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Behavior and Institutional Change

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Prohlášení

Prohlašuji, že jsem diplomovou práci vypracoval samostatně a použil pouze uvedené prameny a literaturu

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Poděkování

Chtěl bych především poděkovat konzultantovi Prof. Ing. Karlu Koubovi, DrSc.,
a to jak za podporu a důvěru při psaní této práce,
tak za výbornou a cennou spolupráci během celého mého studia.

ABSTRACT

The main aim is to explain, why we can observe strong persistence in human or firm behavior despite substantial change of economic environment and why persistence of informal institutions occurs. During recent two decades there were various trials to provide explanation of persistence of behavior based on presumption of existence of path dependency and increasing returns, reflecting findings of experimental economics with methodological background in bounded rationality or using simulations of interactions or networks. My practice is slightly different as I'm trying to incorporate findings of cognitive psychology and social cognitive learning into economics. Cognitive psychology implies that behavioral regularities, routines, are based on subjective mental models. Evolution of behavior can be now understood as evolution of routines and mental models, and thanks to their nature routines have high propensity to long persistence despite changing environment. This approach is applicable to evolution of informal institutions and it allows to explain persistence of them using shared mental models. Then informal institutions are seemed as behavioral regularities used by decisive part of the society and their evolution can be now described as diffusion of new behavioral regularity in the society and modeled using biased transmission approach. Finally formal models of contagion and of cultural transmission are presented and evaluated.

ABSTRAKT

Hlavním cílem této práce je vysvětlit přetrvávání vzorců chování jednotlivců i firem navzdory významné změně v jejich prostředí a také, proč se objevuje značná setrvačnost v neformálních institucích. V minulých letech zde bylo několik pokusů, počínaje vysvětlením založeným na existenci path dependency, pomocí experimentální ekonomie nebo simulací. Můj přístup je odlišný, snažím se konzistentně pracovat s poznatky kognitivní psychologie a sociálního učení. S pomocí rutinního chování a mentálních modelů jako obrazů reality v hlavách jednotlivců jsem pak vysvětlil existenci institucí jako důsledek sdílených mentálních modelů. Neformální instituce jsou pak považovány za jistý druh ustálených vzorců chování a jejich evoluce pak může být popsána jako difuze nového vzorce chování ve společnosti a modelována pomocí modelů difuze nebo kulturní transmise.

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Introduction

The main aim of this thesis is to explain reasons, why we can observe strong persistence in human or firm behavior despite substantial change of economic environment and why persistence of informal institutions occurs. During recent two decades there were various trials to provide explanation of persistence of behavior based on presumption of existence of path dependency and increasing returns, reflecting findings of experimental economics with methodological background in bounded rationality or using simulations of interactions or networks. My practice is slightly different as I'm trying to incorporate findings of cognitive psychology and social cognitive learning into economics and use it for explanation of those phenomenons.

Cognitive perspective makes also formalization of evolution of informal institutions possible. Although I personally share a common point of view that formalizing of such adaptation processes and evolution of informal institutions is not trivial problem according to great complexity and many interdependencies I suppose that some formalization is necessary, at least because formalization itself helps to more accurate explanation and identification of causalities. This paper should be a small step ahead as my aim is to show that such formalization is possible and also that considerable progress were made in this field recently.

The text is organized as follows: first behavioral foundations of economics are summarized and then Behaviorism and Cognitivism as two different approaches in psychology are described. After, several implications of cognitive psychology for economics are pointed out, persistence of behavior is justified and the role of observation for learning is emphasized. Finally cognitive framework is used for explanation of informal institutions as a consequence of shared mental models and this perspective enables to deal with informal institutions in a similar way as with behavioral regularities. Explanation of the nature of institutional change follows and the parallel between institutional and technological change is explored, together with path dependency. The idea of similar nature of institutional and technological change is revisited in the next section, however in slightly different way - evolution of informal

institutions is described as a diffusion of new behavioral form in population of agents and this process is modeled as a contagion in a similar way as a diffusion of innovation usually is. The last section is devoted to cultural transmission of norms.

1. Behavioral Foundations of Economics

Microeconomics and modern macroeconomics are based on several behavioral assumptions which enable sophisticated formalization. Extensive discussion about behavioral assumptions of economics can be found in Knight (1921), Blaug (1980) or in Winter (1986) and North (1990). For further argumentation it is useful to point out several of these assumptions:

- The economic world is viewed as being in equilibrium.
- Individual agents face repeatedly similar choices (or to good structured situations under certainty) and they evaluate the outcomes according to stable criteria, each of them is able to identify the best opportunity from a set of all available choices (*Rationality*).
- People are formally free to act according to their motives, they „own themselves” and their choice is not constrained by the society or other individuals. Furthermore every member of the society acts as an individual only, in entire independence of all other persons¹. (*Methodological individualism*).
- Because the world is approximate equilibrium prevailing behavioral regularities are close to maximizing behavior.
- So concepts of representative firm and representative consumer can be used as a sufficient approximation.
- Uncertainty can be parametrised and modelled using expected utility hypothesis.
- Adaptive processes to an optimal choice exist, nevertheless they are supposed to be costless and instantaneous.

¹ Knight (1921, ch. 2, paragraphs 3 and 6).

Additionally some more restrictions are common in economic models like strictly costless adjustment processes, preferences are derived from utility function, which is twice differentiable and so on (see any advanced microeconomics textbook like Mas-Colell et al. (1995) for many examples). Furthermore it is assumed that complexity and uncertainty don't play such important role for decision-making process that they should be included in analysis. In other words, that optimization is a sufficient approximation of behavior because individuals and firms will be forced to change their behavior through competition, if they could achieve better results, because otherwise they would be eliminated. This is called behavior *as if optimization* (Friedman, 1953)².

2. Behaviorism and Cognitivism in Psychology

Perspective of psychology is slightly different, although both psychology and economics study behavior of individuals. Psychology explains determinants of human behavior, their motivational aspects³, development of behavior, personality, interaction with others and other related topics. In economics, and especially modern microeconomics, it is simple, all aspects of motivation and changes of behavior were reduced to incentives defined by relative prices and their relation to utility or production function. Withal it is assumed that change in relative prices (etc.) would change allocation and so behavior would change, too. In fact this view corresponds to

2 Friedman (1953, p. 15) quoted several articles published in AER in the late 40's devoted to adequacy of microeconomic modeling. His work should be viewed as continuation of discussion between George Stigler, Fritz Machlup and others.

3 Contemporary psychology often follows explanation of Abraham Maslow, who introduced hierarchy of human needs theory, nevertheless this approach is not the only one, other prominent examples are Herzberg's two factor theory, theory of cognitive dissonance, social conformity view or self-determination theory. Any basic textbook of psychology can provide brief overview about this topic, also Mantzavinos (2001, p. 10-15) broadly discuss Maslow's theory and its implications. Here question of motivational aspects is not omitted, although not explicitly described. Instead we implicitly deal with eclectic view accomplishing basic aspects of several theories as presumption that only unsatisfied needs can affect behavior, but satisfied needs cannot (Maslow, Herzberg), that human beings have not only economical but also „social” and emotional needs (this implies altruistic behavior and weakens the self-interest paradigm of economics) and that they are rather conformist within particular social group or community than pure individualists.

one of the main psychological school: behaviorism⁴. The main presumption of this school is that in order to explain human behavior it is not necessary to study mental processes. Roughly saying behavior can be explained without any knowledge about what happen in mind, because behavior is consequence of simple mechanism „stimuli-response” and following reinforcement, so it is purely deterministic, influenced by the environment and by genetic factors. As we will see this distinction is very important with respect to our main problem, evolution of behavior during institutional change.

On the other hand different influential psychological school Cognitivism stress importance of memory, attention, perception, reasoning, creativity and mental representation. Behavior is viewed as a consequence of mental processes and simple „IF-THEN” perspective is combined with own experience of other actions, which happened in past or which were observed, so it is much broader. Difference between these two schools can be described on their attitude of learning. Example of pure behaviorist view is the famous story of Ivan Pavlov and his dogs, this well-known experiment was nothing more than simple reinforcement resulting from repeated action – so long was light of bulb connected with meal that after some time dog started to salivate only when bulb was turned on. However cognitive approach to learning is based on problem-solving. Explaining cognitive perspective on learning of dogs would be quite peculiar, so I will use example presented in Mueller (2004) – choice of cigarette brand. Non-cognitive – once a man had tried Marlboro (or another one), in fact it had happened by an coincidence, but he had found them really good, so he has been buying it further. This is unconscious reaction on previous events. Cognitive approach is based on another idea: once a man was in a situation, in which he had to choose his favorite brand, and he has chosen Marlboro. So he used his cognitive abilities, found „his” brand in the past, he has been buying it continuously and the consequence is a new habit. And this habit has another nature than pure unconscious result of training.

As far as mental processes behind learning and formation of behavioral regularities concerns, cognitive psychology emphasizes the importance of perception of real world and re-elaboration or interpretation of obtained information in human minds. The idea

4 However most psychologists hold eclectic viewpoints that combine views of many schools.

is that there exists one “real world” and its ideal image in mind, called **mental model** (or cognitive map), which is schematic (in other words symbolic), subjective and basically incomplete representation of reality. This mental models cover the most essential relationships between various objects („cause-consequences-relations”) and all new acquired pieces of information are associated and confronted with previous experience and knowledge. Process of perception is assumed to be highly selective and the character of this selection depends strongly on experience of individual and sometimes on coincidence as well. The same characteristic also holds for re-elaboration of knowledge.

3. Implementing Cognitive Psychology into Economics

Can be such cognitive approach implemented into economics? First we should summarize what are direct consequences for economics. Importance of mental processes means that not only incentives but also learning, experience and social network does matter as they influence perception of real world, this means that some events would be evaluated as incentives and others can happen without being registered. Also experience and observed behavior of other members of the society determine how perceived information would be re-elaborated and used in practice, if behavior changes or not and how. Furthermore it is reliable to assume that different people would react differently thanks to different knowledge, different direct experience etc. And adaptive or adjustment processes are hardly straightforward, neither instantaneous and nor costless, because lack of information, uncertainty and limited cognitive capacity. This means that agents are not able to evaluate outcomes of all possible actions in advance and sometimes they have problems to do that ex-post as well.⁵

Importance of such interpretation of equilibrium have been pointed out just by

⁵ Those phenomenons will be discussed later. However relaxing assumptions of costless and instantaneous nature of adjustment processes are perhaps much more important for interpretation of economic models than the whole discussion about rationality in economics. Hodgson (2001) came to the same conclusion.

Alfred Marshall⁶ or Frank Knight⁷. Knight in his work *Risk, Uncertainty and Profit* wrote about „psychological elements” in preferences, about influence of social group, in which agents are embedded, on perception and on changes in preferences caused by change of fashion in the society, yet the main topic of his book is uncertainty and consequences of uncertainty on behavior and entrepreneurship. Uncertainty is according to Knight the main cause of profits as profits arise as consequences of changes in economic conditions that cannot be fully anticipated. He emphasized that the crucial point is our imperfect knowledge of the future, not change as such, which cause that consequences of change on profits would not be eliminated by competition (Knight, 1921, ch. 7). Adaptation to changes depends on foresight and conscious readjustment to predicted changes. Additionally „*we perceive the world before we*

6 Marshall in his *Principles of Economics* devoted the whole first book to methodological preliminaries – especially chapter 1.3. Economic Generalizations or Laws is about the notion of equilibrium in economics, which should be viewed not as a state but as a tendency. Marshall (1920) distinguished also between physical and social laws etc. Hodgson (2001, p. 95 and followings) pointed out also another aspect of Marshall’s works, that historical specificity as the core argument of the German historical school was fully acknowledged by him and omitting this fact (as for example Lionel Robbins did) is a great misinterpretation of his thoughts. Egidi and Rizzello (2003) emphasize distinction between Schumpeterian and Marshallian approach to evolution, the first based on exogenous forces of competition and the latter one on endogenous change and adjustment. They also highly appreciate his attitude to learning processes not only in *Principles* but also in his early work *Ye Machine* published in Raffaelli, T. (1994), “Alfred Marshall's Early Philosophical Writings”. *Research in the History of Economic Thought and Methodology: Archival Supplement*, n. 4, 53 - 159.

