

**An Evolutionary Approach to Institutional and Technological Change:
Challenging Determinist Explanations of Socio-Economic Transformation**

Nuno Ornelas Martins*

Faculdade de Economia e Gestão
Universidade Católica Portuguesa
Rua Diogo Botelho, 1327
4169-005 Porto, Portugal

E-mail: nmartins@porto.ucp.pt

Telephone number: +351917729069

24 May 2007

Abstract:

The study of economic activity consists in the analysis of the activities of production, distribution, accumulation and consumption of goods and services, and the investigation of the underlying causal factors that govern these activities, like institutions, technology and human capabilities. Some sociological and economic traditions conceptualize the relationship between causal factors like institutions, technology or human agency in a deterministic way, assuming that one of these causal factors overrules the others. In such a deterministic framework, economic change is brought through changes in one of these causal factors, which in turn determines change in the remaining socio-economic structures and in socio-economic activity in general. In this paper, an evolutionary conception of socio-economic transformation where change can be brought or constrained through any of these causal factors (institutions, technology or human capabilities) will be suggested.

JEL Classifications: B41, B52, N01

Keywords: Evolutionary models, economic methodology, technology, social structures.

* Professor Auxiliar na Faculdade de Economia e Gestão da Universidade Católica Portuguesa, Porto, e investigador no CEGE. CEGE – Centro de Estudos em Gestão e Economia – é financiado pela Fundação para a Ciência e a Tecnologia, Portugal, pelo Programa Operacional Ciência e Inovação (POCI) do Quadro Comunitário de Apoio III, que é co-financiado pelo FEDER e pelo Governo Português.

1. Introduction

The economic literature has been much concerned with the quantitative impact that institutions, technology and human capabilities have on economic growth. It is possible that a quantitative measurement of the causal impact of institutions, technology and human capabilities on economic activity provides a non-deterministic approach to socio-economic transformation. This is so because a quantitative approach can, *prima facie*, include in its analysis all the causal factors of socio-economic transformation, by measuring the relative strength of each causal factor. However, whereas the quantity of human agents and material resources can be objectively measured, the measurement of the causal impacts on economic growth and development of factors like institutions, technology and human capabilities is not an easy task, to say the least. Institutions, technology and human capabilities are valuable for economic growth and development because of the knowledge they incorporate, and knowledge cannot be directly observed like resources and population are.

Robert Solow (1956, 1957) provided a framework in which the impact of factors other than the quantities of labor and capital on economic growth can be obtained by computing the difference between quantities that are objectively measurable, namely output growth on the one hand, and the growth of the labor force and physical capital on the other hand. However, this difference – the so-called Solow residual – can be attributed either to technology, or to other factors like institutions or human capabilities. Many authors after Solow attempted to formulate models that separate the different contributions that technology, institutions or human capabilities have on economic growth. Examples are Paul Romer's (1986, 1990) study of technology, the empirical analysis of institutional and political factors undertaken by Robert Barro and Xavier Sala-i-Martin (1999), the literature on human capital by Robert Lucas Jr (1988), or Kenneth Arrow's (1962) models of learning by doing.

The quantitative analysis of economic growth has followed the mathematico-deductive methodology that pervades modern mainstream economics, which consists in establishing causal sequence correlations, between measurable quantities that account for growth on the one hand, and explanatory variables that account for factors like the stock of capital, labor, technology, institutions or human capabilities on the other hand. This methodology is underpinned by a particular conception of science that characterizes mainstream economics. Throughout the twentieth century, the success achieved by natural sciences like physics led to the generalized belief that the use of the

methods of sciences like physics, most prominently mathematico-deductive modeling, is not only useful, but also essential for economics to become a successful scientific discipline (see Lawson 2003).

However, mathematico-deductive modeling is successfully applied in physics because an experimental set-up is built so that the phenomena under analysis can be insulated from disturbing factors. In such an experimental set up, a closed system (which can be defined as a system in which constant conjunctions of the form ‘if event X then event Y’ hold) is thus artificially generated so that causal factors are permanently actualized, and the observed data is measured through mathematico-deductive techniques. But when it comes to the study of the impact of institutions, technology or human capabilities on socio-economic transformation, such an experimental set-up cannot be created as in physics, and hence data will be obtained from an open system. In an open system, where the available data reflects the joint effects of causal factors like technology, institutions and human capabilities to the production process, it will be very difficult to obtain a mathematico-deductive model that successfully quantifies the effects that changes in each of the causal factors of socio-economic transformation have on growth.

The use of quantitative methods in economics can be seen under two different perspectives: as a statistical measurement of observable data, or as correlation analysis aimed at modeling causal sequence connections between observed phenomena. The former is essentially a descriptive exercise (and includes the development of statistical tools or indicators, like national accounts’ aggregates), while the latter is an explanatory endeavor, which relies on mathematico-deductive models in order to establish causal sequence correlations. Whilst quantitative methods can be very useful if applied under the first perspective described above, the causal analysis of open systems using methods that presuppose closed systems generates a methodological inconsistency.

The methodology of economic historians often overcomes this inconsistency. Economic historians have been mainly interested in the joint effects of factors like institutions, technology and human capabilities in a concrete spatio-temporal scenario, and not in disentangling their separate effects. Hence, their analysis takes into account the total effects of the complex interrelationship between these factors. However, while the analysis economic historians undertake provides insight as to how social and technological structures co-produce events in a given period of time, within the context of an open system, usually it does not provide us a model of the transformation of social

structures and technology through time. And when a model of socio-economic transformation is provided, such a model often provides a deterministic account of socio-economic change, by assuming that a particular structure (such as the mode of production, or technology) determines, or drives, history.

In this paper I will suggest an evolutionary approach in order to provide a non-deterministic model of institutional and technological change. I shall start by providing a broadly defined evolutionary model that conceptualizes the reproduction and transformation of social and technological structures in section 2. In section 3 a Darwinian evolutionary model will be suggested as a more specific account of socio-economic change. In section 4 I shall scrutinize how socio-technological structures shape human capabilities and dispositions. In section 5 some illustrations will be provided, of how the evolutionary model suggested in this paper can provide better accounts of socio-technological transformation than deterministic perspectives of socio-economic change. In section 6 the evolutionary model presented will be used to analyze the transformation of economic agents. Some concluding remarks will be made afterwards.

