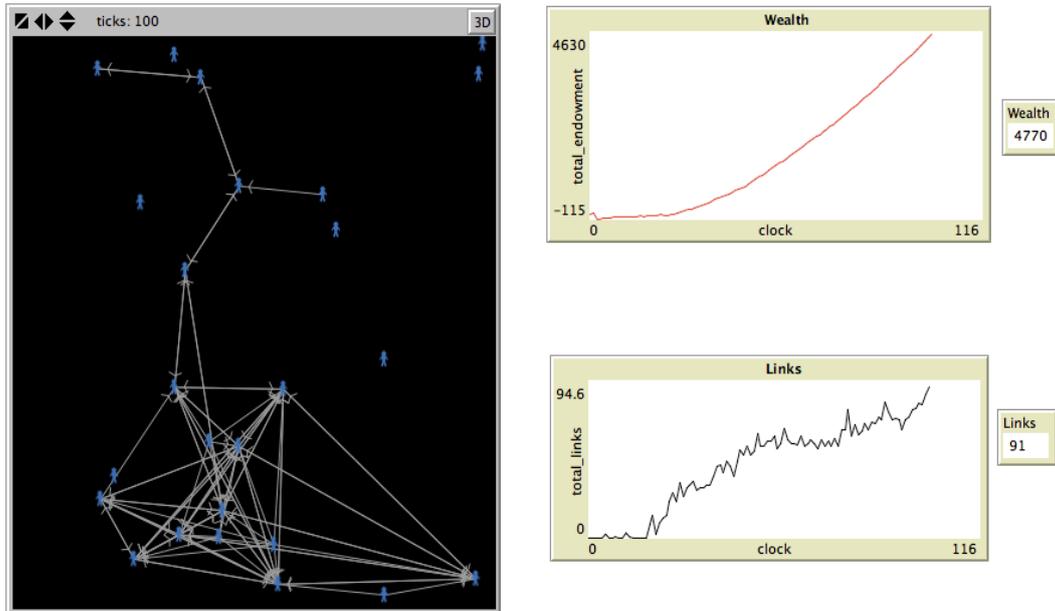
E.2 – Decrease the initial endowment (from 7 to 2)

At the 10° tick



E.2 – Decrease the initial endowment (from 7 to 2)

At the 100° tick

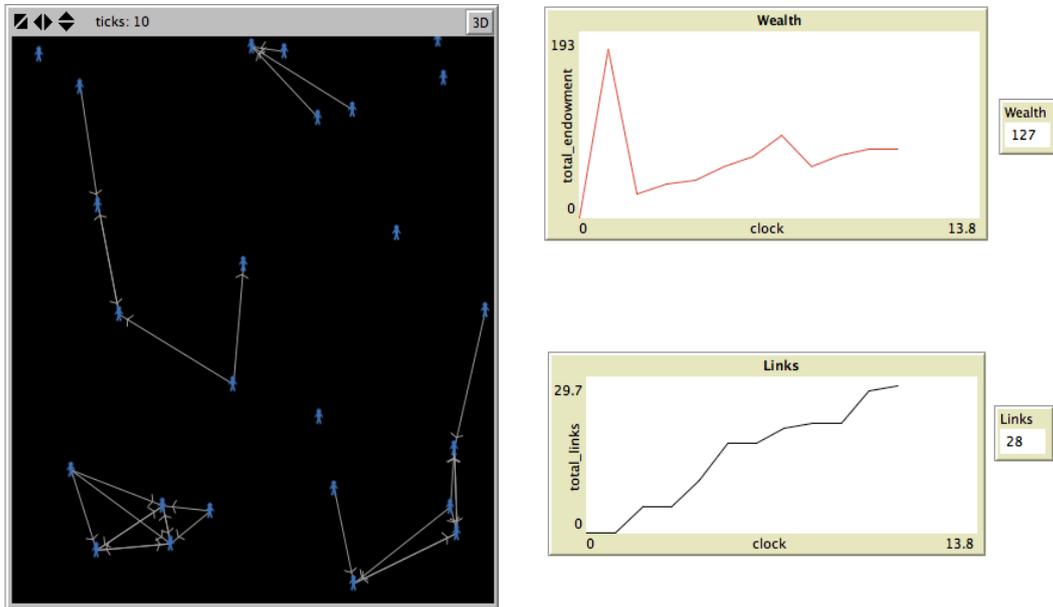


E.2 – Decrease the initial endowment (from 7 to 2)

This simulation leads to a curious situation. At the 10° tick the counters show values for wealth and the number of links in line with our expectations. In particular the wealth value is under 0 because of the higher value of the consume of endowment compared to the initial endowment. At the 100° tick, instead the situation is opposite. The simulation infers displayed values for the number of links and wealth respectively of 91 and 4770, higher than in the “basic situation”. The value of the general economic situation passed from 0.95 to 2.71.

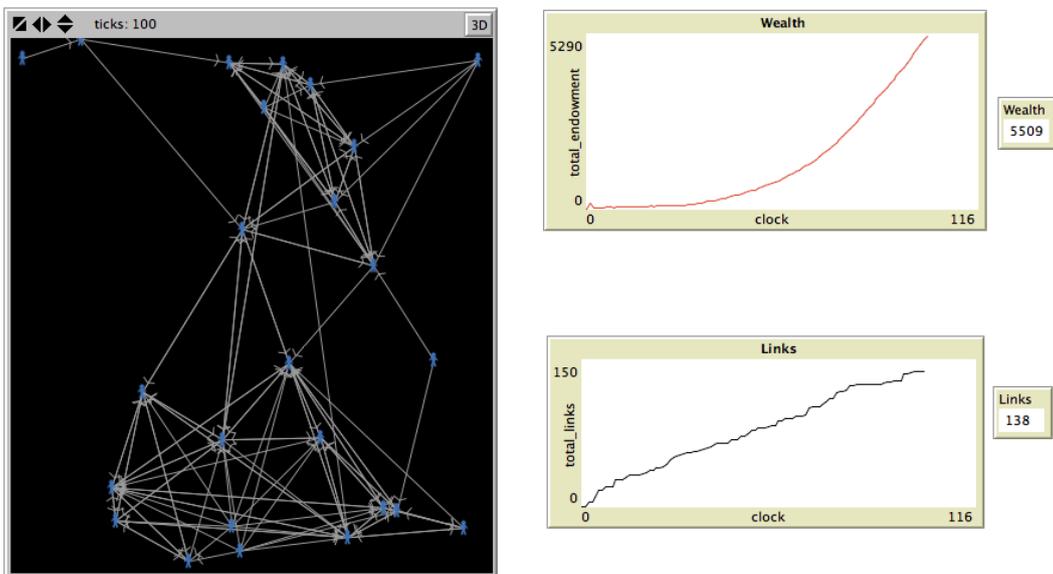
F.1 – Increase the reputation break-even (from 6 to 9)