7 Frank H. Knight (1921, ch. 5 – Adjustment and the Notion of Equilibrium): „*The early writers regarded the equilibrium condition as constantly at hand in a sense analogous to the normal price equilibrium between the production and consumption, cost and value, of consumption goods. Their "static state" was, if not the actual condition of society, a condition on which it constantly verged. It makes a great deal of difference in the theory when we recognize, as the facts require, that the equilibrium is an indefinite and usually a very great distance in the future. The condition must then be viewed as the theoretical result of a particular tendency only, which may be modified to any extent or reversed by the effect of other tendencies, or the conditions may be entirely changed by unforeseen developments long before any considerable approach to the equilibrium has been made. The equilibrium, then, in a particular case, is not a result actually to be anticipated; a concrete prediction of the future course of events must take into account all the tendencies at work and estimate their relative importance, and in addition must always be made subject to wide reservations for unpredictable influences.*”

react to it, and we react not to what we perceive, but always to what we infer. We do not perceive the present as it is and in its totality, nor do we infer the future from the present with any high degree of dependability, nor yet do we accurately know the consequences of our own actions” (ibid.) because of uncertainty about the future. Decision-making process under uncertainty then can be classified with respect to the level of probability situations: a priori probability and statistical probability derived from empirical evaluation of frequency are known and on the other hand we have situations, in which agents have to rely only in his own estimates (ibid.). The latter one corresponds to uncertainty (or *Knightian uncertainty*) and previous two to risk, which can be modeled using expected utility theorem.

Many authors evolved further Knight’s ideas, although other approach in mainstream economics prevailed, and A. Alchian and H. Simon were perhaps the most influential of them. Armen Alchian in his famous article *Uncertainty, Evolution and Economic Theory* (Alchian, 1950)⁸ argued that under uncertainty the only goal of any choice is to achieve any positive outcome, not in principle an optimal or maximal one, and strategy is evaluated as a successful one if it leads to positive outcomes (or better outcomes than those resulting from strategies of the others) in a long term. The reason is that individuals are not able to evaluate the outcomes of possible strategies *ex ante* so they have to use trial-and-error behavior or to imitate successful patterns from their environment and which manner will be chosen is mostly question of good luck,

8 Summary of discussions about Alchian’s article and parallels between his and Friedman’s approach can be found in Hodgson (1993, p. 198-199) and Hodgson (1999, chapter Biological Metaphors in Economics from the 1880’s to the 1980’s). In order to make the difference between both approaches clearer Hodgson uses for behavior described by Alchian term “*evolutionary*” *maximizing*, which means long-term effort to achieve satisfactory result, and for Friedman’s view term *optimizing*. As far as Friedman concerns in his view only those agents who continuously maximize would survive, on the other hand Alchian emphasizes that not only maximizers but simply those, who are better according to their competitors. Hodgson also pointed out objections by Edith Penrose against using Darwinism in economics – according to her point of view Darwinism is not appropriate because there’s not anything in economics, which could replace heredity. Nevertheless this problem was also solved by cultural anthropologists who introduced concept of so called *memes*, by culture transmitted information about norms and other behavioral regularities, from which each agent implicitly chooses and further evolves that ones, which he finds useful (Boyd-Richerson, 1985 and 1994).

accident and individual experience. Evolution itself, Alchian argues, doesn't necessary assure convergence to optimal decisions if two conditions are not satisfied – good information feedback, which is easy identifiable by agents, and contracts, which run for a long time without substantial shocks.⁹

Herbert Simon pointed out other aspect than pure uncertainty – as a psychologist he tried to implement most important findings of cognitive psychology into economics explicitly and so according to Simon the main problem with optimization or *as if* optimization was limited cognitive capacity of human mind. He explained that it is far unrealistic to assume that individuals are able to take into account all possible alternatives and he stressed out the importance of heuristics in behavior, high selectivity in searching processes and lack of information. Those limitations of rationality have lead Simon to introducing bounded form of rationality as an opposite to neoclassical fundamental rationality, where the only limits like budget constraint etc. have external character. Thanks to lack of information individuals are forced to use their specific experience and knowledge to solve problems according to their subjective expectations of the outcomes and its probabilities (Simon, 1957) and behavior cannot be evaluated as an optimal according to the outcomes but only if it is conscious and if it has any appropriate reasoning. Additionally Simon suppose the main aim of agents is not necessary achieving the optimal solution but people usually try to satisfy their needs and wants.¹⁰

9 In the eighties Ronald Heiner added to Alchian's arguments, that under strong uncertainty the agents, who don't try to respond optimally but who are willing to limit themselves to a smaller set of possible responses, achieve better outcomes than the others. Thanks to limited cognitive capabilities and uncertainty agents are not able to evaluate and use properly all those actions and according to smaller number of trials for each strategy the probability of undesired outcomes increases (Heiner, 1983). This conclusion is consistent with simulations of strategies in repeated prisoners' dilemma made by Robert Axelrod where the most successful one was the simplest strategy: tit-for-tat (Axelrod, 1986).

10 For example they try to get some positive profit with respect to their costs or to profits of other competitors. To illustrate his concept of satisfying behavior Simon (Simon, 1955) uses the example of real estate man who wants to sell a house with a value let's say \$15,000. And any dollar above this so called aspiration level is satisfactory, any below unsatisfactory. Of course it still holds that \$25,000 is much better than \$16,000 and everyone would prefer the previous one but usually there is a risk that after rejecting this contract the next offer would be lower than that \$16,000 and his profit would

Considerations about cognitive limitations, uncertainty, learning and importance of learning-by-doing, imitation and trial-and-errors behavior are reasons for rule-following approach to human behavior, because experience from various situations and problems push individuals to use successful /satisfactory/ strategies repeatedly, and after several trials routinely, and cognitive capacity is saved for evaluation of new situations. Such routines are according to Simon's work algorithms for more than 90% situations and are changed only if their utilization doesn't bring satisfactory outcomes. It is necessary to emphasize that evaluation of outcomes is very subjective and it is also connected with cognitive boundaries – sometimes some outcomes are evaluated as successful ones although they are not according future development, in that time unavailable information etc., so individuals and firms can use misleading strategies also in long-term.

Empirical research in the direction of problem-solving, decision-making process and creation of strategies made by Simon himself and other authors as well (namely March and Simon, 1958, Newell and Simon, 1972) demonstrated that the *as if* assumption is also untenable, because under strong uncertainty players' actions are not distributed around a single optimal strategy. Rather they are fully differentiated and none of them can be simply considered as a “best one” and this conclusion was also acknowledged by various experiments in experimental economics (Dosi, 1999, Egidi, 1996, Hogarth – Reder, eds. 1986). Others object that using mainstream microeconomics we cannot explain neither why do some firms survive and some don't, nor if their profitability would continue also during next periods.

Simon's view of behavior as a rule-following and of decisions influenced by limited cognitive capacity was extended to analysis of firm and economic change by Richard Nelson and Sidney Winter in their book *An Evolutionary Theory of Economic Change*. They based their theory on routines and tacit knowledge inspired by Michael Polanyi in it. The meaning tacit knowledge can be easily summed up in one sentence “We do more than we can tell.” (Nelson – Winter, 1982) which means that theoretical knowledge itself is useless if there are no practical skills, which often can be acquired only by learning-by-doing. Implication of tacit knowledge is that practical

decrease.

implementation and learning by doing are crucial for success of reuse and imitation of any action or routine. Processes of learning, adaptation and innovations become the highest importance for the theory of the firm and the whole set of routines including managerial skills, technological process, personal management, research and development and many others play a role significant at least as transaction costs and contracts emphasized by the new institutional economics for performance and ability of adaptation of each the firm or industrial sector. Nelson and Winter went so far that they compare the role of routines with genes in biology.¹¹

Mental processes and other aspects of human reasoning were mentioned also by Friedrich Hayek in his today quite forgotten book *The Sensory Order*¹². Hayek (1952) described causes of differences between real world and its reflection in mind – he found that every sensation is a consequence of subjective interpretation of any sensorial sensation and it is based on association with previous experience (that’s the reason why interpretation is subjective and unique for each individual). Resulting mental models are stable nevertheless not strictly invariant and they evolve in time according to continuous evaluation of outcomes of strategies. In this perspective Hayek's view is quite well compatible with Simon’s concepts of bounded rationality and routines¹³.

4. Explaining Persistence of Behavior and Heterogeneity of Agents

In previous part we have mentioned bounded rationality and rule-following behavior as an opposite view to standard neoclassical microeconomics and now we devote our attention to persistence of behavior, routines and the problem of formation and evolution of routines. We have just mentioned that behavior has mostly routinized character and that routines (or strategies) are left if their utilization doesn’t bring

11 Langlois and Robertson (1995) suppose that firm is defined not only through relative costs of production, transaction costs (as in Coase, 1937) and costs of governance (like Williamson, 1985) but in a long-term mostly by routines and capabilities and so they found useful to define dynamic form of transaction costs, costs that arise in real time in the process of acquiring and coordinating productive knowledge.

12 Hayek (1952), this book further re-elaborates main ideas from his article *Economics and Knowledge* (Economica, 1937).

13 Many notes to similarities between Hayek’s and Simon’s view are in (Loasby, 2003).

satisfactory outcomes anymore and, because people are able to anticipate, also if new situation incompatible to an old one is expected. Also we pointed out that usage of routines in most actions saves cognitive capacity for solving of new problems or for dealing with unexpected outcomes of actions, so implicitly we suppose that cognitive capacity is „scarce good” as such, expressed in terms of economics.

The main contribution of cognitive psychology to explanation of process of abandoning old routine, formation of new one, mechanisms of acquiring new knowledge and learning follows: routines are viewed as products of learned and adopted behavior represented by subjective mental models. This means that evolution of behavior corresponds to evolution of routines and as routines are in accordance with agent’s mental models, evolution of routines is followed by change of mental models as well, because the source of change – relevant information - was perceived and represented in particular mental model.

In fact in comparison with economics psychology is much more skeptic to human capabilities and it supposes that changes in mental models, which result in changes in behavior, are very gradual and slow. Realization of any shift of routines is mostly a question of intensity of incentive and its harmony with other aims and motivations. Additionally individuals are often bounded in their capabilities to evaluate if their routines are suitable or not as it was just mentioned in previous section. The idea that agents tend to explain causes of undesired outcomes by coincidence and the like was confirmed by experiments – nice illustration can be found in Egidi (2002). Egidi ran an experiment with two groups of players, who learned to play simple card game with different cards – group A became cards where strategy A was much more successful than strategy B and group B cards where strategy B was favorable although with complete package of cards both strategies lead to win with the same probability. Not very surprisingly this selection of cards had fundamental consequences for strategies developed and used by agents from both groups when both groups played together with complete package of cards, too, since players from group A used much more often strategy A and from B strategy B and this difference was substantial also after 24 iterations. Egidi provided explanation based on adaptive learning and selective perception of events: Players were forced to learn the game on some subset of possible

initial strategies. According to selection of these subsets players from different groups “created” different routines (corresponding to their mental models), because for each group the other initial configuration was considered to be an exception. Nevertheless why there such strong persistence emerged? If individuals are confronted with an “exception” they try to create some more specific rule, but the problem arises, if this new one stays in conflict with the old one. If the number of “exceptions” exceeds some acceptable level, individuals are forced to re-elaborate their strategies but in this case they face to their cognitive boundaries, because they have to find, which part of strategy was wrong.