2. An Evolutionary Conception of Institutions, Technology, Human Agents and Resources

Social structures and technology constitute the conditions of possibility for the human activities of production, distribution, consumption and accumulation of material resources, which are ultimately supported by biological structures. Biological structures are usually taken as stable in economic analysis (changes in the total stock of natural resources are taken into account, but changes in the biological structures and processes through which natural resources are generated and transformed are not considered), because throughout most of world history biological structures changed at a significantly lower pace than social and technological structures (albeit economic activity has been causing significant changes on the natural realm in the last two centuries). So although biological structures are entities in continuous transformation, the analysis of economic change has been mostly concerned with structures that change at a faster pace, like social structures and technology.

Evolution, in turn, can be characterized as a process of descent with modification, where descent means that entities are reproduced, and modification signifies that the entities reproduced can be transformed in this process. Under this light,

evolutionary processes can be broadly characterized as transformational processes of cumulative change. Applied to economics, an evolutionary perspective would conceptualize material resources, human agents, social structures and technology as entities in a process of continuous transformation, wherein the outcome of every modification or transformation shapes the conditions under which further reproduction (descent) and transformation (modification) can take place.

A first advantage that springs from an evolutionary conception of material resources, human agents, social structures and technology as entities in a process of continuous transformation is that it enables us to solve some difficulties in the conceptualization of the causal relations between these entities. In many sociological and economic traditions, processes primarily related to one of the entities named above have been considered as the sole determinant or causal force of human activity, with the complex interactions between these processes being neglected, by assuming that one of them overrules all the others.

Thus, perspectives like neoclassical economics neglect the causal role of social structures, by assuming social reality to be the outcome of the atomistic interaction of human agents who permanently optimize an objective function that describes their goals. In such perspectives, the human agent's preferences and behavior (characterized in terms of mathematico-deductive techniques inspired in physics) are assumed to be the ultimate cause of events – and social norms, when taken into account, are interpreted as the outcome of the strategic interaction of optimizing agents.

On the other hand, some sociological traditions (often identified with the work of Émile Durkheim) follow the opposite route, and assume that human agency is determined by social structures (by the existing rules, conventions and norms). In these cases, social structures are considered to be the only determinant of human agency. Other authors consider technology to be the ultimate cause of events, a position often labeled as “technological determinism” (for a useful discussion of this position, see Heilbroner (1967), Smith and Marx (1996)), or Clive Lawson (2006)), while Marxian authors often place the economic activity of production of material resources as the ultimate determinant of history (for a discussion see, for example, Althusser (1968)).

The problem with models that omit the causal role of social structures or technology (like the models of neoclassical economics) is that they fail to take into account that economic activity takes place under conditions which are not chosen by human agents, but provided by an historically and geographically situated socio-

technological configuration, which shapes the conditions of possibility for future activity, and has causal powers of its own. Conversely, the difficulty with models that assume human agency to be completely determined either by social structures, technology or the mode of production of material resources is that, in those models, human agents are relegated to the role of passive subjects that are entirely shaped by underlying forces. However, human beings are essentially active creatures, and not passive subjects, as Veblen (1897) notes. One reason for this can be found in evolutionary biology: the most active individuals were the ones with greater capability for controlling resources, and thus the ones that had greater probability of survival (see also Veblen 1898b).

To be sure, social, technical and productive activity all contribute to the formation of many habits and routines, and so have some effect on the capabilities, propensities and dispositions of human agents. But unless we neglect the causal powers of human agents as creative and active beings, we cannot presuppose that human dispositions and propensities are entirely shaped either by social structures, technology or a given mode of production. This issue will be further clarified in section 4.

An evolutionary conception of material resources, human agents, social structures and technology as entities in a process of continuous transformation provides the grounds for an account of economic activity where all these entities can play a causal role in economic growth and development, and the greater causal power of one of these entities can be conceptualized as a particular case within a broader evolutionary and transformational model.

There are already transformational conceptions of entities like social structures, technology, human agents and material resources in the literature, which contain the central insights of the evolutionary conception sketched here. In a series of contributions to the economic literature under the heading of critical realism in economics (see, for example, Tony Lawson 2003), a transformational conception of social structures and human agency has been suggested, where social structures and human agency are argued to be *ontologically* distinct entities. By “ontology” it is meant an inquiry into the nature of social reality. Hence, to say that social structures are ontologically distinct from human agency means that both social structures and human agency are a constitutive part of social reality (of social being), and that even though social structures and human agency are interdependent, they are different modes of social being, irreducible to each other. The social structure in which human agents are

positioned is ontologically distinct from the human agent who slots into it, and from her or his own subjectivity. So social structures are a condition of possibility of human agency. But human agents, as ontologically distinct and active entities, may not just reproduce social structures in their daily practices but also modify them. Social structures facilitate or constrain human agency, by providing a set of possible options, but do neither determine, nor are determined by, human agents.

Clive Lawson (2006) has recently made an important contribution to the transformational conception of social reality, by suggesting a transformational conception of technology. Lawson argues that in the same way that social structures are continuously reproduced or transformed through human agency, so are technical objects continuously reproduced and transformed by technical subjects (that is, by human agents). Technical objects are the condition of possibility of human agency (in particular, technical activity), but are ontologically distinct from human agents.

Of course, the human agents themselves will also be transformed through social activity and technical activity. For while some dispositions and instincts were shaped through biological evolution, and hence are, to a great extent, biologically innate, other habits and propensities will be acquired through experience and the interaction with the social environment (that is, during a process of socio-economic evolution). So social structures, technology and human agents can all be seen as ontologically distinct entities that are continuously reproduced and transformed through socio-economic evolution.

In this sense, causal factors of economic activity like social structures, technology or human agency can all be seen under a broad evolutionary conception of continuous transformation. Social structures (including institutions and organizations), technological structures and economic production are set into motion by human dispositions (propensities, habits and instincts) to engage in intentional human agency, wherein the descent and modification of social and technological structures shape the conditions under which the human activities of production, distribution, consumption and accumulation of material resources will take place.

Now, the broad evolutionary conception summarized above gives us a general outline of how social rules, ideas, habits, technology and individuals are transformed and modified. But in order to undertake an analysis of concrete historical processes, a more specific evolutionary model is required, in order to explain the reproduction and transformation of social institutions and technology. Without going into a further level of specificity, it is not possible to distinguish between the mechanisms through which

social institutions, technology and human agents causally affect each other, and contribute to economic growth and development. This issue will be addressed in the next section.