At the 10° tick



F.1 – Increase the reputation break-even (from 6 to 9)

At the 100° tick

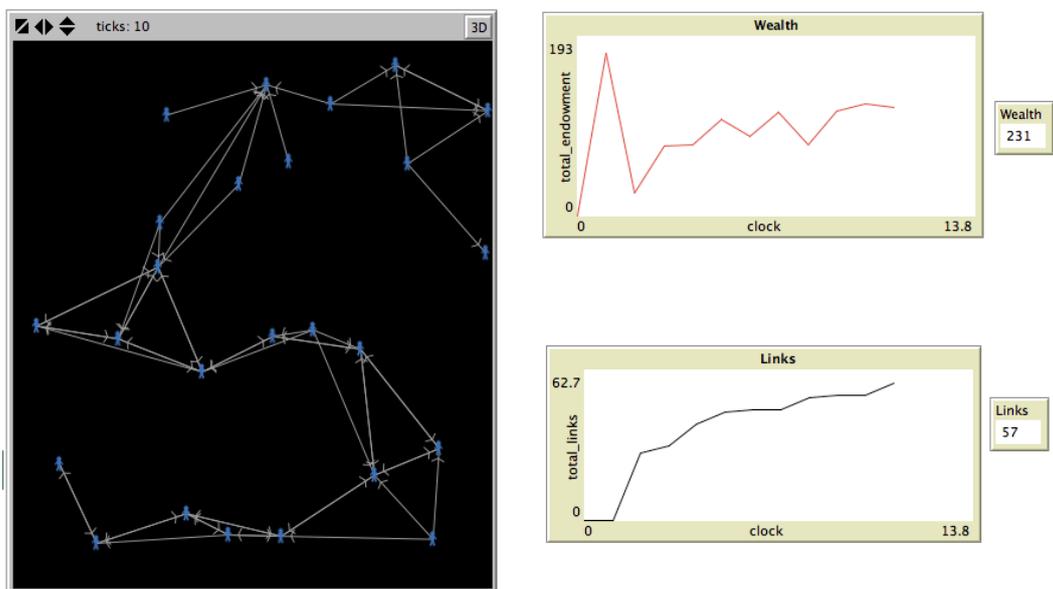


F.1 – Increase the reputation break-even (from 6 to 9)

We can see how compared to the basic situation, at the 10° tick the simulation displayed worst result. Instead at the 100° tick both the values are higher: number of links equal to 138 and wealth level equal to 5509. The general economic situation passed from 1.3 to 2.2.

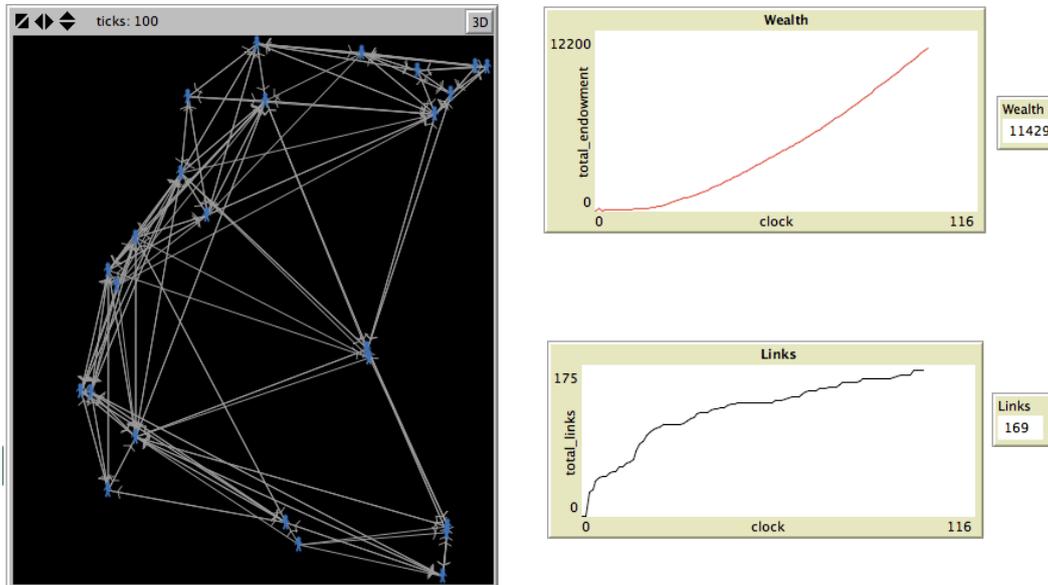
F.2 – Decrease the reputation break-even (from 6 to 3)

At the 10° tick



F.2 – Decrease the reputation break-even (from 6 to 3)