Cognitive approach leads to an important question – what is then a difference between case-by-case decision making and rule-following behavior based on subjective mental models although if the latter considers a dynamic selection, so this seems to be in accordance with Friedman's defense of neoclassical assumptions. Dosi et al. (1999) found that in general surviving agents use routines, like mark-up pricing or simple imitative behavior, in all environments they have experimented except the simplest ones. Only in very simple cases they observed behavior not far from assumed rational agents would do. Thus the conclusion from their experiments is that the more complex situation and tasks are, the simpler behavioral norms tend to be used and the more relevant information would be omitted. This is very similar conclusion to those of Herbert Simon, Ronald Heiner and others.¹⁴

¹⁴ Dosi et al. (1999) came to these conclusions from series of simulations based on genetic programming. The first simulation was the situation of a single agent in a monopolistic market and other variables were assumed to be stable. In this case the only single equilibrium exists – the one, which maximises its profit. The result was that price rapidly converges to the optimal one. In a modified experiment, where costs and demand are not fixed, the result about optimality was quite the same. Now let's move to more complex situation of oligopolistic markets: first the demand function was stable, unit costs were random variables and the same for both players. For the both, market-leader and market follower, they behave as if they follow simple mark-up rules. In the second scenario the demand function randomly fluctuated, moreover agents changed their strategies also randomly. The result was highly changeable environment where strategies were not proved for long-term facing various reactions of the second player. Despite this strong uncertainty “mark-up type policies still turn out to be the most frequent and most efficient response to environmental uncertainty.” (Dosi et al., 1999) In other simulations with more agents and other modifications rather than Nash-equilibrium cooperation in the “tit-for-tat” sense emerged.

Until now we have shown that behavior can persist despite changing environment because of the nature of routines. Other reasons are connected with the fact, that at the firm-level adaptation (or implementation) of new routine is costly because it requires specific investment into both human and physical capital. And those investments are usually performed under strong uncertainty about future profits resulting from those investments. In addition choice of routine itself creates strong incentives for abidance in it as staying on one routine brings gradual improving in efficiency through learning no matter, if it has been optimal or not. Other reason for persistence of routines is nature of learning process itself – this process is much easier for individual agent than for firm or other organization because individuals don't have to solve problems with coordination etc. However individual agents (and of course organizations as well) are often limited by their readiness to admit that their strategy is not the optimal one according to (perhaps changed, but not only) situation and they tend to explain causes of undesired consequences by coincidence and the like. There is also another cause of limitations for both firms and individuals that bears on shady and chaotic nature of information according to them they judge their behavior.

Nature of the firm as an organization with routinized behavior and tacit knowledge leads to different results in case of economic change than standard microeconomic theory offers: the first concept of representative firm is rejected because each the firm has its specific experience and routines of production, management, marketing and research and development, the second external change is not described with costless shift to a new equilibrium anymore but it is viewed as a complex process of adaptation with respect to firm- and branch-specific conditions. Those “evolutionary” analyzes are mostly based on case studies, on models of diffusion of innovations and induced innovation approaches as economics of innovation does or on empirical studies¹⁵.

15 More on this topic and some examples can be found in Loasby (2002). Brian Loasby quoting many classical works by Alfred Marshall (*Industry and Trade*, 1919), Edith Penrose (*The Theory of Growth of the Firm*, 1959), Richard Cyert and James March (*A Behavioral Theory of the Firm*, 1992) emphasizes the role of switching costs for explanation of different market structures in various branches and limitations of choice in organizations. Similar statements are in Langlois – Robertson (1995). Richard Langlois and Paul Robertson explain the nature of firm strategies – although strategies decisions affect the entire firm they are made by the top level firm or divisional managers, so with respect to firm routines we should not omit that decisions in organizations are made by the

Such adaptation is everything else than instantaneous and usually possibilities for shifting to a new routine are constrained in a short-term by various reasons like long-term contracts (but they slightly increase in a long-term). External change also increases fundamental uncertainty; these results into higher probability of false interpretation of information and investments into adaptation became more risky because of high uncertainty about expected gains from available alternatives. In this case decision-making process seems to be very subjective and it depends on experience and knowledge of each the firm and now history matters. So it is reasonable to expect that investments into adaptation would differ – differences between all firms would increase with respect to the level of uncertainty – and now there's a crucial question if there would be any convergence in realized actions in consequence of natural selection, imitation and so on. The answer is not trivial and further empirical research mostly based on case studies is needed in order to build consistent theoretical framework and to find determinants of convergence to one or few patterns.

5. Learning in Economics and in Psychology

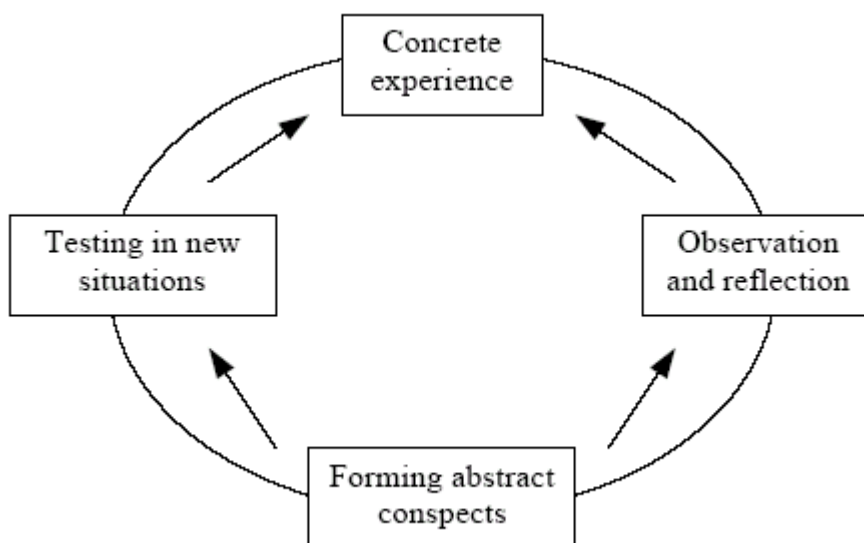
The basic statement from previous sections is that routines are changed if the old ones lead to unsatisfactory results or if they are evaluated as incompatible with expected problems. Then, expecting change in external environment, agent has basically two possibilities, either he use routine, which is similar or identical to one stored in his mind, or he interprets it as a new problem and forms a new routine. However how is new routine formed? New routine is acquired through learning process, which is usually conscious. Nature of learning and various approaches to it are

people with all their cognitive limitations etc. and that these decisions affect the firm at least in the same proportion as organizational structure, learned routines, resistance to change etc. So psychology is applicable also for evolution of firms, for explanation of decisions of managers. They also decide in uncertain environment, sometimes they have to implement untried production process with usage of specific skills and knowledge, which is often tacit. By the way unchanged perfect markets, identical access to research and financial approximation are simply a fiction which cannot be found in any textbook of management, there are many pages about how to cope with changes, how to decrease level of uncertainty, how to introduce a new product on a new market etc. Sometimes it does matter, sometimes it does not.

discussed in this section.

Economists often deal with simple mechanic learning-by-doing, learning and this kind of learning can be easy modeled, however it is quite difficult to deal with creativity, qualitative change of routines and changes from one behavioral regularity to another one, let's say because the former was inappropriate to current situation. Psychological definition of learning is much broader: Learning is the process of acquiring knowledge, skills, attitudes, or values, through study, experience, or teaching, that causes a change of behavior that is persistent and allows an individual to formulate a new mental model (or revise a prior one). Such process depends on experience and acquired information. There are several approaches to learning in psychology, one of the leading and still used is the theory of experiential learning by David Kolb (Kolb – Fry 1975), who identified four elements of learning – concrete experience (which could be a parallel to learning-by-doing), observation and reflection of that experience, formation of abstract concepts based upon the reflection, active experimentation (trial-error process) or, alternatively, testing in new situations. Learning is viewed as a mixture of all these elements and it can begin with any of them. Scheme of experimental learning is depicted in Figure 5.1.

Figure 5.1. Experimental learning



Cognitive theory of learning concerns the question how knowledge and skills are modified through its use and how problem-solving activity leads to new behavioral regularity. This theory was synthesized by Holland et al. (1986) and following its interpretation by Mantzavinos (2001, ch. 3.2.) it can be summarized into subsequent aspects.

- People perceive and learn only if they face some problems, which need to be solved, so learning is in fact pragmatic behavior.
- Elementary units of knowledge are simple rules with condition-action rule, this means rule „IF such-and-such, THEN so-and-so”. *„Action can be then conceptualized in terms of three steps – matching facts against rules to determine which rules have their conditions satisfied; selecting a subset of rules to be executed and living the selected rules to take specific actions.”* (Holland et al. 1986, p. 15). Rules and conditions usually don't have one-to one representation, more likely more parallel rules exist.
- The mind is viewed as a system of classification, it is interpretative structure of perceived real world build from subjective mental models.
- Rules are often activated together, because if using simultaneously different rules are associated to themselves and they build clusters of rules associated to particular conditions. Rules and clusters are organized into default hierarchies according to „subordinate or superordinate relations among concepts” (Ibid.).¹⁶
- Existence of more parallel rules implies competition among them and consequent selection¹⁷. Such selection is of dynamic nature and depends on feedback from the environment.
- Problem solutions are stored and became unconscious so routines emerge. Important is that stored knowledge has often knowing-how and not only knowing-that nature.

16 This means that some rules are more specific and some very general and it depends on a situation, the problem to be solved, which one will be used.

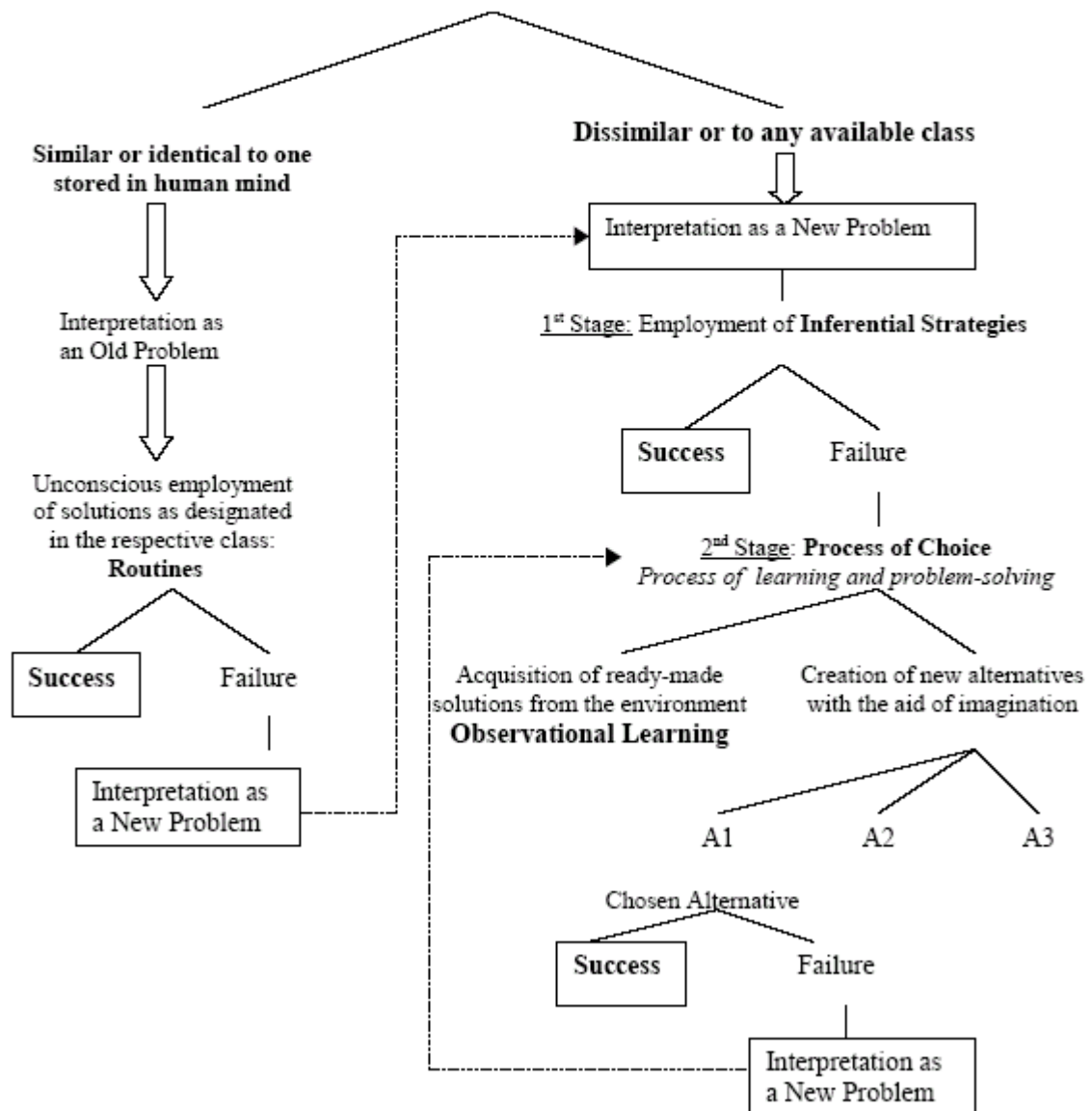
17 Holland et al. (1986, p. 49 ff.) give four main selection criteria: „match” to given situations, it was „strength”-ened through positive history of usage, „specificity” and it must be „support”-ed by other currently used rules.