3. A Darwinian specification of evolutionary processes

In order to provide a more specific evolutionary model of socio-economic change, I will now suggest a Darwinian evolutionary model of social and technical activity. Three essential elements to a Darwinian evolutionary model are *variety*, *reproduction* and *selection* (see Darwin 1859). A central distinction (which was not introduced in the literature by Darwin himself) is also required at this stage, namely the distinction between interactors and replicators. *Interactors* are the entities that compete in the environment of selection (see David Hull, 1981), while *replicators* are the entities that pass on its structure (i.e., are reproduced) in the evolutionary process (see Dawkins, 1976, 1978). After this distinction is made, we can combine it with the three elements of a Darwinian evolutionary model mentioned above, and discriminate three mechanisms: a *variety* generating mechanism that generates different sorts of replicators; a *replication* mechanism, which transmits each replicator from an interactor to another; and a *selection* mechanism through which the interactor is selected in the environment of selection.

Now, which social entities should we specify as the social interactors and the social replicators? In his PVRS model, Tony Lawson (2003) argues that social practices are the most promising feature of the social realm to be used as a social interactor, and chooses social rules as the social replicators which are selected (or not) through the competition of social interactors. Lawson (2003:37) also notes that a social rule can be seen a “code, convention, or understanding about how an act could or should be performed”, where such code can be tacitly or consciously followed. The replicators or social rules can then be taken in a broad sense, including also ideas, techniques and any type of codified information. For the essential feature of replicators in evolutionary models is that they contain a code that is transmitted through the replication mechanism. Such codes or information will often be combined with a material basis. Social rules, conventions, ideas and techniques can be materialized in books, artifacts or any means of recording codified information.

Replication mechanisms will be any mechanism that (while acting relatively independently from the environment of selection) contributes to the reproduction of a

given rule, technique or code, while variety-generating mechanisms will be any mechanism that (again, while acting relatively independently from the environment of selection) creates new rules, techniques and codes. Competition between social practices will take place as social rules, techniques and codes become actualized in social practices.

But let us now focus on Lawson's choice of social practices as the social interactors. Social practices are enabled by social, technological and psychological structures, and include the actualization of any of these structures of rules as actual practices. Now, a question one could ask is whether another interactor could have been chosen. Nelson and Winter (1982), for example, choose organizations as the social interactors. And like organizations, so can human individuals be selected in an evolutionary social process. The same can happen to a geographical region (which does not physically disappear, but can lose economic, social, technological or demographic characteristics, or even see its biological and natural qualities disappear).

But note that Lawson's formulation can still encompass a situation where it is an individual, organization or region that is selected. For there are two ways in which the selection environment – the population of competing social practices – can cause the selection of social practices in Lawson's formulation. The first, which will be termed here as *direct selection of social practices*, is by causing (or even forcing) individuals, organizations or regions to keep or to change their social practices (or at least influencing them to do so). In this case, social practices are selected directly through the decisions of individuals, organizations or regions (in the latter case, with decisions being made by the regional community) that choose to keep or abandon given social practices.

The second type of selection, to be termed here as *indirect selection of social practices*, consists in selecting/excluding those individuals, organizations or regions who engage in given social practices (for it may well be the case that people, organizations or regions decide to maintain given social rules, ideas or techniques regardless of how favored they may be by the environment of social practices). In this second case, social practices are selected indirectly through the selection of the individuals, organizations or regions that reproduce them. In both cases, the replicated code or information is selected through the selection of the social interactors (viz., social practices), but only in the latter case human individuals, organizations or regions are also themselves selected.

Veblen (1899) also refers to a similar distinction between these two types of selection, by differentiating selection of stable types (that could be seen here as indirect selection of the stable replicators of an individual, organization or region) on the one hand, and selection as adaptation of the agent's habits of thought (including the direct selection that individuals, organizations and regions make of their codes and rules of behavior and action) on the other hand.

However, the central concern here will be the evolution of replicators (of codes, social rules and techniques), and not the particular selection mechanism through which evolution occurs, or which specification of social interactors provides a better evolutionary analogy. In fact, Veblen himself seems to be more concerned with the evolution of institutions than with discerning between these two types of selection. Thus he writes:

“For the present purpose, however, the question as to the nature of the adaptive process – whether it is chiefly a selection between stable types of temperament and character, or chiefly an adaptation of men's habits of thought to changing circumstances – is of less importance than the fact that, by one method or another, institutions change and develop. Institutions must change with changing circumstances, since they are of the nature of an habitual method of responding to the stimuli which these changing circumstances afford. The development of these institutions is the development of society.” (Veblen 1899: 118)

A key question at this stage concerns which particular social replicators have been selected throughout history. Veblen (1898b, 1899) noted how different social rules were selected depending on the specific environment of selection.

Veblen (1898b, 1899) noted how the struggle for survival in a difficult natural environment would lead to the need of group solidarity and to an active propensity towards the search of nutrition and protection. Such were the conditions until the last Ice Age, and these conditions shaped the instincts and habits of thought (and the social replicators) of Veblen's 'savage society'. The term “savage society” springs from the distinction between 'savagery', 'barbarism' and 'civilization' Veblen took from Lewis Henry Morgan (1877).

The development of tools that enable a larger production of goods (including the production of a surplus), and of tools that make predacious activities more efficacious

or destructive, led to a change in the environment, which promoted invidious comparisons and competition between groups and individual within the group. This leads to Veblen's 'barbarian society', where invidious comparisons led to the development of a system of authoritarian relationships.

At a later stage, the technological innovations in transportation which enabled the transportation of goods through long distances (including the technological innovations in shipping throughout the fifteenth, sixteenth and seventeenth century, or the railroads throughout the nineteenth century), together with the institutional struggles between monarchs and feudal lords (during which monarchs tended to promote the development of cities and markets in order to weaken the economy of each feudal domain and hence the feudal lords' power) led to the formation of markets, which required that land, labor and capital be exchangeable, and made necessary the emergence of an abstract system of rules of exchange, which substituted the feudal system (which, for Veblen, was just a more advanced stage of the 'barbarian society', since the vassalage system is just an elaborated system of authoritarian relationships similar to those developed in the 'barbarian society'). This led to the formation of the 'commercial society', in which social relations follow an abstract system of rules that are applicable to every individual – for the efficiency of the market requires that its rules can be applied to any individual or good, and collides with the feudal system where land, labor and capital are governed by a complex system of authoritarian relations.

Finally, the emergence of the technology of mass production gives us the 'industrial society', in which social activity is governed by the discipline of the machine process, for it is the machine logic that sets the pace of human activity. Of course, this is a cumulative process, in which a later society maintains characteristics of a previous society – Veblen gives the example of how the high level of consumption of expensive material goods observed in the 'industrial society' exists because individuals often consume for an invidious motive, that is, consumption of expensive goods is a 'barbarian' symbol of superiority. Hence, the contemporary society comprises a variety of social rules (grounded in different principles like solidarity, authority, abstract laws and technological requirements) which were developed in specific selection environments. Each of these social rules will be present in corresponding social practices to a greater or lesser degree, depending on the selection environment.