At the 100° tick

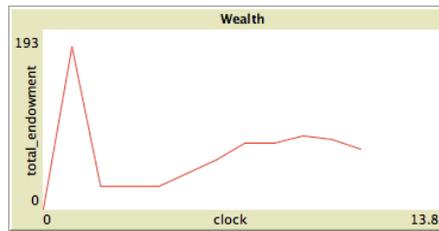
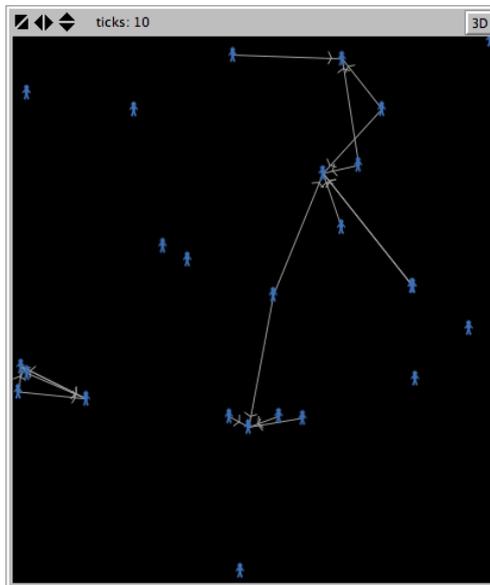


F.2 – Decrease the reputation break-even (from 6 to 3)

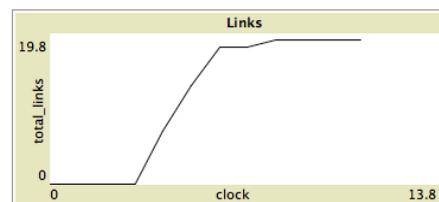
As expected a decrease in the reputation break-even increased the possibilities for the agents to create networks. At both time lags the wealth and links counters displayed values higher than in the “basic situation”. The general economic situation passed from a value of 1.5 to 2.58.

G.1 – increase the ability to attract business break-even (from 6 to 9)

At the 10° tick



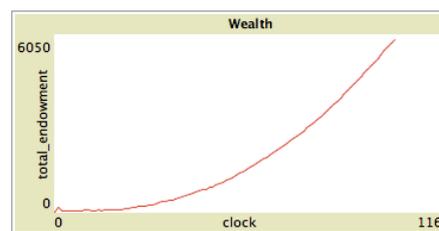
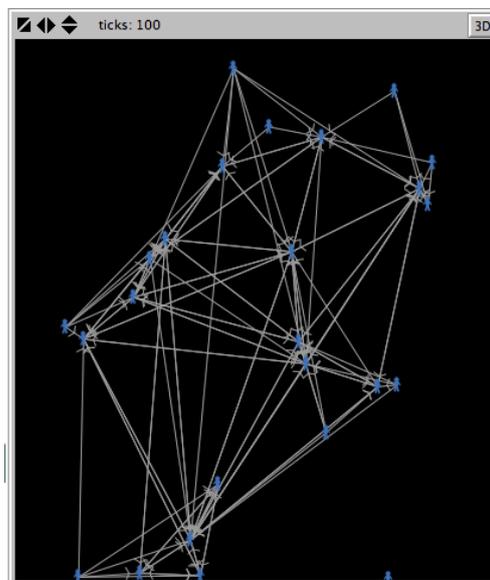
Wealth
103



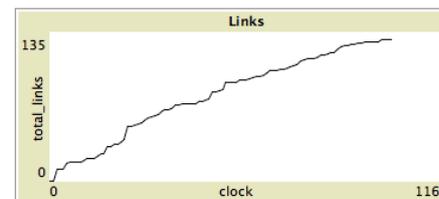
Links
19

G.1 – increase the ability to attract business break-even (from 6 to 9)

At the 100° tick



Wealth
6161



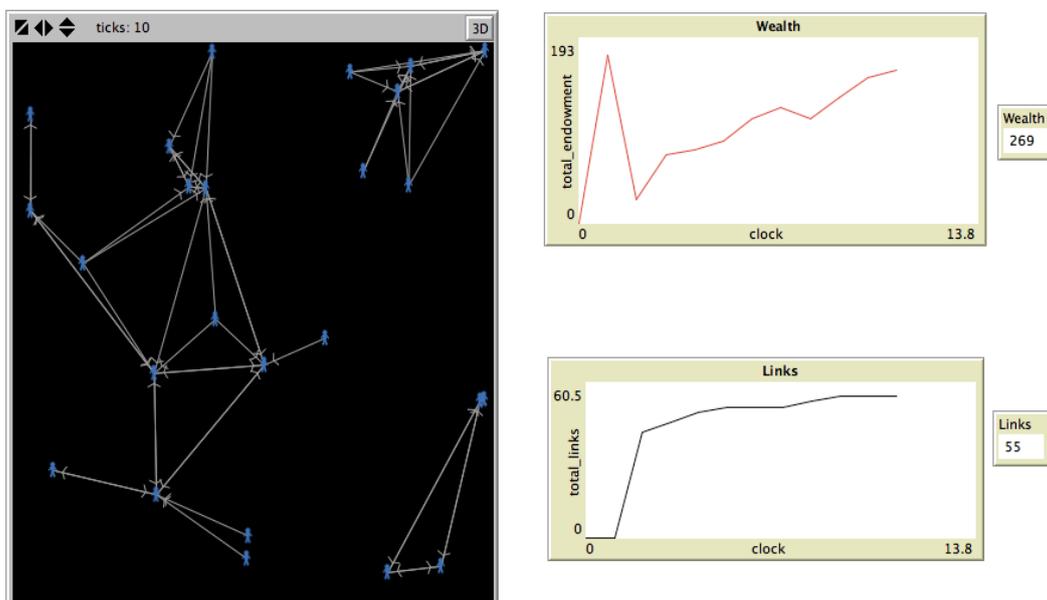
Links
129

G.1 – increase the ability to attract business break-even (from 6 to 9)

Respect to the “basic situation”, as expected, at the 10° tick both values are lower as result of higher requirement for creating networks. At the 100° tick instead the situation is overturned, with values higher compared to the 100° tick of the “basic situation”. The general economic situation passed from a value of 1.2 to a value of 2.88.