Figure 5.2. Cognitive Perspective on Learning

Situation: changed environment and expected or just realized decrease of utility and profit.

⇒ Forming Mental Models of the Problem Space

(Perception – Interpretation of new situation. Re-elaboration and representation of information. Association with current mental models)



Source: Mantzavinos 2004, modified by J.B.

Cognitive perspective is summarized in Figure 5.2. The problem to be solved is a change in the environment, which could lead to decrease of utility in case of individual or profit in case of firm. Agents then interpret new situation and form a mental model of the new problem, the new situation is also confronted with existing classes stored in mind. Consequently either one of old routines is applied or a new one is formed, process of formation of new routine will be described further. If chosen alternative is confirmed, so evaluated as a „success”, it is stored and further employed.

Alternative but with this cognitive approach well compatible theory of social cognitive learning was developed by Albert Bandura (1975). He describes different types of learning in a situation, in which existing behavioral regularity became inadequate and new one must be formed. As we will see his theory is based on cognitive aspects of problem solving, but using this framework we will be able to explore impact of other agents on agent's behavior.

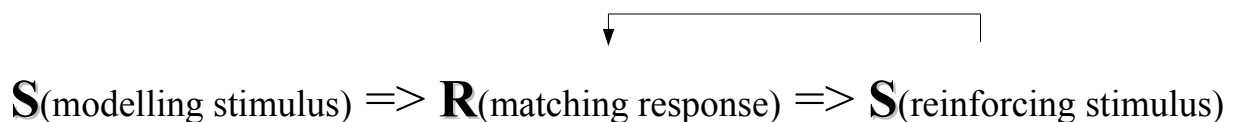
So, assume an agent who knows that his routine must be changed unless his income would decrease below satisfactory level. In fact agent got impulse, so called stimulus, from his environment.¹⁸ With respect to persistence of behavior and reactions to stimuli we can (following Bandura, 1975) distinguish two basic kinds of learning – first on trial-error based learning by response consequences and second social cognitive learning, (alternatively learning through symbolic modeling or observational learning), which means acquiring new knowledge or skill through observation and imitation of other agents in similar situations, corresponding to cognitive psychology.

Mechanism of learning by response consequences (depicted on Figure 5.2.) emphasize the role of direct experience and it results from positive and negative effects that actions produce. Successful, those with better outcome than others, are selected

¹⁸ For our purposes we can omit objections of many psychologists, who suppose that we cannot simply assume stimuli as the main motivational factor, because such viewpoint does not take into account enormous complexity of human mind, interdependence between „person” and „environment” etc. To put the relation between behavior (B), person (P) and environment (E) more precisely, behavior can be seen as function of two exogenous variables P and E ($\Rightarrow B=f(P,E)$) or we can allow complex and endogenous co-evolution such that we will get complex relationship $B=f(P\leftrightarrow E)$, where behavior stands for interacting determinant, not simply as an outcome of person -situation interaction. Bandura (1975, p. 10).

and inferior abandoned. First stimulus (incentive from the environment is modeled, this means that agent acquires an information and evaluates outcomes of possible alternatives. Then second stage, called matching response, takes a place in which some of evaluated actions is applied. Finally reinforcing stimulus transmits information if that action lead to success or failure to agent and responses corresponding to the models' actions are positively reinforced and thanks to it also re-used, however divergent responses are either unrewarded or punished.

Figure 5.3. Learning by response consequences



Source: Bandura (1975, p. 38)

Reinforcement theories are useful for regulation of behavior that has already been learned, but it is a relatively inefficient way of creating them. In fact process of formation of new behavioral regularity remains unexplained. However approach of social learning and cognitive psychology says that people do not rely solely on the effects of their own actions and substantial part of behavior is acquired observationally through modelling actions of others – observation helps to form an idea how some kind of behavior is being performed and such information is coded and stored for later occasions. So it is reasonable to ask, what are conditions and determinants of successful imitation, how mechanism of social learning looks like in comparison with learning by response consequences and in which situations observational learning prevails.¹⁹

¹⁹ Albert Bandura, founder of the social cognitive learning theory, defined social cognitive learning against simplistic behaviorism and also against holistic approaches which assume human behavior to be determined only by the society and environment: „*Social cognitive learning approaches the explanation of human behavior in terms of continuous reciprocal interaction between cognitive, behavioral and environmental determinants. Within the process of reciprocal determinism lies the opportunity for people to influence their density as well as the limits of self-direction. This*

Bandura (1975, p. 22-29) identified four components required for modeling (imitation) of behavior of somebody else:

- Attention, as an agent must first observe and perceive actions of others. Those attentional processes are strongly shaped by social network, simply by group of individuals, in which agents live. This means actions of firms depend on actions of other firms, competitors etc. and in fact there is only minority of new firms who explore some completely new way how to do something. Experience and communication influence what will be observed, then really perceived, re-elaborated, stored and used in the future.
- Retention of actions is a second condition. Agents try to understand and remember, what the imitated agent does, and to include as much details as possible. Retention processes consist from three main part: symbolic coding (highlighting essential components of imitated actions and their representation with abstract symbols), cognitive organization (association with current mental models and previous experience) and finally rehearsal, both symbolic and motor, in which learning-by-doing and gradual improvements take a place.
- Motor reproduction process and real replication of behavior is a following stage of imitation, which is constrained by physical capabilities, quality of self-observation and accurate feedback.
- Motivational processes and opportunities are also essential part of imitation, because the observer must be motivated to carry out the action he has observed and remembered, thanks to external or internal reinforcement in order to fulfill subjective criteria of income or whatever. Necessarily he must have an opportunity to do this.

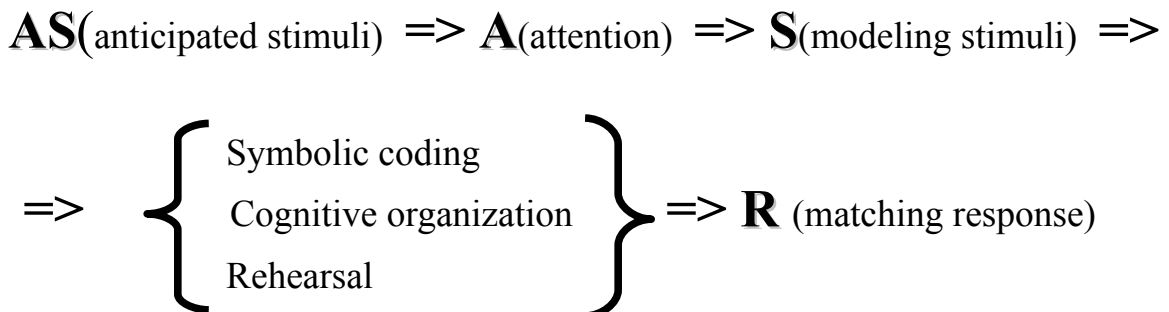
In comparison to learning by response consequences social cognitive learning suppose that behavior of others comes to the function as a cue for matching process. Furthermore according to social learning view, observational learning occurs through symbolic processes during exposure to modeled activities in advance to any responses,

conception of human functioning then neither costs people into the role of powerless objects controlled by environmental forces nor free agents who can become whatever they choose. Both people and their environment are reciprocal determinants of each other..” (Bandura, 1975, p. x).

so it need not to rely on extrinsic reinforcement. So different stimulus have not to lead to abrupt change of behavior if it was anticipated, on the other hand some stimuli can left behavior unchanged as agents do not observe it and also that stimulus must be first perceived and second re-elaborated by agent in order to change behavior correspondingly.

The social cognitive learning theory explains learning leading to behavioral change starting with anticipation of stimuli thanks to information or active observation in advance about costs and benefits of acquiring new model, so it is not only passive waiting until imitation spontaneously emerges. Anticipation of stimuli is then followed with stage of attention and consequent modeling stimuli. Then cognitive processes are used as stimuli are coded into symbols, associated with existing mental models and new behavior is rehearsed. Finally after matching response and reinforcement new behavioral regularity emerges. Nevertheless here reinforcement plays slightly another role, it has mainly antecedent influence as also reinforcement is anticipated, because what is rewarded or punished and how much determines what will be modeled and what goes unnoticed. This implies that in social learning theory reinforcement is considered more as a facilitate condition rather than necessary one (Bandura, 1975, p. 37) Change of behavior through learning from social learning perspective is summarized in a figure 5.4.

Figure 5.4. Social cognitive learning



Source: Bandura (1975, p. 38)

Now we have two alternative approaches to learning, but which one to choose? Trial-error or observing others and wait-and-see strategies? The later prevails in case at risk-averse population and is more common in situations where costs of possible mistakes are too high (Bandura, 1975, p. 10). So learning depends not only on economic environment but also on social environment, on experience and knowledge how to find what is important and what is not and so learning processes are highly path dependent and everything else than instantaneous. Such knowledge and experience necessarily differ through population as well as available set of information and this leads to divergence in behavioral regularities. If consequent process of adaptation through imitation and learning leads to convergence is not clear and we suppose that no universal law exists.

6. Diffusion of New Behavioral Regularity.

So far the discussion has been concerned mainly with learning and behavior at the individual level and now we turn to the problem of how new ideas, social practices or behavioral regularities are spread within society from one agent to another one. In fact successful diffusion of innovation²⁰ follows usually a common pattern as a new behavior is introduced by prominent examples and then adopted at accelerating rate by other agents, followers. After some time either stabilization occurs or new idea is declined upon its functional value.

The general pattern of diffusion is similar, but the mode of transmission is slightly different and it consists from two parts, first acquisition of innovative behavior takes a place and adoption in practice follows. During the stage of acquisition modelling plays important role in spreading new ideas and social practices within a society or from one society to another. In this stage new knowledge and information about possible benefits are acquired and modeling directly instructs people in new styles behavior through social, verbal or pictorial display. Consequently some agents change their patterns and further modeling of expected benefits accelerate diffusion by weakening the restraints of the more cautious potential adopters. At this point personal interactions influences

²⁰ It is important to note that innovation does not represent only technological or commercial change but also new behavioral regularity (Bandura, 1975, Budzinski, 2003, Henrich 2001)

diffusion of information about novelty through existing networks of interpersonal communication. During the second stage initial reluctance of most agents is either overwhelmed and change in their attitudes occurs or effects of adoption are not persuasive enough and spread of innovation stops. Reinforcement plays here specific role as benefits cannot be experienced until new practices are tried and adoption of innovation depends on anticipated and vicarious enforcement rather than on direct one (Bandura 1975, p. 52).

Presented nature of diffusion process implies substantial heterogeneity of agents, Bandura itself, following Rogers (1995), explicitly deals with this structure of agents: innovators – first adopters – later adopters and laggards and assumes it to be a general structure (Bandura, 1975, p. 53). Differences among agents are in this approach natural consequence of differences in different experience of agents according to social group, branch and country-specific development and of different human qualities. Also behavior of other agents in their social network influence which stimuli would be perceived and re-elaborated, the same effect has corporate culture etc.