Note that Veblen's typology contains some similarities to other typologies that appeared later in the literature. Karl Polanyi (1944) distinguishes between different modes of distribution of goods, like reciprocity (the mutual exchange of goods as part of a long-term relationship), redistribution (which requires the existence of a central entity or figure, to which all goods are directed, and who then distributes them to the community) and (market) exchange (the exchange of goods through a market mechanism, i.e., according to a price system). Now, Polanyi's reciprocity seems to be the key coordination mechanism at play in Veblen's 'savage' society, in which group solidarity is crucial for survival. Redistribution by a central authority would be the key coordination mechanism at play in a 'barbarian' society, and market exchange would be the coordination mechanism in the 'commercial' society.

Robert Heilbroner's (1993) makes a distinction similar to Polanyi's, between tradition (comprising a rigid structure of standardized norms, like those that characterize societies based on reciprocity), command (the coordination mechanism in authoritarian societies) and market (a decentralized coordination mechanism) as modes of production and distribution. In fact, a similar distinction to Heilbroner's also exists in the analysis of organizations. Henry Mintzberg (1983) distinguishes between three different types of coordination mechanisms in organizations, which are standardization (of work processes, outputs and skills), that consists in following a set of rigid rules just like tradition, direct supervision, which relies on personal authority, and mutual adjustment (a term Mintzberg took from Braybrooke and Lindblom, 1963), which provides a decentralized decision making mechanism.

Of course there are some differences between these taxonomies. For example, tradition and standardization need not mean reciprocity. But there seems to be enough scope for a distinction between: coordination mechanisms based upon a set of traditional or standardized rules of reciprocity like those of Veblen's 'savage society'; coordination mechanisms based upon authoritarian relations of command and direct supervision like those of Veblen's 'barbarian society'; and decentralized mechanisms of mutual adjustment like the market exchange mechanism of the 'commercial society'.

Now, the replicators can be conceptualized here as the set of social rules which specify which of these coordination mechanisms will be used in any organization or region. But how can we rank these mechanisms in terms of competitive advantage? Three key aspects of these coordination mechanisms are: (i) their time-efficiency; (ii) the amount of information they enable an agent to manage (including information about

the internal functionings of the organization or region, and information concerning the external environment and the allocation of resources in general); and (iii) the incentive structure they implement in the organization or region.

The three coordination mechanisms mentioned above will perform differently on each of these three aspects. Mutual adjustment processes (including markets and exchange) seem to be the ones where a higher creative potential exists, because in those processes all agents have the ability to respond to new information that arises. Standardization (or tradition) will be the most time-efficient process, albeit it will display less creative potential, because here no agent is engaging in deliberate reasoning, and hence no new information is being taken into account. But traditions based on reciprocity can be particularly important when facing a difficult environment of selection.

Direct supervision (or command) will display some creative potential because here there are some agents that are required to engage in deliberate reasoning to a greater extent than most, and hence some agents can respond to new information, and it will be the most efficient mechanism when a change of the incentive structure is needed – because only in this mechanism there is enough centralization of power to enforce a change in behavior, together with the possibility of deliberate reasoning (that enables a decision about change to be made).

So in this Darwinian model of socio-economic transformation, we have individuals, organizations and regions competing through the actualization of their rules and codes (including techniques) as social practices. The most competitive entities will be those that have replicators which enable a better adaptation to the environment of selection.

4. The Evolution of Human Capabilities

A Darwinian model requires a clear distinction between the environment of selection – constituted by the competing social practices – and the other aspects of human behavior that may generate some variety of codes, rules, routines and techniques. Now, even though some distinction between selection mechanisms and variety generating mechanisms is necessary for Darwinian analysis, it is also the case that these mechanisms may be to some extent interdependent.

In what Tony Lawson (2003) calls a *strictly Darwinian* process, the variety generating mechanism (or the variety of traits) is regarded as independent from the

selection mechanism. So human dispositions, psychological preferences, habits of thought, and any feature that may influence the replication and variety of social rules, are independent from the environment of selection – i.e., the competing social practices – in a strictly Darwinian model. When the environment of selection has some sort of causal influence on the variety generating mechanism, Lawson names the evolutionary process as a *Lamarckian* process.

The possibility of Lamarckian processes means that structures do not just provide a set of possibilities. In some cases, all possibilities enabled by a socio-technological configuration are equally (or approximately equally) likely. But in other cases, some options will be more likely than others because of the way in which the environment of selection shapes replication and variety-generating mechanisms. This is so, for example, because the daily repetition of social rules and techniques within a given environment will lead human agents to be disposed to, or have a tendency to, act accordingly to these (habitual) routinized procedures.

In fact, supporters of either the hypothesis that social structures determine human action, or that technology is the ultimate cause of events, make their point by noting how the agents' dispositions, propensities and habits are formed in everyday activity, and thus shaped by the social or technological structures that condition human activity. This causal force is undeniable, and the question is not its existence, but the extent of its influence.

Following given social rules and the repeated use of a given technology often endows the human agent with what Anthony Giddens (1984), following Laing (1965), names as “ontological security”, that is, the sense of inner security that is provided by sameness and continuity in daily routines and activities. When planning their activity, human agents expect their surrounding environment to remain relatively stable. The continuous engagement in familiar routines and the temporal endurance of familiar objects provides the agent a sense of psychological security and trust in the external environment. Even the agent's attempt to differentiate and distinguish herself or himself from other human agents can be seen as an attempt to ensure the maintenance of a familiar structure of differences, or an effort to preserve her or his own identity, and her or his conception of herself or himself as a distinct entity.

Such sense of inner security will lead to a tendency to reproduce the existing social and technological structures, regardless of whether such structures promote human well-being and advantage. For the daily routines and activities that are

reproduced through such structures will be perceived as being essential to human well-being, regardless of whether they really are the best promoters of well-being. The tendencies and dispositions to reproduce (rather than to transform) the existent social and technological structures will be particularly strong in such cases, and a processes of direct selection will lead to the reproduction of existing structures.