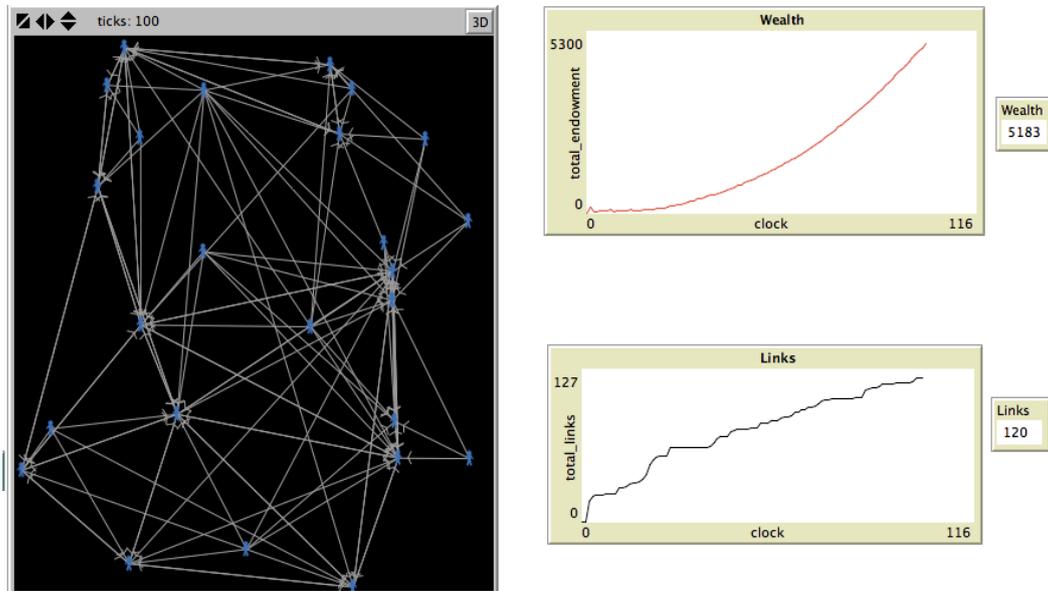
G.2 – Decrease in the ability to attract business break-even (from 6 to 3)

At the 10° tick



G.2 – Decrease in the ability to attract business break-even (from 6 to 3)

At the 100° tick

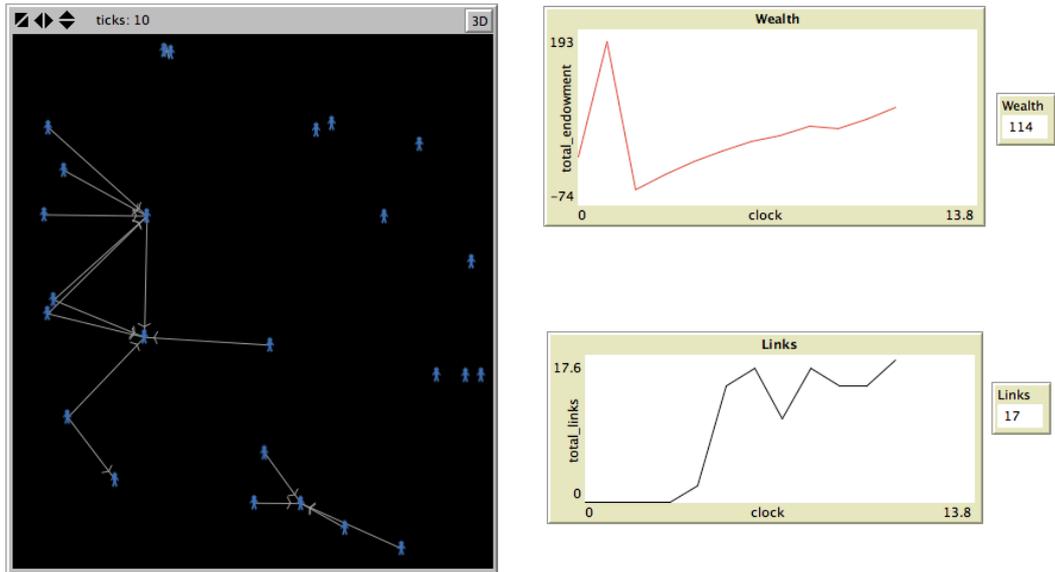


G.2 – Decrease in the ability to attract business break-even (from 6 to 3)

As expected a decrease in the ability to attract business break-even increase the possibilities for the agents to create networks. Both the wealth and links counters displayed values higher than in the “basic situation”. The general economic situation dismayed at the 10° tick a value of 1.5 that increased to 2.4 at the 100° tick.

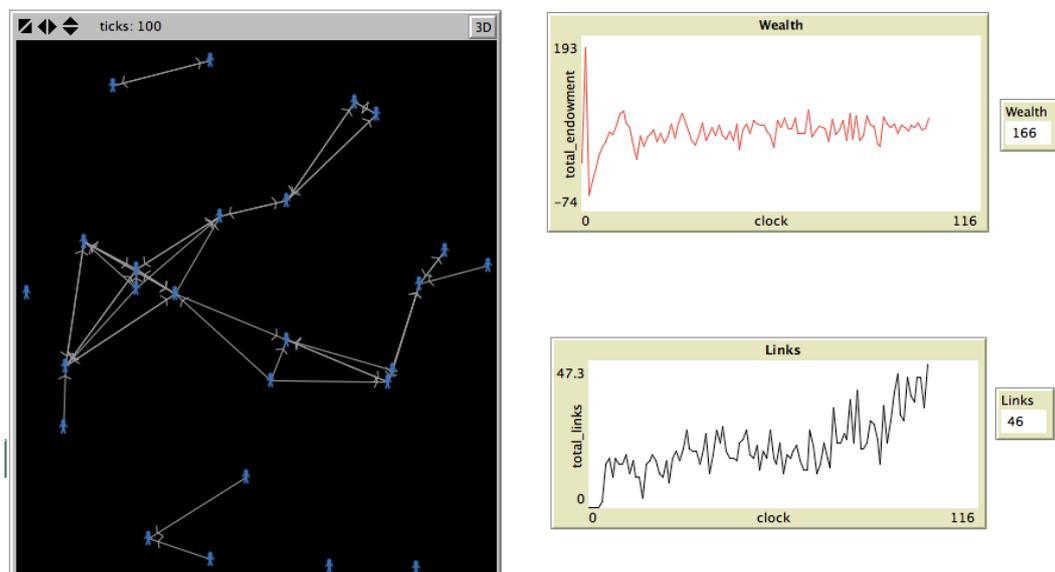
H. 1 - increase the consume of endowment (from 6 to 9)