Perhaps the main implication for economics resulting from social learning theory and other psychological insights into economics is that the concept of representative firm is sometimes inappropriate and too restrictive assumption, which could lead to unrealistic predictions. However using this approach we don't have any problem with persistent differences in corporate governance models, ownership structure at the firm-level and different goals and methods of managers. Also it is natural to assume that convergence to one, the most efficient pattern is neither automatic and nor desirable thanks to different conditions. Obviously this does not mean that convergence cannot happen and that we must abandon the whole concept of representative consumer and firm, for many purposes these concepts are good enough to provide valuable predictions.

7. Explaining Nature of Institutions - From Shared Mental Models to Institutions

Learning of individual as described before can be viewed as a process of reinterpretation of current mental models. On the other hand learning at the societal level was described as a diffusion of new behavioral regularities in the society and we found that transmission of new knowledge depends on information acquired either by personal experience or observation of others and communication. Reasonably communication and observation lead partly and incompletely to a compatibility of mental models of individuals from the same sociocultural environment. Still each person evaluates new situations individually and subjectively but common knowledge emerges and leads to analogous mental models in decisive part of the group. Shared knowledge then turns into shared mental and those further influence behavior of those agents (Denzau-North, 1994), because the more shared mental models are formed, the more homogeneous cognitive processes such as attention and interpretation and resulting behavior will be.

Set of shared mental models leads to institutional set of the society, to culture, in E. Taylor's words "complex of knowledge, belief, art, moral, norms and other capabilities and habits adopted by individual as a member of community" (Taylor, 1871). This definition of culture contains one important feature – it is adopted through imitation, experience and learning and it is highly insufficient if it is only written in books. Cultural anthropology calls such process of „learning culture“ cultural transmission process²¹.

In this perspective it seems to be far unrealistic to suppose that individuals behave strictly autonomously as microeconomic theory assumes. It doesn't mean we should reject methodological individualism as a whole because agents are still autonomous in their decision-making processes in that sense they often have to decide themselves and nobody can do that instead of them, nevertheless some impact of external environment

21 Boyd and Richerson (1985, 1994) described not only cultural evolution, but they explored also effects of biological and cultural evolution to each other, they called their model as „dual inheritance model“.

is key assumption if we want to study micro effects of institutions and norms²².

Here we consider the notion institutions in a very broad meaning in the same way as D. North does: “Institutions include any form of constraint that human beings devise to shape human interaction.” (North, 1990, p.4) Those constraints help to reduce uncertainty in everyday life insomuch that they define and constrain individual’s choice. This simplifies anticipation behavior of other agents and directly reduces transaction costs in the economy. Importance of stability of institutional framework results from this approach because uncertainty couldn’t be reduced in turbulent environment. Hence stability of institutions is more important for economic development and growth than their one hundred percent efficiency.

Institutions are usually derived into formal and informal institutions according to their form and type of enforcement, formal ones are laws or other written norms, which arise usually from political process, and informal ones are set of norms, habits, traditions, common knowledge and so on, simply building blocks of culture²³. As North and others noted (North, 1990, chapter 5) informal institutions are much more important than the formal ones, which of course also form behavior but we should stress that it is more implicit and indirect process than explicit learning of formal rules and behavior in accordance with them. Jurisprudence calls this behavior *secundum legem* – in accordance with (written) law, although most of us don’t know exactly what is written in any legal code. More important thing for everyday use is moral and the main importance of written law stays in judging of conflict situations among interests of more individuals. It can be seen from various examples from history and from societies living in a peace without any written law like aboriginal tribes that informal institutions are important in itself.²⁴

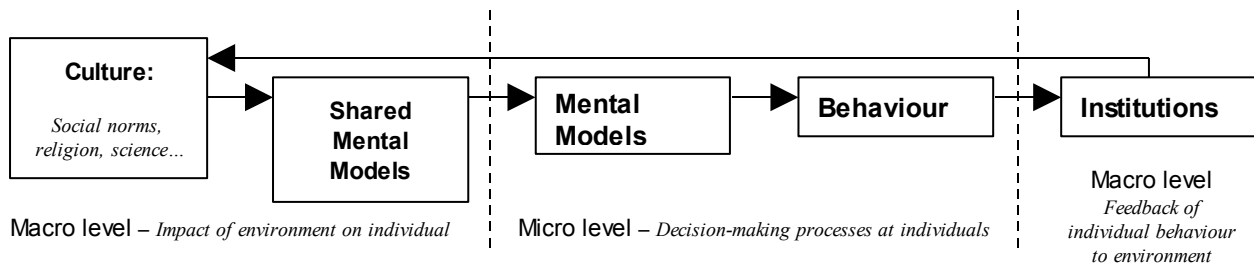
22 Extensive discussion about methodological individualism and its relation to institutional economics can be found in Rutherford, 1994.

23 Broader and more extensive discussion about various types of institutions can be found elsewhere, see for example Budzinski (2003) for more detailed discussion. Budzinski as other authors from German-speaking universities highly appreciated distinction between external and internal institutions with respect to the type of enforcement, which can be either internal to human mind or to social group or external from state authority, framework developed by Ludwig Lachmann (1963).

24 D. North in his book (1990) provides various examples illustrating this argumentation.

As far as mental models and resulting behavior are at individual micro level, institutions are consequences of shared mental models and thanks to this we can consider institutions as consequences of behavior of all agents observed at the level of the whole society. Mechanisms influencing individual behavior and mutual feedbacks can be seen in Figure 6.1.:

Figure 7.1. Mechanisms influencing individual behaviour



Source: Stahl (1998), modified by author

However difference between formal and informal institutions concerns also mechanisms of their formation and evolution as well. Formal institutions are product of political process while informal ones are result of evolutionary process as consequences of shared mental models. In fact we can abstract from this difference if and only if formal institutions were codification of existing informal institutions in order to lower transaction costs by unifying and clarifying it. Unfortunately situation is usually slightly different and various interest groups, who want to secure or improve their position, often influence process of adoption of formal institutions and analysis of formal institution should take rent seeking and state capture reality into account²⁵.

The indivisible part of institutional framework is enforcement of institutions. The situation is clear at formal institutions, because the state authority at least should be able to guarantee abidance by laws, but as we could see in transition countries in previous decade it is not self-evident. Differentiated will enforce some norms and some doesn't depend on attitude of decisive part of the society to that norm which could be either *rule-harmony* or *rule-conflict* (Budzinski, 2003).

²⁵ Mantzavinos et al. (2004) go much further and they explicitly decline any possibility of similar approach: „*Informal institutions are product internally, that is they are endogenous to the community. By comparison formal institutions are imposed externally to the community as the exogenous product of political process.*”

Harmonic relationship between informal and formal institutions occurs if individuals intuitively consider existing formal institutions as correct no matter if thanks to education and process of socialization or thanks to adjustment of individual preferences to social norms and written legal rules. Rule-harmony by itself leads to integration of institutions and own cognitive theories of individual into one entity and institution become important for him not only because there's some enforcement and potential punishment but because he finds it simply beneficial.

According to these considerations it is natural to expect that enforcement would be without substantial complications since all individuals would find violation of rule as their own endangerment and legal enforcement would be followed by social ostracism. However it doesn't mean that organized enforcement would be redundant, because continuous violations of norm also by few individuals can cause erosion of that norm and increase pressure to its abandonment.

In case of rule-conflict relationship institution is found as a "bad" one for most members of the society. In fact such conflict can arise only if unexpected change of the environment, which influences preferences of most people or leads to erosion of persistent norms, or on the other hand at formal rules, which don't codify common law and shared norms but which arise in political process under influence of rent-seeking activities and corruption. Results can be either continuous violation or increased effort to change that rule and process of institutional change would occur although sometimes this could take place only after external shock which push decisive part to change its behavior like revolution and the like. If important part of the society abandon this rule and others follow social enforcement mechanisms erode and social consensus is lost. Now enforcement loses its functionality and sometimes legitimacy as well, this would be also the same in case of formal institutions where enforcement cease to insist on social consensus. The next sections are devoted to more detailed and systematic description of process and various approaches to institutional change.

8. Explaining Institutional Change - Mechanisms of Institutional Change

There were various trials to provide explanation of institutional change in economics. Some of them were based on presumption of existence of path dependency and increasing returns, others reflected findings of experimental economics with methodological background in bounded rationality or institutions and their change were explained in terms of cooperative game theory. With respect to our main interest, behavior and institutional change, we will first follow and discuss view by North (1990) and we discuss possible parallel with technological change, second we will show that such parallel is possible namely with diffusion of innovation and contagion models.

Over time agents change their behavior as they gradually adjust themselves to changes in their environment. Such changes of behavior can be divided into two basic groups – the first is change of behavior within institutional framework, those changes outweigh and in most cases it concerns continuous adjustment to given rules and norms; the second group consists from changes of institutional framework itself caused by change in relative prices (which shape incentives for behavior defining benefits and losses of alternative actions, methods and technologies) or by change in preferences. Consequently bargaining positions change and it leads to changes of current economic and political contracts.

It is natural to ask when such change of relative prices or preferences leads to institutional change and when it only creates incentives for renegotiation of contracts within existing rules. Douglass North solved this problem with theoretical construction of institutional equilibrium – state in which given bargaining positions of the each agent and given set of contracts none of the agents finds it advantageous to devote resources into restructuring them. It doesn't mean that everybody is happy with existing rules and contracts, but only that the relative costs and benefits of running that game doesn't make it beneficial (North, 1990, p. 86). Relative costs of bargaining are often prohibitive and so immune to small changes of relative prices²⁶ and thanks to it

²⁶ Causes of costly changes stem from the nature of collective bargaining, in free-rider phenomenon – see (Olson, 1965) for details, basically such problems can be described as results of inequality

often only substantial change of the environment can lead to shift of one rule to another as it was just described at the end of previous section.

However institutional change doesn't run only in this gradual way and from time to time discontinuous change occurs, in which whole set of institutions is re-evaluated and changed, mostly because of war, revolution, natural catastrophe etc. Reasons for that are various: institutional framework doesn't offer enough flexibility for bargaining or institutions, which could help to achieve compromise, don't exist at all, the next possibility is an existence of broad consensus about change of institutions and several groups are able to cooperate in order to achieve that goal. Necessity of forming coalitions leads to compromises among those groups and this contributes to decrease intensity and deepness of the whole change. The next factor, which limits complexity of change, is impossibility of liquidation of all administrative and executive agencies from previous regime (or any organizational structure at all) just because new leaders only seldom dispose of other people, which could execute all administration.²⁷

Due to discontinuous change structure of formal institutions rule-conflict between formal and informal institutions can easily occur, because there was no time for evolutionary process of mutual adjustment and for achieving harmony, so enforcement of new formal institutions is more difficult as these have no support in their informal counterparts. The same holds for informal institutions since also social structure has changed, norms and moral are no more supported by formal rules. Hence directly after change of formal rules stage of consolidation turns up until rule-harmony is restored. Established new order will be probably far from ideal spontaneous order, in which all contracts last for ages and any agent has its reputation based on long-term experience of his counterparts with him, and temporarily behavior of all agents will embody

between costs of bargaining, which are paid by group of active agents, and profits, which are distributed equally between all agents. The second reason is mutual cohesion of rules and their hierarchical structures, when a change of superior rule is much costly than of the secondary one

27 Impossibility of such practice was experimentally proved by the U.S. administration in their zone in Germany after the Second World War – first they in order to denazify German administration fired all employees with any suspicion of cooperation with Nazi regime. Results were gloomy: chaos, problems with food-supply, overloading of the rest of state administration and so on and during 1948 this program of large denazification was abandoned (Hájková, 2000).

typical features of both systems as agents will gradually adjust it to new conditions.

Process of adaptation means shift from one routine to another compatible with new system or in other words to routine, which would lead to better outcomes. We showed that behavior of both individuals and organizations has mostly rule-following nature and we pointed out that case-by-case decision is used either in well structured situations under certainty or if agents are confronted with substantial change in their environment and current routines don't lead to satisfactory outcomes. Evidently although we didn't point it out explicitly case-by-case decisions are used also if individuals expect correctly that following situations are completely new and that they should develop new way in which they would solve it. Nevertheless such process of forming expectations and developing new routine is often routinized, too and individuals and organizations face to their cognitive boundaries and capabilities to change their behavior. The latter refers more to organizations because such change of behavior sometimes goes together with change of organizational structure and new investments into both physical and human capital. As Peter Murell (1992) emphasized searching and evaluating of alternatives depends on acquired information and knowledge from the past so in fact searching process is not choice of many alternatives but path dependent process in which similar alternatives to existing ones are detected and proved.