An important question then is the extent to which human agents just reproduce structures, or use their capabilities to transform them. The tendencies, dispositions and propensities that social structures and technology set into motion can contribute to their reproduction or even to their transformation. When tendencies contribute mainly to the reproduction of such social and technological structures, their transformation will be possible only if human agents have the capability to act contrarily to those tendencies. That is, the capability to act contrarily to the tendencies that are set into motion by social and technological structures must be one of the capabilities that the latter enable. Otherwise, the existent social and technological structures will become 'locked in'. So for transformation (or modification) to occur, choice must be a real possibility, as Lawson (2003) also notes.

In addition to the possibility of choosing, human agents must also have the ability to perceive a given social structure or a given technology as constraint to their well-being and advantage. And it may happen that such social and technological structures are not perceived as constituting a constraint to well-being and advantage. Like our actions, so is our reasoning, as our goals and values, shaped by dispositions, propensities and habits of thought which, in turn, are strongly influenced by underlying biological, social and technological structures.

But for transformation or modification to be possible, either the tendencies triggered by social processes must lead to transformation of its underlying structures (and be stronger than other countervailing tendencies that contribute to the reproduction of underlying structures), or the capability to act contrarily to tendencies for reproduction must be one of the capabilities that the existent social and technological structures enable. Such capability is closely associated with our ability to perceive and analyze events, and engage in deliberate processes of decision-making through which existent knowledge is transformed.

In fact, the epistemological conceptions we have can also be seen under a transformational or evolutionary perspective: the production of knowledge draws upon previous knowledge, and hence knowledge is a produced means of production, subject

to evolutionary processes of descent with modification. The Darwinian analysis suggested above is applied to codes in general, and these include social rules, techniques, and ideas or epistemological conceptions.

So the question of whether evolution is a deterministic process or not, depends on the range of capabilities that are left to the human agent. Whenever tendencies, propensities and dispositions have a strong influence in limiting the scope of human capabilities, evolution will be constrained to proceed in a particular direction. But such a situation happens only in particular cases. Whenever human capabilities are sufficiently broad, human agents will be able to choose amongst different courses of action and various evolutionary sequences will be possible.

In the conception suggested, agents are influenced, but not totally shaped by, technology and social structures. The causal influence of technology and social structures on human agents can be conceptualized as a Lamarckian process, wherein the environment of selection has some influence on the mechanisms through which variety and replication occur, i.e., changes the dispositions and propensities to create or maintain rules (and the deterministic case is just an extreme particular case, in which no independence between Darwinian mechanisms exists, and the process becomes exclusively Lamarckian).

Either in the evolutionary model presented or in a deterministic account of social activity, the mechanism through which biological, social and technological structures influence outcomes is not only by providing the conditions of possibility for action, but also by, to some extent, transforming the (dispositions and propensities of the) agent. But deterministic conceptions of social activity would argue that events and agents are *entirely* shaped by technology or social structures, in what could be conceived as a model where selection mechanisms completely determine replication mechanisms and variety-generating mechanisms.

5. Evolutionary Analysis and the Causal Efficacy of Social Structures, Technology and Human Agency: Some Illustrations of Why Evolution is a Non-Deterministic Process

The distinction between variety-generating mechanisms, replication mechanisms and selection mechanisms, made in the context of a Darwinian evolutionary model of socio-economic transformation, can illuminate some disputes in the literature on social structures, technology and agency, like the question of whether social structures or

technology are the ultimate determinant of history. The evolutionary perspective described above enables us to conceptualize the causal efficacy of social and technological structures, while taking into account the irreducibility of the causal powers of human agents.

Under the Darwinian perspective specified above, the disposition and propensity of the agent to create new codes, rules, techniques and ideas can be conceptualized as a variety-generating mechanism. The causal force of existing social and technological structures can be seen as part of the selection environment, constituted by the actualization of codes, rules, techniques and ideas in social practices. Whether social and technological structures determine human agency or not will depend on how strong is the pressure of the environment of social practices, and whether it leaves the agent with more or less possibilities to choose amongst possible courses of actions, and possible rules of behavior.

As noted before, technology has often been regarded as the ultimate determinant of events in economic history, in a perspective often referred to as “technological determinism”. Technological determinism neglects not only the causal powers of human agents, but also the causal efficacy of social structures, for assuming that technology is the only cause of events (on this, see Clive Lawson 2006).

An author who was particularly influential in emphasizing the role of technology in the transformation of society was Veblen. However, a question that can be made is whether technology really is the only driving force behind historical transformation even in Veblen’s conception. Previous perspectives on the work of Veblen have taken into account the joint effects of technology and institutions, while nevertheless still attributing the cause of change to technology alone. Clarence Ayres (1944, 1952), for example, argued that technology is the dynamic force of change in economic activity, while institutions are a static force that constrains change, in a conception often referred to as the “Veblenian dichotomy”, because such a conception has been interpreted in the literature as representing Veblen’s position (on this see for example Hamilton (1953)). But note that new technologies need not necessarily contribute to the emergence of a variety of new institutions (such as markets), and change can also come through institutional factors.

Under the light of the Darwinian model specified above, the causal role of technology can be conceptualized in a non-deterministic way. The invention of new technologies can be seen as a variety generating mechanism. In this perspective,

technology is not the only determinant of history because whether technological innovations will be successful or not depends on the environment of selection in which new techniques are implemented.

For example, the technological innovations in transportation which enabled the transportation of goods through long distances, enabling the expansion of the market system, would not be widely implemented if there were not a social environment supported by corresponding institutions (and, of course, by other technologies as well), including the coordination mechanisms that could manage such enterprises. Coordination mechanisms based on tradition could not accommodate the enormous amount of new information to be managed concerning the new varieties of products from different places. The need to manage new information led to the predominance of command coordination mechanisms on the one hand, and market coordination mechanisms on the other hand.

It is true, nevertheless, that technological innovations in transportation helped to the expansion of the market as the key coordinating mechanism throughout the world economy (an expansion Polanyi (1944) sees as the key characteristic of the modern era, and the cause of the destruction of economies based on reciprocity), which has been conjoined with the existence of centralized command mechanisms, like the political and military command mechanisms of nation-states, or the centralized economic mechanisms used by large private companies. However, the expansion of the market and command as coordination mechanisms, replacing tradition, and of the technologies that enabled transportation of goods through long distance, was a co-evolution in which institutional coordination mechanisms and technology mutually reinforced each other, and not a deterministic process driven by technology alone.

In fact, it can be argued that institutional conflicts were the key element in the generation of an environment that favored the market above feudal economic systems. Before the changes in transport technology named above, markets already existed as coordination mechanisms within given cities, and their development depended essentially upon institutional power struggles. As Adam Smith (1776) notes, the monarchs' support to the expansion of cities, and the development of commercial activities in cities that were outside of the feudal system, was a way for kings to centralize their power, by reducing the economic influence and power of feudal lords.