At the 10° tick



H. 1 - increase the consume of endowment (from 6 to 9)

At the 100° tick

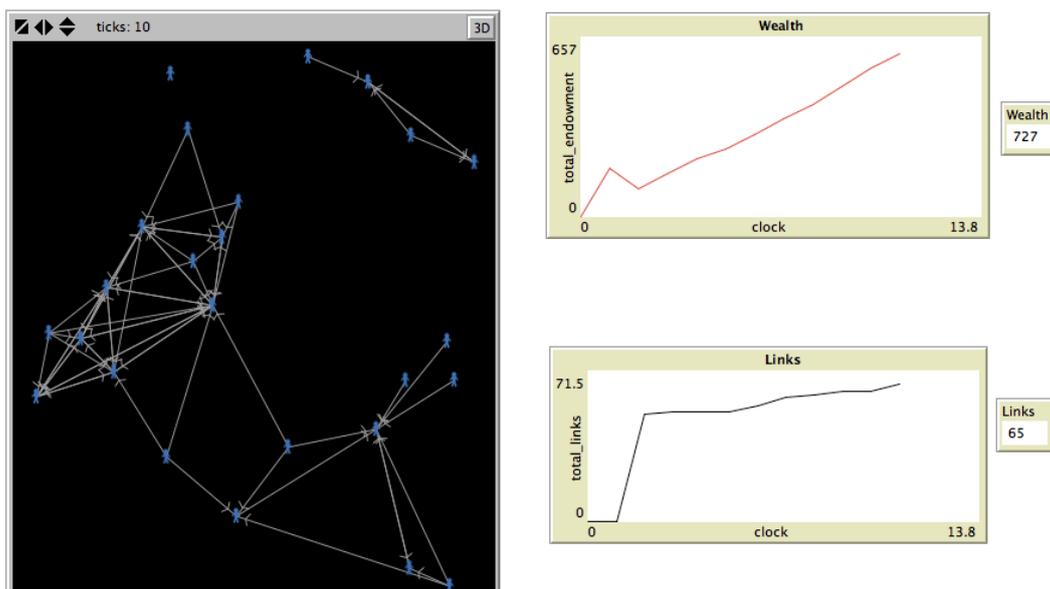


H. 1 - increase the consume of endowment (from 6 to 9)

Both value at the 10° and 100° tick are lower than in the “basic situation” mirroring the great handicap that every agents occurred trying to find a commercial partner. The general economic situation moved from 1.32 to 4.47.

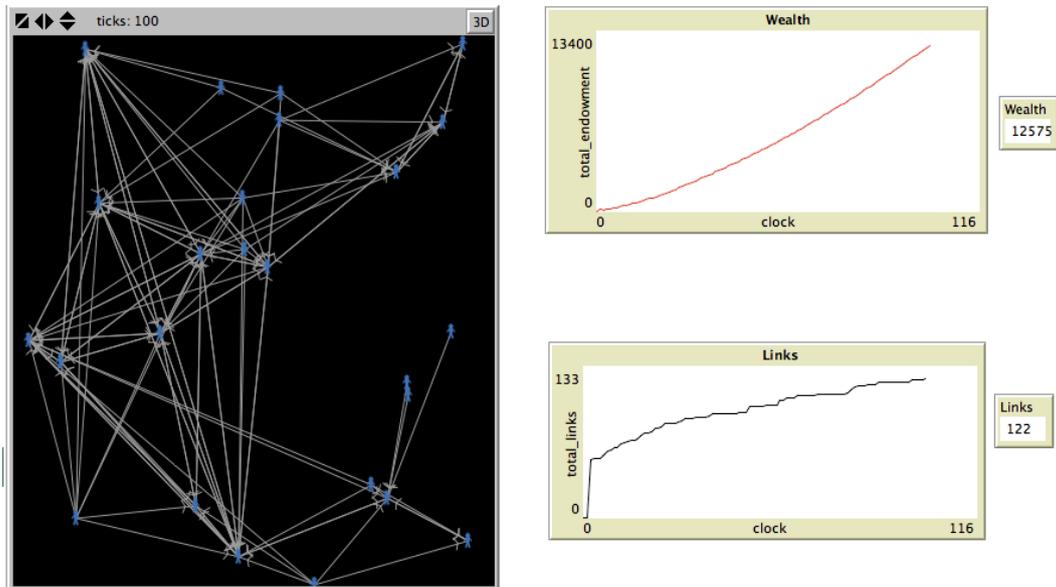
H. 2 – decrease the consume of endowment (from 6 to 3)