If institutional framework was changed (or any substantial economic change like financial collapse of the most important business partner, no matter if firm or country, occurs) agents are forced to change their mental models and correspondingly routines as well and they have to do so under strong uncertainty and imperfect information. Arguably not all agents will react in the same way, more probably various approaches will be tried according to specific knowledge of each one like exclusive information, good luck or better business partners. Gradually alternative actions are evaluated, imitated and inferior ones eliminated through natural selection. However such process of natural selection runs not only through alternative routines but also through firms and those, whose adaptation is too slow, are eliminated.

9. Parallel with technological change

The problem of choice of new routine can be likened to technological progress and choice of new technology. Paul David (1975, p. 4) described mechanism of decision about new technology this way: Over time firm has to decide with respect to two time horizons simultaneously – in short-term mostly what and how many to produce and in long-term how to do that, it means which technology should be bought and used. Here firm looks at relative price of factors of production and their expected evolution in the future. So diffusion of innovations needn't be seen as way how to achieve higher profits than competitors have by saving some costs but more as a reflection of changes in distribution of production among technologies, where each of them was deliberately chosen by member of heterogeneous population of firms, who mostly in a moment decisive for purchase didn't know, which technology will become dominant. Such approach can be easily applied to routines of both individuals and firms – under strong uncertainty routines are chosen according to their expected utility in a future and then it will be continuously evaluated if satisfactory results were achieved.

But is such approach applicable also to the evolution of institutions? If we understand institutions as it was described in section two so as consequences of shared mental models seen from macro-level, then change of institution can be described as gradual substitution of one institution by another after the main part of society adopted new mental model and new shared mental model emerged.²⁸ Speed of adaptation process depends on available information, capabilities of agents to re-elaborate the most important and most relevant of them, level of uncertainty, structure of organization etc. Together with nature of rule-following behavior and difficulties with learning those factors lead to persistence of old routines and institutions in changed environment and to dependence of new emerged institutions on old ones, known as path dependence.

Path dependent behavior was in economics first described at technologies²⁹ and it has two basic forms, first weak path dependency, which doesn't mean anything else

28 North (1990, p. 94), Rizzello (1997, p. 116) and others admit such analogy without any problems, several objections to it are in Kiwit-Voigt (1995) and also in Voigt (2002).

29 Path dependency was first introduced by Paul David (1985).

than that past events have some impact on nowadays and future ones, and second strong form, which suppose that there is fixed relationship between past and future, in other words that some event in the past shaped future development and current development is constrained by them (Rizzello, 1997, p. 100).

In a most extreme position path dependency means casual dependence and is connected with lock-in problem, that development can lead to second-best or inferior standard, which is after quite impossible to surpass and shift to an optimal one thanks to technical interrelatedness, returns of scale and quasi-irreversibility of investments, which stays in high costs of learning and acquiring new knowledge (David, 1985, p. 334). Brian Arthur who concerned on increasing returns problem developed similar approach and together with Paul David he stress the difference between ergodic world, in which only one equilibrium exists and development converge to it no matter which way is taken, and its counterpart unergodic world, in which there are many equilibrium and convergence to one of them depends on chosen methods and paths. And if the system isn't concussed by external shock shift to other way is not possible (David, 1994, p. 208). Arthur (1988, p. 10; extensive citation in North, 1990, p. 93-95) illustrates such case on example of two firms and each of them has chosen different technology. Now suppose unexpected progress in one of them returns of this technology increase and one firm become monopolist on the market although there could be another successful innovation in the future, which eventually could change relative costs in those firms and favour the second one. Arthur suppose that this lock-in can happen if there are (i) high fixed or stand-by costs and decreasing marginal costs, (ii) increasing returns thanks to effects of learning, specialization and (iii) coordination (if more competitors use the same standard etc.) or if (iv) agents have adaptive expectations.

Douglass North accepted such approach without objections, applied it to evolution of institutions and explained persistence of inferior or inefficient institutions using this analogy with technologies. His approach is based on transaction costs, and in his view increased returns of coordination, learning under existing institutional framework and high costs of forming and implementing new institution cause that development of institutions is highly path dependent. Explanation, which he gives, comes from the U.S.

history: Adopting of the U.S. Constitution went along with large initial setup costs but after various organizations started to derive benefits from existing rules and to form contracts, which were not available before. Confidence to existence of constitution lowered transaction costs also because consecutive formal rules codified several informal institutions and decreased uncertainty. Then introducing and implementing of one rule increased returns of all consequent rules and increased also whole performance of the economy, because transaction costs were lowered.

However increasing returns of institutions cannot cause persistence of inefficient institutions itself if markets are competitive and transaction costs marginal. If not and in addition information feedback is poor then mental models of individuals don't correspond sufficiently to the reality and so it is reasonable to expect that at least sometimes they won't be able to shift the path to an optimal (or better) one.

But is it relevant to use such analogy with technologies at evolution of institutions and to explain persistence of inefficient institutions as lock-in problem? Daniel Kiwit and Stefan Voigt (1995, p. 130-132) tried to solve this problem evaluating Arthur's criteria with respect to their applicability to institutions: Increased returns from institutions thanks to high fixed costs and decreasing marginal costs if demand increases, so self-reinforcing process can emerge because increase of demand decreases prices and it further increases demand and so on and natural monopoly occurs. Such analogy is not applicable to institutional change as it is because if one institution (no matter if formal or informal) is introduced it simply exists and increase of demand for this institution does not decrease its "marginal costs of production". Nevertheless high fixed and switching costs can really lead to path dependency at institutions and the main source is seen in complementarity of all institutions (and not increasing returns), that several institutions are adopted and implemented under confidence of long existence of another one.³⁰ On the other hand increasing returns can be seen as source of path dependency thanks to effects of learning since different institutional set favour

30 Complementarity of institutions as the main source for path dependency in institutions was also stressed by Paul David (1994, p. 218-219) and it also explains why same formal institutions can have another impact in different environment with different set of informal institutions, see Ackermann (2003, p. 125-130) for nice description of this problem on the case of Mezzogiorno problem (here Ackerman often uses descriptive studies by Robert Putnam).

different skills.³¹ The same result we get also for effects of coordination in the sense that the more people respect and stick on the rules the more advantageous the rule is for them and the more people join it.

In early nineties Stan Liebowitz and Stephen Margolis criticized the idea of path dependency as market failure how it was presented by both P. David and B. Arthur. First in their paper *The Fable of Keys* (Liebowitz – Margolis, 1990) they objected that examples chosen by both authors (keyboard QWERTY and videotape VHS) are not correct illustration to lock-in at inferior standard because both alternatives (DSK keyboard and BETAMAX) had several important disadvantages, which caused they were commercially unsuccessful. Secondly they developed analytical framework for path dependent processes (see Liebowitz – Margolis, 1995) and they identified three levels of path dependency: the first level means simply that current decisions are influenced by previous ones, the second level stands for choices evaluated as optimal ex ante don't seem so ex post and finally the third, pure form of path dependency, which means that agents stay at one path although they now about better alternatives. As far as first level concerns it is connected with almost all choices about investments, which depend on available capital stock accumulated in the past and so on, and it leads to situations in which some choices are constrained in a short-term (we have to note that nobody knows how “short” such “short-term” is). Nevertheless existence of short-term inertia and higher flexibility in long-term or imperfect information as in the second case are not reasons for market failure. On the contrary the third level can be considered as a market failure because it is evident that efficient solution is not achieved. Nevertheless Liebowitz and Margolis objected there is not any example for illustration of such case.

Liebowitz and Margolis are surely right with respect to cases used by David and Arthur however their arguments suffer from some deficiency, too. They simply didn't take into account height of costs of shifting from one path to another that could be prohibitive – if costs for necessary investments are to high that they temporarily exceed expected profit, then accessibility of financial resources plays crucial role. So it can

31 North (1990, p. 77-78) illustrates effects of learning on the case of society, which favours piracy, and other one, which favours individual entrepreneurship and private property is something inviolable.

easy happen that external change could lead to downfall of firms which cannot react as it happened in former GDR after monetary unification, when those firms didn't have any relevant financial history, enormously increased wage costs and lost markets in former Comecon. Path dependency of the third level then occurs in short-term, but this "short-term" can last for ten or more years until process of natural selection (or "complete destruction" and gradual substitution by FDI's or in this case "WGDI's", West German Direct Investments, respectively) takes place and during this time it is really hard to describe firms as profit-maximizing agents. The second objective concerns Liebowitz and Margolis's approach to choice of technology as a deliberate choice of alternatives made by individual agent (especially in their 1995 paper), however original interpretation of path dependent processes was slightly different and they were focused on spreading of innovation, institutional change etc. and these are processes, which are consequences of many individual choices in the whole society seen from macro-level.

Last but not least Liebowitz and Margolis are optimistic about possibility of achieving optimal solution only through market processes.³² Thereat necessary conditions for convergence to such solution are existence of competitive market with negligible transaction costs, efficient feedback and ability to re-elaborate information from market correctly however these are too restrictive assumptions thanks to cognitive boundaries of agents and presumption of low transaction costs. Those conditions are only seldom fulfilled at market choice and at non-market choices like at norms and institutions the situation is even worse, because there is nothing like market with relative prices of institutions or at least not an explicit one. Here transaction costs, problems with bargaining processes and problems with learning and perception namely at social level play crucial role and it is reasonable to expect that third level of path dependency can occur. After all later Liebowitz and Margolis accepted this view, too³³.

32 Ackermann (2003, p. 81) goes in his critics much further than I do as he wrote that Liebowitz and Margolis come from market efficiency ex-ante and also they ex ante suppose that market interaction always leads to transactions, which are ex post as well as optimal evaluated, then they are at untutored terrain of indemonstrable Panglossian assumptions.

33 LIEBOWITZ, S. – MARGOLIS, S. 1997. Why We Write the Title Last: An Overview of Path Dependence. Paper prepared for presentation at George Mason University, 31. 3. 1997. Quoted by

We have provided several arguments why there should be indispensable persistence in institutions, on the other hand this evolutionary approach based on parallel with institutional change and path dependency resulting from increasing returns does not explain mechanism of institutional change at all. Fortunately this does not hold for everything, with respect to previous chapters the idea of evolution of informal institutions as gradual substitution of one institution by another one through diffusion of new behavioral regularity seems to be correct, but we need different approach to it. In order to explain diffusion of norm and internalization of change in environment we will use approach used in social psychology and cultural anthropology so called social cognitive learning.

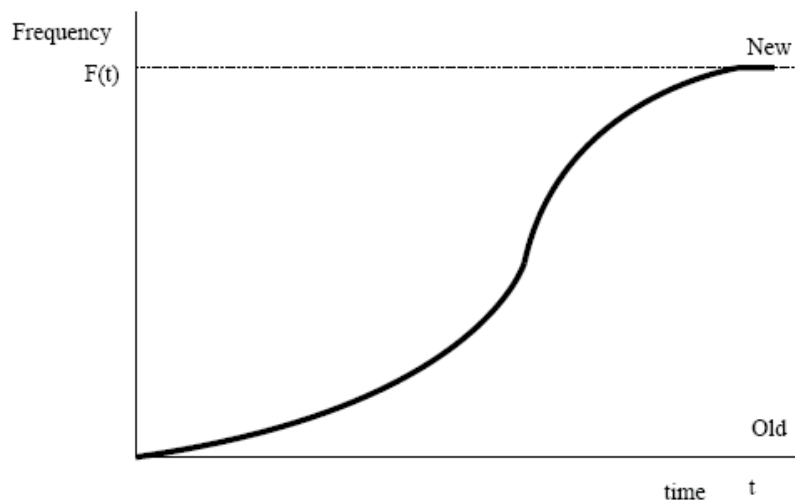
10. Social Cognitive Learning and Rethinking Parallel with Technological Change – Diffusion and Contagion models

Cognitive approach to behavior developed in previous chapters based on rule-following behavior, learning through both own experience and observation of other agents together with interpretation of institutions as a consequence of shared mental models allows us to describe their evolution as diffusion of new behavioral regularity in the society. Success of such diffusion depends on the character of a new one, which can be either in conflict or in harmony to current institutional framework, and on expected profit of adoption. Such expectations are formed upon the own experience of each agent and observed benefits of adoption at those agents, who have already adopted it. Both own cognitive capabilities and social environment (existing interpersonal network of communication) determine perception of information about novelty, agents from social group of „optimists”, let’s say those, whose experience supports hypothesis of positive effect of innovative behavior, will tend to be optimistic as well, the same holds for the opposite situations of „pessimists”. Of course if the new regularity is beneficial enough, adoption of a new rule can be much faster and easier because related information of its advantage spreads rapidly and it is easily recognized and so imitated by other agents.