Between the power struggle opposing monarchs and feudal lords, cities outside of the feudal domain, and a wide variety of commercial activities within such cities,

coordinated through market mechanisms, found a favorable environment for their development with the kings' support. Changes in transport technology only led to the selection of an already existent coordination mechanism – the market, which was already developing within cities – as the coordination mechanism articulates relationships between different locations in the world economy.

As cities became more important than feudal domains, the power of feudal lords declined relatively to the power of kings, and centralized monarchies gained control over a centralized national economy that contrasted with the decentralized feudal world. The reinforcement of the asymmetrical power relation of the centralized monarchies over feudal lords created a new balance of powers, and a national economy of cities replaced decentralized feudal systems, becoming the new environment of selection. This new environment of selection was constituted by a world economy where nation states, which were geographical regions with a centralized and independent political organization, became central institutional forces.

This was a major institutional change that was not directly caused by any technological change. It led to a change from an authoritarian system of devolution to a system based on economic competition, which in turn required a given institutional setting. Feudal society provided an environment where authoritarian relations were relatively more efficient due to the need of protection, as John Stuart Mill (1848) notes. The market, in turn, created an environment that favors competitive relations, and requires the specification of a set of rules that are equally applicable to all agents regardless of their status (on this, see also Veblen 1904).

In this new environment of selection, centralized monarchies became increasingly important buyers for economic goods related to national activities (armadas, armies, palaces and related industries, for example), providing new markets for economic activity. An example of the influence of this new environment of selection is the French national demand for tapestry, which led to the redirection of economic activity in suppliers of wool (such as England) to its production, leading to the expropriation of land to be used in the pasture to produce wool, and the enclosure of private properties, which before were common lands. This change in the selection environment, in turn, caused a great decline in the well-being of agricultural laborers. In the feudal system, most of the product of work in common lands (unlike the product of work in the lords' lands) was kept for the laborer. So there was increasingly less opportunity to keep a share of product above the subsistence level, and agricultural

workers were willing to move into cities if they had the opportunity to find better prospects there.

While the development of cities and their commercial activities provided some opportunities for a different living, it was the emergence of a variety of new technologies after the industrial revolution that mostly benefited from this environment of selection where a large labor force was willing to leave lands in which agricultural workers no longer could work at least a part of the day for their own profit. So even the technological innovations of the British industrial revolution benefited from a favorable environment for their implementation, rather than imposing their logic regardless of the surrounding environment. Technological innovations in agriculture, together with the technological innovations that led to the appearance of factories and mass production in urban centers not only benefited from the availability of this labor force, as they generated again a new environment of selection where urban centers had now a competitive advantage over rural areas and traditional modes of production. Moreover, the technology of mass production has since then become a force that maintains the competitive advantage of urban centers above rural areas, rather than a cause of change in such a state of affairs.

Furthermore, mass production required not only an increasingly larger number of workers, but also an increasingly larger number of buyers, and the selection environment provided by mass production made larger cities even more competitive due to their high population density. Of course, one town did not constitute a sufficiently large market for mass production, and therefore the technological innovations that led to mass production would not have been successful outside of an environment of selection where new technologies of transportation (which once installed came to support the new selection environment) combined with market mechanisms enabled a large number of consumers to receive those goods, and relied also on the emergence of institutions like decentralized smaller companies, and the modern large corporations, which relied on coordination mechanisms that were sufficiently flexible to new information. This, again, reinforces the point that institutions and technology co-evolve in a process where both can be inducers of, or inhibitors of, socio-economic change.

The contemporary increase in the amount of new information to be managed ultimately led to the emergence of the market as the most important coordination mechanism in distribution. This does not mean that asymmetrical power relations do not exist in the market, for market competition is often imperfect competition whenever

some companies have higher control over components of the selection environment, such as prices. Also, nation states, and their centralized mechanisms of political decision, still play a key role in economic relations. This political and economic institutional framework governed both by market mechanisms and command mechanisms is, like technology, essential to evolutionary processes of variety, replication and selection.

The point to note is that this historical digression contains episodes where both institutions and technology contributed to selection, and where both institutions and technology generated variety and replication. This fact shows that there seems to be no basis to attribute only one of these roles to each of the terms of the so-called Veblenian dichotomy. The expansion of markets (but not its emergence) was enabled by technology, which in turn provided the ideal environment for the development of the market, in a mutually reinforcing process of cumulative change. Ayres position seems to focus on a particular aspect of this co-evolution, which captures the fact that variety is often introduced through technological change, but its selection faces the institutional forces continuously replicated and actualized in the environment. However, the conception of technology as the ultimate determinant of change is difficult to sustain when scrutinizing the latest transformations throughout economic history, because technological innovations were selected only when they found a favorable environment.

Both institutions and technology can act either as forces of change or against change, because both can act as variety generating mechanisms, replication mechanisms or selection mechanisms. It need not be the case that technology is the only cause of change, or that institutions are everywhere static. Not only can institutions provide variety, as it is also the case that once technology becomes a part of the environment it often acts as a force of stasis and maintenance of the current state of affairs, and not as a force of change. This is certainly the case when technologies become 'locked in', on which see David (1985).

6. Evolutionary Analysis and the Transformation of Human Agents and Epistemological Conceptions: Some Further Illustrations of Why Evolution is a Non-Deterministic Process

It is not just institutions and technology that are transformed throughout economic activity, but also the human agent. In fact, a possible argument for deterministic

conceptions is that technology or institutions determine events by shaping the habits and dispositions of human agents, as noted before.

As seen before, Veblen (1898b, 1899) noted how the environment of selection shapes habits of thought, and how the need of group solidarity that characterized earlier communities was a necessary requirement for the survival of the group. As human beings became able to produce a larger amount of goods, the environment of selection changed, for the existence of a higher level of abundance enabled invidious comparisons and competition between groups and individual within the group. These two tendencies of human agents (for group solidarity and for individual competition within a group, respectively) continue, of course, to exist, and tend to become more or less prominent depending on the environment of selection. Evolutionary selected entities like markets, large companies and large urban areas provide an environment of selection that conditions the development of these human propensities.

The contemporary environment enables the consumption of necessary goods in markets, whereas before it was necessary to belong to a network of traditional or reciprocal social relations to obtain goods. This absence of a need of belonging to social networks, combined with the expansion of an urban environment in which the population's increase renders social relationships less frequent, contributed to the expansion of individualism in our culture.