At the 10° tick



H. 2 – decrease the consume of endowment (from 6 to 3)

At the 100° tick

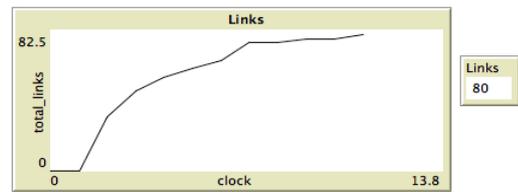
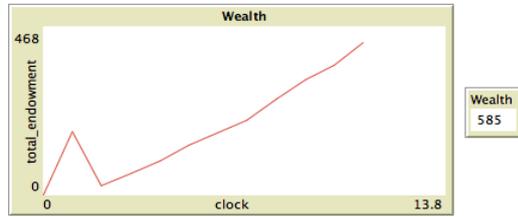
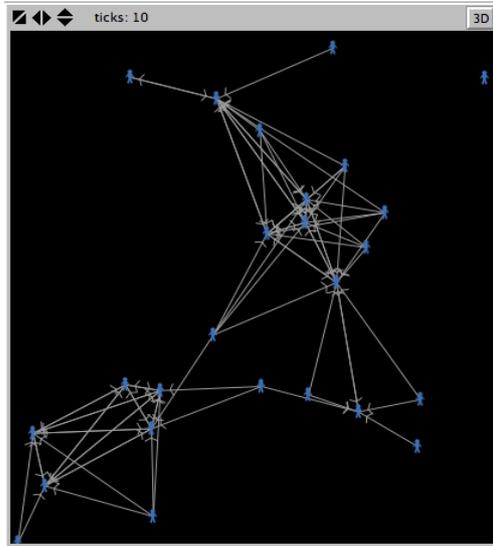


H. 2 – decrease the consume of endowment (from 6 to 3)

As expected, decreasing the consume of endowment, increased the level of wealth and the number of links created. The general economic situation passed from 1.48 to 1.73.

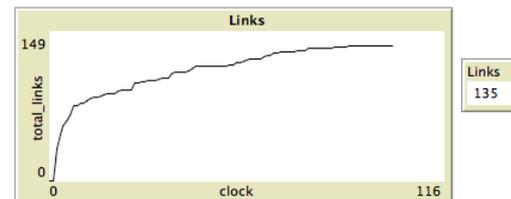
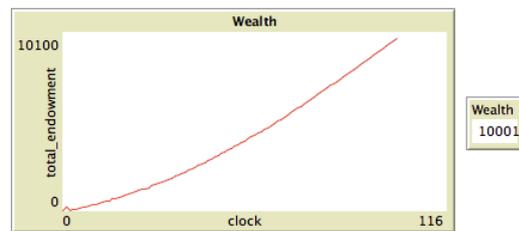
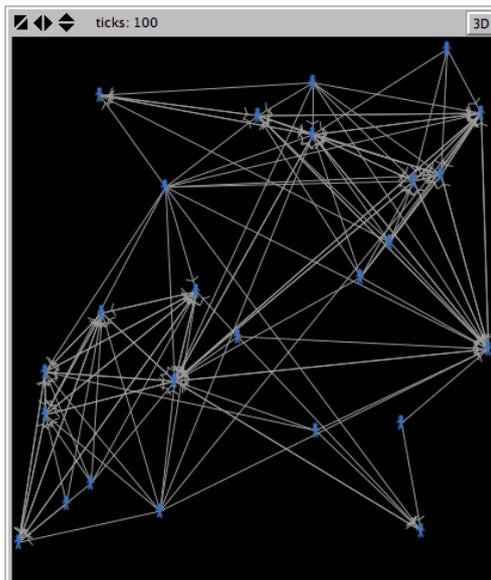
I.1- Increase alfa (from 0.2 to 0.3)

At the 10° tick



I.1- Increase alfa (from 0.2 to 0.3)

At the 100° tick

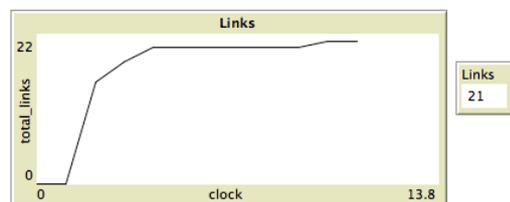
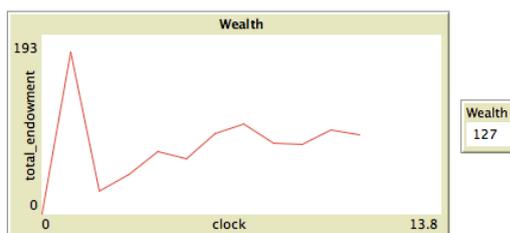
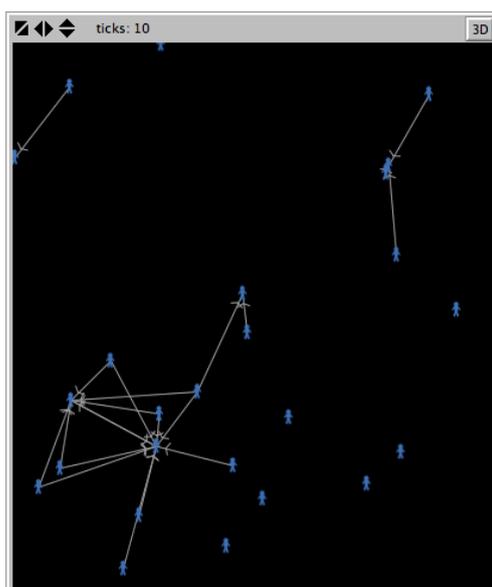


I.1- Increase alfa (from 0.2 to 0.3)

As expected increasing the value of α , a determinant of the general economic situation and consequently of the optimism/trust level leads to better economic performance. The general economic situation passed from 1.66 to 2.7.