Ackermann, 2003, p. 82

Such perspective on evolution of informal institutions corresponds well to biased transmission of norms, an approach of cultural anthropology³⁴. Process of biased transmission, at least implicitly, deals with comparison of alternative patterns of behavior and subsequent choice of them (Boyd – Richerson, 1994, p. 81) and from this point of view it can be likened to dynamics of diffusion of innovative technologies as described by Rogers (1995), David (1975) or Jensen (1982) and differences among agents lead to different times of switch from one technology (or behavioral regularity) to the other. Hence the rate of cultural change, the level of agents with changed behavior depends on the variability in the population, and adoption curve is mostly S-shaped. This shape means that first only few agents adopt a new rule, after some other agents change their behavior thanks to observed effect of change and the more people are exposed to it the more the rate of diffusion accelerates until the old rule becomes rare and only few agents insist on the former rule. This means that probability of adoption of a new behavioral regularity or institution is positively correlated with share of group using a new rule or norm on the whole population thanks to social acceptance, effects of coordination and, in case of innovation, forces of competition (Figure 10.1.).

Figure 10.1. Idealized S-shaped adoption curve



34 Boyd and Richerson (1994) deal with two types of transmission of memes (theoretical concept of units of cultural information, similar to genes in biology), unbiased, in which population of descendants has the same proportion of memes as their parents, and as an opposite – biased transmission reflecting that people preferentially adopt some memes rather than others.

Although S-shaped adoption curve was acknowledged by many empirical studies of evolution of innovations there are various approaches explaining reasons, why S-shaped adoption curves prevail and what is the theory behind. The most prominent examples are models of information contagion or sophisticated dynamic models of adoption of innovation in a population of autonomous firms, in which the S-shaped adoption curve is generated thanks to different prior beliefs, and last but not least the models of cultural transmission of knowledge from one generation to another. In this section diffusion as a contagion and dynamic models are introduced and evaluated, models of cultural transmission follow in the next section.

S-shaped adoption curves have been fitted to many available data sets, particularly to adoption of new products (Bass, 1969, 1980), technologies and ideas as a hybrid corn among Iowa farmers in 30's, new governance practices among Fortune 500 companies, novel approaches to teaching of math at secondary schools and so on³⁵. Henrich (2001) noted that S-shaped cumulative distribution function is surprisingly robust result from over 3,000 studies in diffusion of innovation literature. Furthermore such curves are usually right-hand skewed, in other words their inflection point corresponds to lower proportion than 0.5.

The simplest way how to model dynamics resulting into S-shaped adoption curve is contagion model. Suppose that an innovation occurs and it spreads in a population thanks to communication and imitation automatically, simply because people hear about some innovation (or they observe it) from prior adopters and they adopt once they have heard about it. This means that at time $t = 0$ there is a small group of individuals in a population, who heard about innovation from external sources and they adopted them. And then each period people interact and they adopt this novelty with probability α if they meet some of prior adopters³⁶.

Let $q(t)$ denote the frequency of individuals, who adopted the idea by time t and we just noted that $q(0) > 0$. Denote $q(t+1) = q'$, $q(t) = q$. We just sketched how the

35 Many examples in Rogers (1995) and also Aunger (2002).

36 Contagion models are quite common and can be found in many textbook of dynamic systems. The version presented here is the one presented in Young (2005) and Shone (2002), only letters are changed.

dynamics looks like, let's do that more precisely - at time $t+1$ the α -proportion of prior adopters adopts the novelty as well, we suppose that $\alpha \in (0,1)$. Dynamics is described in equation (10.1), the idea behind is simple – in $t+1$ agent i meets randomly with other agent, with probability q he meets someone of the group of prior adopters, with probability $(1-q)$, if agent meet some with novel idea he will adopt with probability α .

$$q' - q = \alpha q(1 - q) \quad (10.1)$$

Equation 10.1 can be rewritten for continuous time, here $\lambda \in (0,1)$ means instantaneous conversion rate:

$$\dot{q} = \lambda q(1 - q) \quad (10.2)$$

This is separable differential equation (with separable variables), which solution is a logistic function

$$q = \frac{1}{1 + ce^{-\lambda t}}, \quad c = -1 + \frac{1}{q(0)} \quad (10.3)$$

Function q is S-shaped and symmetric around $q=0.5$ for every λ^{37} , and it is depicted on figure 10.2.³⁸

A useful generalization was provided by Bass (1969), who introduced information from external sources into the model and this case can be described with following equation, in which λ represents instantaneous conversion rate if information comes from other agents and γ if when the information comes from outside.

$$\dot{q} = \lambda q(1 - q) + \gamma(1 - q) \quad (10.4)$$

We suppose that both λ and γ are positive, so we can obtain solution (10.5), in which β is a positive constant, so called Bass model.

$$q = \frac{1 - \beta \gamma e^{-(\lambda + \gamma)t}}{1 + \beta \gamma e^{-(\lambda + \gamma)t}} \quad (10.5)$$

37 Solution procedure is straightforward and it can be found for example in Shone (2002, p. 50-52).

38 What if new rule will be in rule-conflict to the existing set of rules? We can expect that in this case agents won't adopt it, so λ will be very small or even negative. As a consequence at the beginning some adopt but the process would converge to zero.

Figure 10.2. S-shaped adoption curves generated by contagion for different values of λ

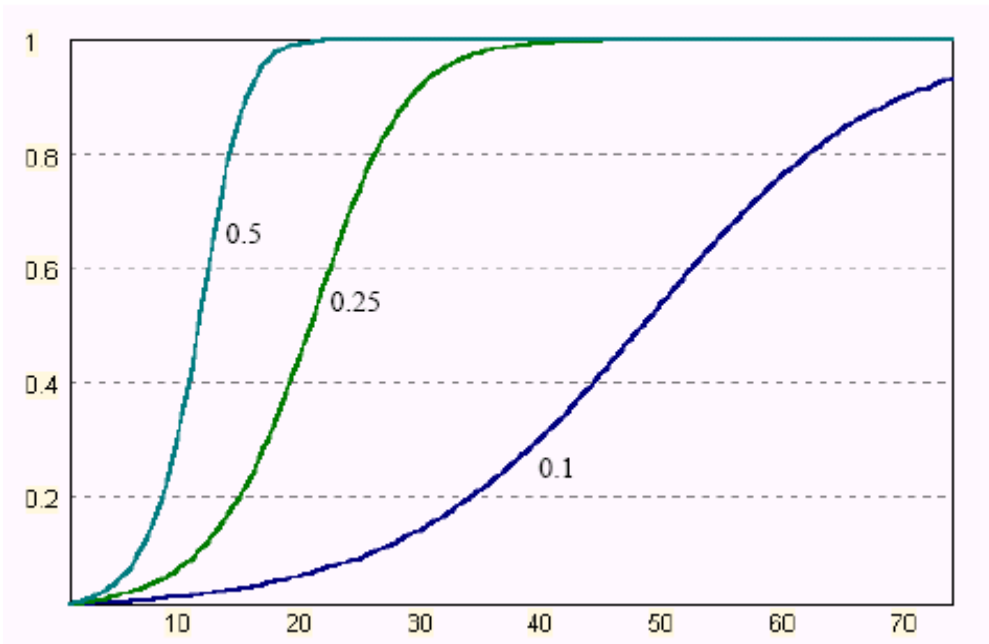
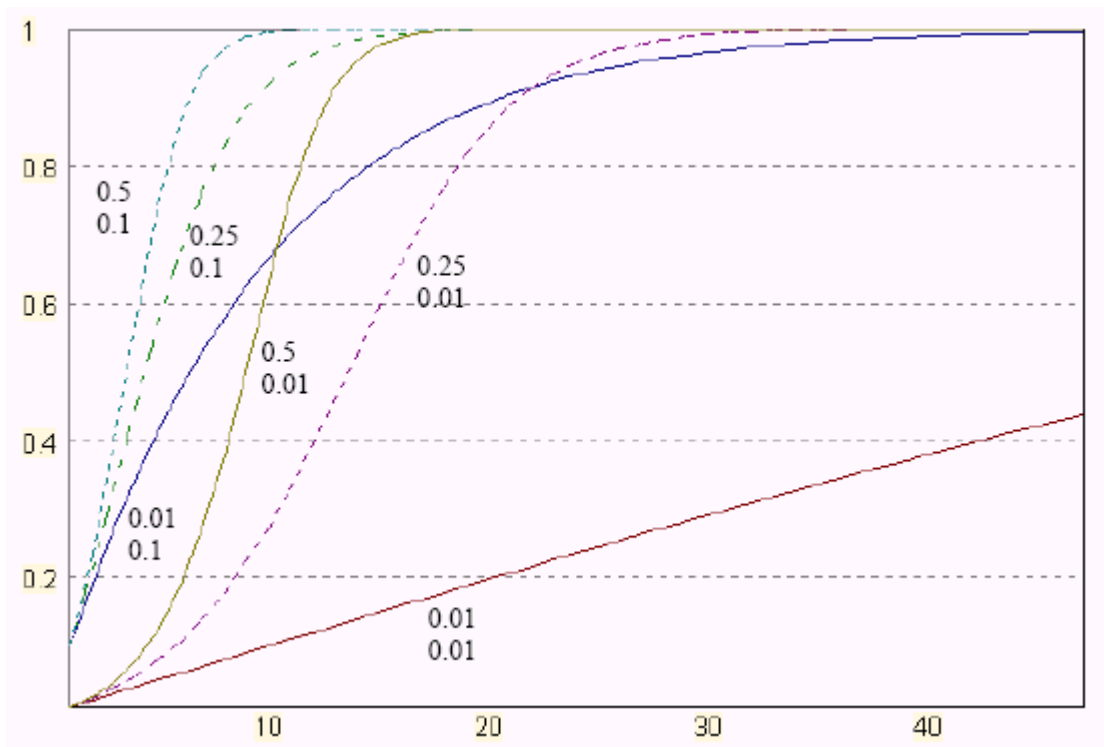


Figure 10.3. S-shaped adoption curves generated by Bass model



Note: Upper number γ , lower λ .

A useful generalization was provided by Bass (1969), who introduced information from external sources into the model and this case can be described with following equation, in which λ represents instantaneous conversion rate if information comes from other agents and γ if when the information comes from outside.

$$\dot{q} = \lambda q(1-q) + \gamma(1-q) \quad (10.4)$$

We suppose that both λ and γ are positive, so we can obtain solution (10.5), in which β is a positive constant, so called Bass model.

$$q = \frac{1 - \beta \gamma e^{-(\lambda+\gamma)t}}{1 + \beta \gamma e^{-(\lambda+\gamma)t}} \quad (10.5)$$

Generated adoption curve is however not S-shaped for every combination of λ and γ , if $\gamma > \lambda$, then impulse from external environment is so high that everyone from the population can observe it and adoption curve is concave (so called R-shaped)³⁹. Otherwise adoption curve remain S-shape, but now it is not symmetric and the concave part prevails – see in figure 10.3.