Furthermore, market relations involve the careful calculation of gains and losses. As more people engaged in market relations and in the corresponding calculation of gains and losses, the latter attitude became widespread across increasing segments of the population, who once accustomed to this instrumental mentality began to use it to assess not only economic institutions (the change of attitude towards guilds is an example), but other social institutions as well, as Schumpeter (1942) notes. This instrumental approach is present today in philosophical perspectives like utilitarianism, and in the neoclassical economic models of choice and behavior (for an alternative evolutionary analysis of the tendency towards instrumental pursuit of individual well-being, see Dawkins (1976)).

Economic security, which before was assured by belonging to a network of social relations, now depends increasingly on the rational engagement with the market system. The need of ontological security discussed before, relied now on the market mechanism. The shift towards habits of thought that privilege instrumental calculation of gains and loss, facilitated by the selection environment of market relations, led to a

Lamarckian process of change of human dispositions that accelerated the destruction of traditional relations that characterized pre-industrial societies. These individualistic dispositions generate a new environment that poses new challenges, due to the tendencies towards the production and consumption of private goods that they generate. Market mechanisms based on individual self-interest led to a lack of balance between public and private goods (while both are necessary for individual well-being, the market only provides efficient allocation of resources for the production of private goods), and to a lack of balance between investment in material resources and human resources (the market privileges investment in the former only), as Galbraith (1958) notes. The centralized nation state command mechanisms that were left as an offspring of centralized monarchies are increasingly unable to produce an amount of public goods and investment in human resources that successfully balances the market production of private goods and market investment in private resources.

However, not even the development of individualistic attitudes can be seen as a deterministic process. In fact, similar environments to the ones that led to the development of individualistic attitudes, also led to cooperative, as opposed to individualistic, social relations through the cooperative movements in the 19th century. The emergence of machine production led to the bankruptcy of many smaller companies throughout the 19th century. This led many workers to lose their job in virtue of a change in the mode of production, and created an environment of selection in which workers could either join the new industries, or create other companies that could compete in such a new environment.

While many workers chose to take part in the new emerging mode of production, other workers decided to create alternative organizations with different modes of production. The need of incorporating new information about a new and rapidly changing environment led selection mechanisms to favor more innovative organizations, with variety-generating mechanisms creative enough so that organizations could adapt. This creative potential was found in coordination mechanisms based on reciprocity, such as those instituted in cooperative movements like Rochdale – where all agents were owners with similar property rights, and with a more participatory method of decision making enabling the inclusion of a greater amount of information in its collective decision processes.

Here, there was a direct selection mechanism at play, for it was the pressure of the environment (including social structures, technology and the mode of production)

that led workers to develop coordination mechanisms based on reciprocity. However, as John Stuart Mill (1848) documents, as soon as cooperative movements like Rochdale become successful enough to soften the pressure of the competitive selection environment over the cooperatives, the cooperative's members started to include members that did not have any right to property, and whose activity was coordinated through the mechanism of direct supervision. That is, the change in the environment led to a process of direct selection in which individual members were no longer pressured towards mutual adjustment by external competition, and thus chose to establish asymmetrical relations of power with new members of their organization. Note again how it is the pressure exercised by the environment of selection upon the group that leads to the emergence of group solidarity, as in the case of the primitive (savage) communities analyzed by Veblen (1898b, 1899), and how it is again the reduction of such pressure that leads to the abandonment of the original group solidarity through a process of direct selection.

The fact that the market mechanism was the key means of distribution was not the only factor contributing to the expansion of rationalistic attitudes. The change in the mode of production also contributed to this process. The pre-industrial mode of production was dependent on uncertain weather conditions, and made unpredictability a constant factor in human life. The post-industrial mode of production relied on technologies that were not dependent on such uncertain factors, and promoted the expansion of rationalistic attitudes, in a process designated by Veblen (1904) as the "machine process". In this sense, technology acted first as a promoter of change by generating a new variety of attitudes, but remains now as a selective force acting against change through its contribution towards the maintenance of rationalistic and individualistic attitudes.

So both individualistic and cooperative responses have been given throughout economic history to similar technological and institutional circumstances. The key factor behind the type of response was a process of direct selection that provided different responses to the same institutional and technological situation. Rarely (if ever) the space of human capabilities and human dispositions becomes sufficiently restricted by institutions or technology so that deterministic processes occur. As noted before, the cases when institutions and technology completely determine human action can be seen as particular cases, for example when human capabilities become restricted enough to

force a given choice, or when, in an exclusively Lamarckian process, the environment of selection determines human dispositions.

7. Concluding remarks

The social rules and codes present in contemporary economic activities, and the individuals, organizations and regions that engage in them, can thus be seen as the outcome of a non-deterministic evolutionary process. The personal advantages that spring from the exertion of asymmetric power, combined with an individualistic and rationalistic attitude, led to the predominance of asymmetrical relations as the dominant code (or replicator) in production activities within productive organizations. In distribution activities, the market is today the key coordinating mechanism, albeit market power varies greatly between organizations and regions. The geographical morphology of regions was also radically changed, with the selection environment being more favorable to the development of large urban centers (that function according to the evolutionary selected codes), which continue to gain prominence against rural areas.

Causal forces like social structures, technology, human agents and the mode of production, were each identified by different traditions as being the ultimate cause of events. In the evolutionary model suggested here, all such causal forces can be incorporated under a broader perspective. It may be that at a particular historico-geographical circumstance, some of these forces are more important than others, but such a possibility can be incorporated as a particular case within the suggested evolutionary model.

The social structure, like technology and the mode of production, arises through human agency, but it is not reducible to the interaction of human agents from which it first emerged. Human agents take this structure as given at each moment they act, while reproducing and/or transforming such structure in their daily activity. Therefore, rules, custom, ideas, techniques, beliefs, norms and conventions are to be understood as a constituent of social reality, that are reproduced through human agency, but do not completely determine the latter, so they can also be transformed by human agency.

It may be that as social and technological structures develop, shaping the conditions of possibility for human agency, they end up leaving very few options of choice for agents. Furthermore, social structures and technology are very important in shaping the personality and identity of the individual who slots into a given social

position within such a structure (and different individuals will prioritize different social structures to which they may belong in different ways). But if agents are ontologically distinct entities, they have the possibility of at least trying to choose and change modes of production, institutions, identities, affiliations and social positions, through the exercise of reasoning, subjectivity and reflexivity.