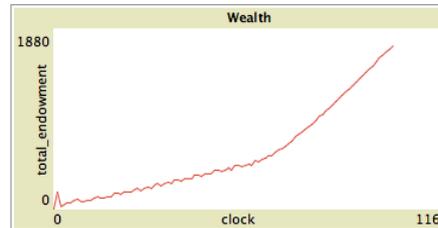
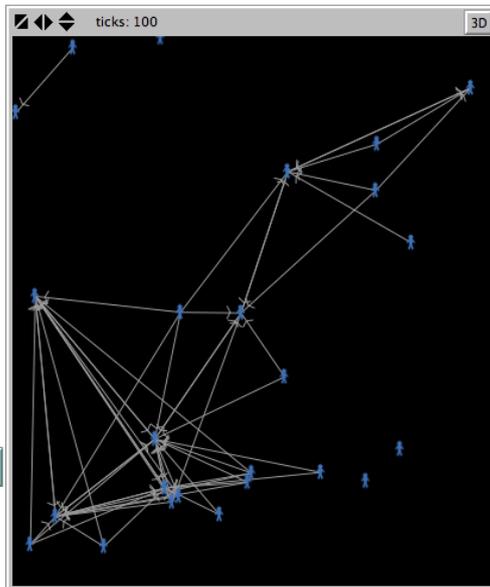
I.2- Decrease α (from 0.2 to 0.1)

At the 10^o tick

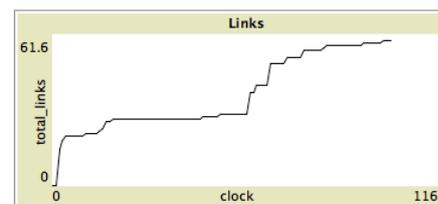


I.2- Decrease α (from 0.2 to 0.1)

At the 100° tick



Wealth
1823



Links
59

I.2- Decrease alfa (from 0.2 to 0.1)

As expected like in the previous experiment, the behaviour of alfa remained coherent with our expectations. Lowering its level leads to worst performances. The general economic situation at the 10° tick is equal to 1.18, instead at the 100° tick increased to 1.83.

3.6 Results of the experiments

This last paragraph of the chapter of the simulation with Netlogo is dedicated to the comparisons of the results between the two sets of experiments. First is useful to resume the outputs of our experimental work in a set of tables comparing every single experiment in the two contest, rational and behavioural, to have a clear and easy view of the differences. We will then move on with a deeper discussion.

1) Increase the number of agents

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	290	40	1002	138
100° tick	3414	68	30632	371

2) Decrease the number of agents

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	5	0	5	0
100° tick	5	0	5	0

3) Increase the rule of the law

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	501	66	295	53
100° tick	7941	120	10813	178

4) Increase the length

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	251	38	651	89
100° tick	1943	51	16851	198

5) Decrease the length

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	45	4	99	19
100° tick	75	14	3045	74

6) Increase initial endowment

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	236	22	210	16
100° tick	1632	47	3762	95

7) Decrease initial endowment

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	-20	0	-16	3
100° tick	400	13	4770	91

8) Increase reputation break-even

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	47	5	127	28
100° tick	67	9	5509	138

9) Decrease the reputation break-even

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	105	24	231	57
100° tick	1181	45	11429	169

10) Increase the ability to attract business break-even

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	55	6	103	19
100° tick	311	10	6161	129

11) Decrease the ability to attract business break-even

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	165	27	269	55
100° tick	1531	39	5183	120

12) Increase the consume of endowment

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	-8	0	114	17
100° tick	22	3	166	46

13) Decrease the consume of endowment

	Rational		Behavioural	
	Wealth	Links	Wealth	Links
10° tick	202	15	727	65
100° tick	2217	31	12575	122

The experiments that we presented, despite the bias caused by the casual positioning of the agents, let us infer on the role played by the emotions in the creation of social capital and consequently wealth.

The first two experiments regarding the increase and decrease of the number of agents give us a first clear signal of the predominance of the behavioural model over the rational one. Goal of these experiments is to see if a numerical change affects the outputs of our simulation. Both rational and behavioural models show performances in line with our expectations: increasing the number of agents helps the construction of networks, as consequence of a greater probability to have possible economic partner inside the “perimeter” of actions. On the other side a decrease of the number of agents have to be seen as a handicap in our simulation: agents, even if they hold the conditions to cooperate they don't find possible partners.

The first experiment regarding the increase in the number of agents shows a great advantage of the behavioural model compared to the rational one at both time lags. At the 10° tick the difference of wealth value between the two models is roughly 3 times in favour of the behavioural model. At the 100° tick the difference between the two model is 10 times in favour of the behavioural model.

Looking at the number of links, we can see how at the 10° tick the behavioural model displays a greater value; a divergence that increases going toward the 100° tick. These results evidenced the great advantage of the behavioural model over the rational one. We can presume that the multiplier effect of an increase of the number of agents is highly augmented by the behavioural environment that better exploits its potential.

The second experiment about the decrease in the number of agents, instead of showing results in line with the first experiment, displayed parity between the two models.

The result, if on one side seems inconsistent with our presumption of advantage of the behavioural model over the rational, on the other side with the reduction of the number of agents from 25 to 5 the model might have reach the break-even value under which, regardless to the kind of models, is not possible to create networks.

In the third experiment we modify the environmental variable that define the level of law enforcement in our simulated world. As expected the experiments will confirm a

positive correlation between this global variable and wealth. Surprisingly the rational model displays better result at the 10° tick; the situation turn in favour of the behavioural model at the 100° tick. In this experiment the benefit of introducing emotions in our model seems less consistent. The unexpected result can be seen as consequence of the greater benefit, on a behavioural contest, of an increase of agents compared to an increase of the rule of the law level.

The fourth and fifth experiments modify the length variable that indicates the perimeter inside which agents are allowed to create networks. The results are in line with our expectations: increasing the length increases the creation of networks, while decreasing leads to the opposite result.

Both experiments show the supremacy of the behavioural model over the rational one. The supremacy, although is clearly evident at the 10° tick, is at the 100° tick that shows all his presence in both experiments.

In the sixth and seventh experiments we analyse the effect of changing the initial quantity of wealth of every agents. The results will show a positive correlation towards these changings.

In the sixth experiment we increase the initial endowment from 7 to 12. While at the 10° tick the performances of the rational model surpass the ones of the behavioural model, at the 100° tick the situation is opposite. The reason for the predominance of the rational model on the first time lag might be a consequence of a better random setting of the agents, facilitating the creation of networks.

The seventh experiment is about a decrease of the initial endowment from 7 to 2. The results are in line with our expectations, infect despite the difficulties that the agents have to pay in order to be able to create networks, the initial endowment is lower than the consume of endowment, especially at the start; the behavioural model shows a slight better result.