The advantage of the evolutionary conception suggested above is that it provides a general outline of the causal mechanisms of socio-economic transformation, while being able to encompass several particular cases in its more general framework. Deterministic accounts often provide an insightful description of one of the causal mechanisms at play (technology, social structures, mode of production or human agency), but take only one of the causal factors into consideration.

Supporters of either the hypothesis that social structures determine human action, or that technology is the ultimate cause of events, make their point by noting how the agents' dispositions and habits are formed in everyday activity, and thus shaped by the social or technological structures that condition human activity. This causal force is undeniable, and the question is not its existence, but the extent of its influence.

In the conception suggested, agents are influenced, but not totally shaped by, technology and social structures. In the evolutionary model suggested above, the causal influence of social structures and technology upon the dispositions and propensities of human agents can be conceptualized as a Lamarckian process, wherein the environment of selection changes the mechanisms through which variety and replication occur, i.e., changes the dispositions and propensities to create or maintain rules (and the deterministic case is just an extreme particular case, in which no independence between Darwinian mechanisms exists, and the process becomes exclusively Lamarckian). Either in the evolutionary model presented or in a deterministic account of social activity, the mechanism through which biological, social and technological structures influence outcomes is not only by providing the conditions of possibility for action, but also by, to some extent, transforming the (dispositions and propensities of the) agent. But deterministic conceptions of social activity would argue that events and agents are entirely shaped by technology or social structures, in what could be conceived as a model where selection mechanisms completely determine replication mechanisms and variety-generating mechanisms.

The forces that act towards the maintenance of codes, social rules, techniques and ideas are replication mechanisms, while the causal powers that contribute to the

transformation of codes, social rules, techniques and ideas are variety generating mechanisms. But in order for social replicators to be actualized as social practices, each variety of codes, social rules, techniques and ideas that are continuously generated and replicated must be selected within an environment constituted by the totality of codes, social rules, techniques and ideas that technology, social structures and human agents generate and reproduce.

References:

Althusser, L. (2005 [1968]), *For Marx*, London, Verso, translated by Ben Brewster

Arrow, K. (1962), “The Economic Implications of Learning by Doing”, *Review of Economic Studies*, 29, 151-173.

Ayres, C. (1944), *The Theory of Economic Progress*, 1st ed. Chapel Hill, N.C., University of North Carolina Press.

Ayres, C. (1952), *The Industrial Economy: Its Technological Basis and Institutional Basis*. Cambridge, Mass., Houghton Mifflin.

Barro, R. and X. Sala-i-Martin (1999), *Economic Growth*, Cambridge MA, MIT Press.

Braybrooke D., and C. E. Lindblom (1963), *A Strategy of Decision*, New York, Free Press.

Darwin, C. (1859), *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*, London, John Murray 1st edition.

David, P. (1985), “Clio and the economics of QWERTY”, *American Economic Review (papers and proceedings)*, 75, 332-7.

Dawkins, R. (1976), *The Selfish Gene*, Oxford, Oxford University Press.

Dawkins, R. (1978), "Replicator Selection and the Extended Phenotype", *Zeitschrift für Tierpsychologie*, vol. 47, 61-76.

Galbraith, J. K. (1958), *The Affluent Society*, New York, Houghton Mifflin.

Giddens, A. (1984), *The Constitution of Society*, Cambridge, Polity Press.

Hamilton, D. (1991[1953]). *Evolutionary Economics: A Study of Change in Economic Thought*, Reprint, New Brunswick, N.J., Transaction Publishers.

Heilbroner, R.L. (1967), "Do Machines Make History?" *Technology and Culture* 8, 335-345.

Heilbroner, R. L. (1993), *21st Century Capitalism*, New York, W. W. Norton & Company.

Hull, D. (1981), "Units of Evolution: A Metaphysical Essay", in U.J. Jensen and Rom Harré (eds) *The Philosophy of Evolution*, Brighton, Harvester Press, 23-44.

Laing, R.D. (1965), *The Divided Self*, Hammondsworth, Penguin.

Lawson, C. (2006) "Technology, Technological Determinism and the Transformational Model of Social Activity" in Lawson C, J.S. Latsis and N. Martins (eds) *Contributions to Social Ontology*, London, Routledge.

Lawson, T. (2003), *Reorienting Economics*, London, Routledge.

Lewis, P. A. (2000), "Realism, Causation and the Problem of Social Structure", *Journal for the Theory of Social Behavior*", 30: 249-268.

Lucas, R. E., Jr. (1988), "On the Mechanics of Economic Development", *Journal of Monetary Economics*, 22, 3-12.

Mintzberg, H. (1983), *Structure in 5's: Designing Effective Organisations*, New Jersey, Prentice-Hall.

Morgan, H. L. (1877), *Ancient Society*, New York, Henry Colt and Co.

Nelson, R., S. Winter (1982), *An Evolutionary Theory of Economic Change*, Cambridge MA, Belknap Press.

Polanyi, K. (1944), *The Great Transformation: The Political and Economic Origins of Our Time*, Boston, Beacon Press.

Romer, P. (1986), "Increasing Returns and Long Run Growth", *Journal of Political Economy*, 94, 1002-1037.

Romer, P. (1990), "Endogenous Technological Change", *Journal of Political Economy*, 98 (part 2), S71-S102.

Schumpeter, J., (1992[1942]), *Capitalism, Socialism and Democracy*, London and New York, Routledge.

Smith, A. (1776), *An Inquiry into the Nature and Causes of the Wealth of Nations*; London, Methuen and Co., Ltd.

Smith, M, and L. Marx (eds), (1996), *Does Technology Drive History? the Dilemma of Technological Determinism*, edited by M Smith and L Marx. Mass., MIT Press.

Solow, R. (1956), "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics*, 70, 65-94.

Solow, R. (1957), "Technical Change and the Aggregate Production Function", *Review of Economics and Statistics*, 39, 312-320.

Veblen, T. (1973 [1897]), "Review of Max Lorenz *Die Marxistische Socialdemokratie*". Reprinted in *Essays, Reviews and Reports* by Thorstein Veblen, edited with an introduction by Joseph Dorfman. New York, N.Y.: Augustus Kelley.

Veblen, T. (1898a), "Why is Economics Not an Evolutionary Science?", *The Quarterly Journal of Economics*, 12, 373-397.

Veblen, T. (1898b), "The Instinct of Workmanship and the Irksomeness of Labor", *The American Journal of Sociology*, 4, 187-201.

Veblen, T. (1899), *The Theory of the Leisure Class*, New York, Macmillan.

Veblen, T. (1904), *The Theory of Business Enterprise*, New York, Charles Scribner's Sons.