The eighth and ninth experiments deal with the level of the reputation break-even.

The results are in line with our expectations: an increase of the break-even limit shows a decrease in the creation of wealth, while decreasing the reputation break-even leads to better results. First we increase the break even from 6 to 9. Despite an increase in the

difficulties to have the requirements for create networks, the behavioural model shows better results.

In line with our expectations are also the results of our experiment regarding this time the decrease of the reputation break-even from 6 to 3. Also here, the behaviour simulation surpasses the rational one for both: value of wealth and number of links.

As in the last two experiments, we will modify a break-even limit.

The tenth experiment deals with the ability to attract business. We decide to raise the break-even value from 6 to 9. Like in the eighth experiment the behavioural model shows better result on both statistics. The advantage is clear at the 10° tick and increase toward the 100° tick.

The eleventh experiment deals also with the ability to attract business. This time we choose to decrease the break-even value from 6 to 3. The behavioural model shows better results: at the 10° tick the value of wealth and the number of links is double compared to the rational model. At the 100° tick the behavioural model shows value of wealth 5 times higher than in the rational model and a number of links 3 times greater. Despite the results of these two last experiments show the predominance of the behavioural model is interesting to compare these result with similar experiments like the one regarding the reputation break-even. Easily we can notice how this set of experiments regarding break-even levels shows, taking into account experimental bias, homogeneous results. Similar outputs augmented our conviction that the experiment is well settled: modifying similar variables gives similar results

The last two experiments deal with the consume of endowment.

In these experiments we want to analyze the effect of changing the consume of wealth spend by every agents moving. The results will show a negative correlation towards these changings. In the twelfth experiment we increase the consume of endowment level from 6 to 9. At the 10° tick the behavioural model shows value of wealth and number of links far higher than the rational model. At the 100° tick the predominance of the behavioural model still clear.

In the last experiment we choose to decrease the consume of endowment from 6 to 3. The results are in line with our expectations: at the 10° tick the rational model suffer

performance 3 times lower on both statistics. At the 100° tick the behavioural model confirm is supremacy.

Summarising, our results show in the 1°, 4°, 5°, 8°, 9°, 10° and 11° experiments a great advantage of the behavioural model over the rational one. With these results, we can presume that implementing emotions, such as optimism and trust, and link them to an environmental variable better off the creation of networks.

Consequences of these improvements have to be found in the implementation that a variable linked to the general economic situation bring in the simulation. Introducing the optimism/trust variable we can easily noticed how almost in every experiments in the long run performances are far better, playing this variable a role that we can define as a sort multiplier, that interacting with the general economic situation, as the economy improve lowering the minimum requests for creating networks.

We can conclude asserting the value that optimism/trust play in the economic field: when everything in our world seems to run in the right direction there is more possibilities that we don't want to miss that train.

General Conclusions

The work began with a review of the main insights of the two theories at the base of our model: social capital and behavioural economics.

First we described social network, a useful construct in social sciences to study the relationships between individuals, group and organizations. In the first chapter we reviewed some of the more important concepts concerning this theory.

We then moved on describing the second pillar of our work: emotions. As for the social capital theory, we described the most important theories; we also added a paragraph on behavioural economics: the application of emotion on economic contests. Last we described one of the paper that most inspired our work: “Robots that have emotions” by Parisi and Petrosino.

Our objective was to build a model able to infer on the mechanism at the base of the creation of networks among agents with the purpose of increase their wealth. We were also interested in understand how emotions amplified or not the ability of agents to create networks.

Under this assumption, we chose to build our simulation inside an agent-based modelling environment. This simulator allowed us to analysed complex interaction thanks to its powerful programming features.

Our simulation is divided in two parts. First we analysed the behaviour of agents inside a purely rational environment. Agents decide to create networks if they have enough endowment to spend for searching a partner and if they find other agents that satisfied their minimum requirements regarding ability to attract business and reputation. If these requirements are satisfied our agents create connections that are metaphors of economic business deals and consequently increased their wealth.

The second part is dedicated to the introduction of the emotional variables inside our simulation. The agents now, not only chose to create networks if their rational

requirements are satisfied, but they are influenced by their level of optimism/trust, to recreate more realistically the human behaviour.

The level of optimism/trust if on one side is randomly given reflecting the realistic differences in personality of people, on the other side is linked to the general economic situation. This implementation recreates a realistic part of the decision making process of human beings.

Using the model constructed we moved on analysing our assumptions with a vast range of experiments. We chose to modify one by one all the variables that affect the creation of networks, first in a purely rational environment and after adding behavioural components. Moreover our plan of simulations worked out of two time lags, to infer if there are temporal differences in the behaviours; short period: 10° ticks and long period: 100° ticks.

The results of our experiments displayed a great advantage on the long period of the behavioural model over the rational.

Introducing the optimism/trust variable we can easily noticed how almost in every experiments, in the long period, the performances were far better, playing the behavioral variable a role that we can define as a sort of multiplier: it interacts with the general economic situation, as the economy improve, lowering the minimum requests for creating networks.

Including a behavioural variable transforms our agents from “rational robots” to something more similar to real human beings. As stated by Parisi and Petrosino, emotional states are an evolved mechanism for making the strategic behaviour more effective, less subject to error and faster: agents with behavioural implementation are more efficient.

The results find could be seen along with other works of famous researchers as an attempt to show the important role played by emotions in the decision making process of human beings. We support the thesis of behavioural economics as an important and necessary implementation to economic studies; economy cannot be studied without paying attention to its main protagonist: man and his main drive: the brain.

The work that here we present of course is construct with theoretical data. Will be interesting to develop this work with the help of real data, to check if the results shown are the same. We think that agent based modelling can be used as an important tool to verify and study economic behaviour along with the classical econometric approach. We would be interested in proceed to study this issue that, through the agent-based approach, is an interesting starting point for a more precise analysis of the economic world surrounding us.

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