Such epidemic models are simple, straightforward, can be easily fitted to observed adoption curves, however they cannot explain why some firms decide to adopt an innovation or individual changes its behavior. Today there is a long tradition in sociology to study the diffusion of innovations through their interaction and usually it is assumed that each individual has its own threshold, in fact minimum proportion of population necessary for pushing him to adopt as well. Those thresholds are viewed as different propensity to conformist behavior, sometimes also as reflecting different prior beliefs (Young, 2005). On contrary Richard Jensen (1982, 1983) based his model on individual decision of firms and showed that heterogeneous beliefs in a population of firms lead either to S-shaped or to concave adoption curve.

R. Jensen (1982) started with a population of firms and each of them has to decide

39 Sketch of proof: take derivative of equation 10.4 with respect to q – we want to know if change of q is maximized for $q=0$ (concave) or for $q>0$ (S-shaped), then it is easy to show that change of q is maximized for $q>0$ if and only if $\gamma > \lambda$. The same procedure is applied several times in both section 10 and 11. Special case is if $\lambda = 0$ so only external information matter. This is so called pure inertia model which produces R-shaped adoption curves.

about innovation. At the beginning each firm has its own original belief about possible profits resulting from innovation and each time this belief is updated applying Bayes' rule as firm gets information from its environment about really realized profits. So decision-making process of firm can be now stated as a stopping problem, until the expected profit of innovation increases above the potential benefit of new information and this was formalized into optimal adoption rule. Derived adoption rule was then applied to the population of firms, Jensen supposes that there is a common knowledge of information and that firms differ only in their prior beliefs and just those differences lead to different times of adoption. Jensen then showed that generated adoption curve would be either R- or S-shaped depending on the distribution of prior beliefs⁴⁰.

In fact Jensen's model has some too restrictive assumptions like uniform distribution of initial beliefs and also that firm, which does not innovate, exists without any decrease of profits, so there is no strategic advantage of prior adoption⁴¹. Also with respect to our discussion into cognitive limitations it seems not very realistic to assume completely identical individuals who would differ in only one parameter and just by mistake it is parameter of their original beliefs. More likely following Young (2005) we explore explicitly how different thresholds affect dynamics of contagion model⁴². First we enable agents to weigh expected benefits of innovation with observed benefits of prior adopters. We suppose that agents differ in their cognitive abilities so their thresholds will be different, furthermore that they don't know distribution of prior beliefs and they don't have any possibility how to infer payoff information just from the decision of other agents to adopt. Instead and perhaps a little bit inconsistently with our statement about cognitive limitations we suppose that agents are able to observe directly benefits of those, who have just adopted⁴³.

40 Jensen (1982) deal only with uniform distribution. Similar framework was used also in Jensen (1983), the latter model suppose that firm has to choose from two competing innovations with uncertain expected profitability of both. Also here S-shaped „transition” curve is derived, however now each firm can decide repeatedly but it cannot observed others. Then different priors (and zero switching costs) are the only necessary conditions for S-shaped adoption curve. This result holds for various distribution functions.

41 Some issues on strategical choice in Jensen model can be found in Kapur (1994).

42 Following model is simplified version of that one, presented in Young (2005).

43 However H. Peyton Young integrated in his model social learning as well, he supposed that each time

Suppose that each agent has its own critical value θ_i and he is ready to adopt if and only if $h(\alpha, m) \geq \theta_i$. Here h is a real function strictly increasing in both its parameters α (number of adopters in the population) and m (observed average payoff). If population size is fixed at n we can define resistance to adoption r_i (10.6) as the minimum proportion of adopters required by i to want to adopt as well.

$$r_i(m, n) = \inf \{ q \in [0; 1] : h(qn, m) \geq \theta_i \} ,$$

$$r_i(m, n) = \infty \text{ if there is no such } q. \quad (10.6)$$

From definition of r_i follows that agent i first adopts at $t+1$ if condition (10.7) holds.

$$q(t-1) < r_i \leq q(t) \quad (10.7)$$

Let $F(r)$ be a cumulative distribution function of the resistance parameter r in the population. Then we obtain discrete time process $q' = F(q)$. However some inertia can be implemented into this process easily: those, whose $r_i > q(t-1)$, are deciding about changing their behavior and they will do so with probability α in a given period t . Because F is distribution function of r , proportion of these agents is given by $(F(q) - q)$. Now dynamics can be described in terms of discrete variables (10.8) or continuous-time analogy (10.9):

$$q' = \alpha [F(q) - q] + q , \quad (10.8)$$

$$\dot{q} = \lambda [F(q) - q] . \quad (10.9)$$

As before $\lambda > 0$ is instantaneous conversion rate. In order to obtain separable differential equation from (10.9) assume that $F(0) > 0$ and $q(0) = 0$. Then let $b = \min(r, F(r) < r)$ and its implicit solution is

$$\forall x \in (0, b), t = q^{-1}(x) = \frac{1}{\lambda} \int_0^x \frac{dr}{F(r) - r} . \quad (10.10)$$

individual weigh observed average payoff with his prior beliefs and as proportion of individuals increase the role of environmental stimuli prevail. Using some calculus he showed that some agent adopt at $t=0$ (optimists), some change their behavior and some stay at current trait, but in fact then he used proportion q only and heterogeneity of agents is implicitly included in assumption $F(0) > 0$, which mean that also at time $t=0$ someone adopts.

This is so called heterogeneous resistance model with distribution function F and inertia parameter $1/\lambda$. Special case in which F is a normal distribution is represented by equation (10.11).

$$\forall x \in (0, b), t = q^{-1}(x) = \frac{1}{\lambda} \int_0^x \frac{dr}{N\left(\frac{r-m}{\sigma}\right) - r} \quad (10.11)$$

Diffusion processes presented in this section were originally considered for diffusion of innovations, so every time we have to ask if application on behavioral norms or institutions is reasonable. Here all of these models (maybe except the simple diffusion models) are based on implicit assumption that individuals are able to evaluate benefits of new rule or behavioral regularity. However with respect to informal institutions it is too strict assumption not only with respect to all cognitive limitations but also to the fact that benefit of the rule often depends on a fraction of population, which follows them, too. So in this perspective game theory seems to be a better tool for analysis formation of rules like conventions, moral etc.

On the other hand contagion models can be useful they explicitly deal with heterogeneous agents and with heterogeneous reactions to changes in the environment. Adjustment to change can be stated as change of behavior within a small subset of agents, because agents of those subset perceive exogenous change as an opportunity for increase of their utility or profit (or bargaining power for example). And others either follow or not⁴⁴.

⁴⁴ Contagion models become much more interesting if we combine it with social network analysis.

Then we can systematically study influence of the topology (=structure of network, society) on speed of diffusion process. For example with respect to innovation it is worth to think also in terms of structural equivalence among agents. Structural equivalence means that agents have similar links to other group of agents, let's say two doctors in one small town. If both want to be profitable, both will have to innovate, because if one does not, then he gradually lose his patients. The implication is that diffusion process will be much faster in comparison with standard contagion models and adoption curves will be concave. This conclusion was acknowledged also by empirics. See Burt (1987) for more information on this topic.

11. Cultural Anthropology and Cultural Transmission

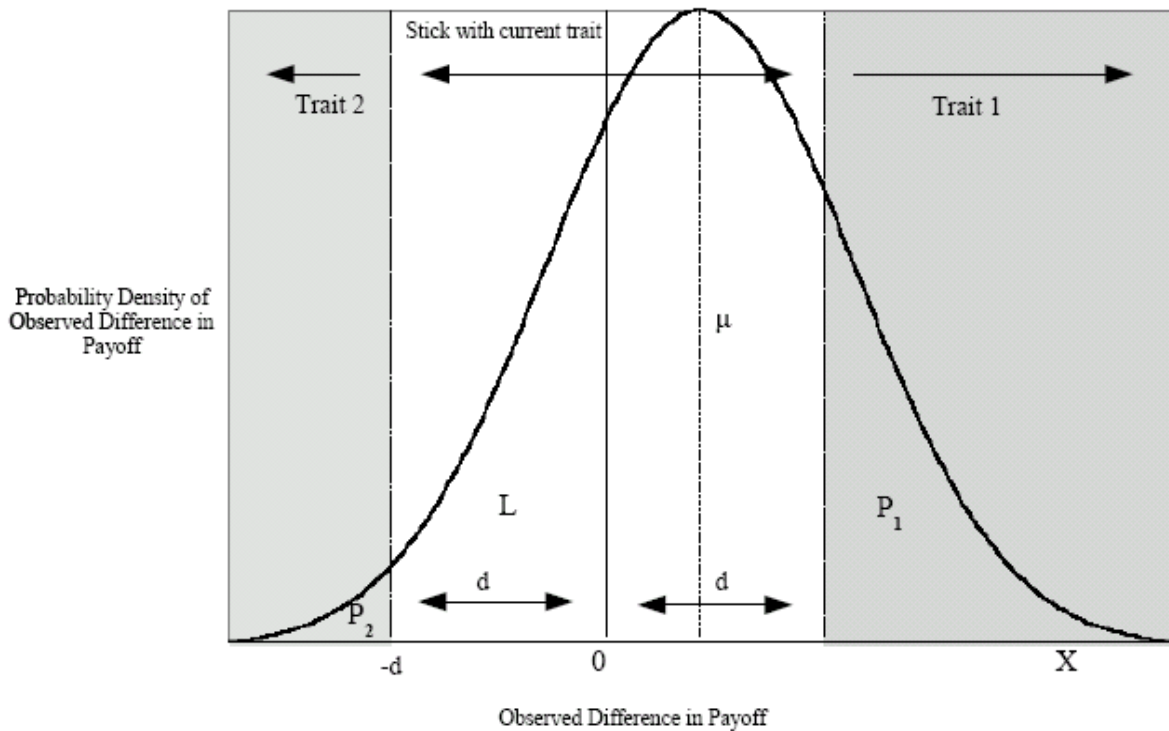
We just noted that the evolution of informal institutions corresponds well to a process of cultural transmission of norms, an approach developed by cultural anthropologists. For Robert Boyd and Peter Richerson (1994, p. 71-73) and others the process of cultural transmission is a „*Darwinian model of the evolution of norms and other aspects of culture*”, which assumes that culture is a system of inheritance. Beliefs, attitudes and values are transmitted from individual to individual by social learning, some of them prevail, some die out. It is important to point out that according to cultural anthropology culture is not only set of behavioral regularities, but mainly set of information stored in brains of individuals and together with genes and external environment influence behavior.

How are these information transmitted? Richard Dawkins (1976) introduced so called *memes*, cultural entities that are passed from one generation to another by nongenetic means, for example by imitation. This transmission has two main forms: unbiased, in which population of descendants has the same proportion of memes as their parents, and as an opposite – biased transmission reflecting that people preferentially adopt some memes rather than others. Such biases comes from natural trials to imitate successful patterns in human environment, so after some „generations” usually proportion of the more adequate memes increases.

Formalization of this approach is not difficult, here we present simple model, which was introduced by Joseph Henrich (2001). He distinguishes between two types of transmission of knowledge (or behavioral regularity): environmental learning, corresponding to unbiased cultural transmission, and biased cultural transmission.

Now suppose that agent in a population face a situation, in which trait 1 represents novelty and trait 2 the current state and individuals obtains information about benefits o innovation from their environment (through observation, experimentation, interaction or experience) and this information is normally distributed. The situation can be seen on figure 11.1. Obviously agents adopt if their information, observed difference in payoff $X > d$. If $-d < X < d$, agent stays with previous behavior and if $X < -d$, inferior trait 2 is chosen.

Figure 11.1. Two-traits-model



Source: Henrich (2001)

Now we can derive population dynamics, when currently all agents are at trait 2 (Note q = trait 1 adopters at time t , $1-q$ = trait 2 adopters at time t), frequency q means probability that observed payoff difference $X > d$.

$$q' = q + \underbrace{(1-q)P_1}_{\text{Trait 1 adopters}} - \underbrace{qP_2}_{\text{Trait 2 adopters}} \quad (11.1)$$

If $L = 1 - P_1 - P_2$ equation (11.1) simplifies to (11.2):

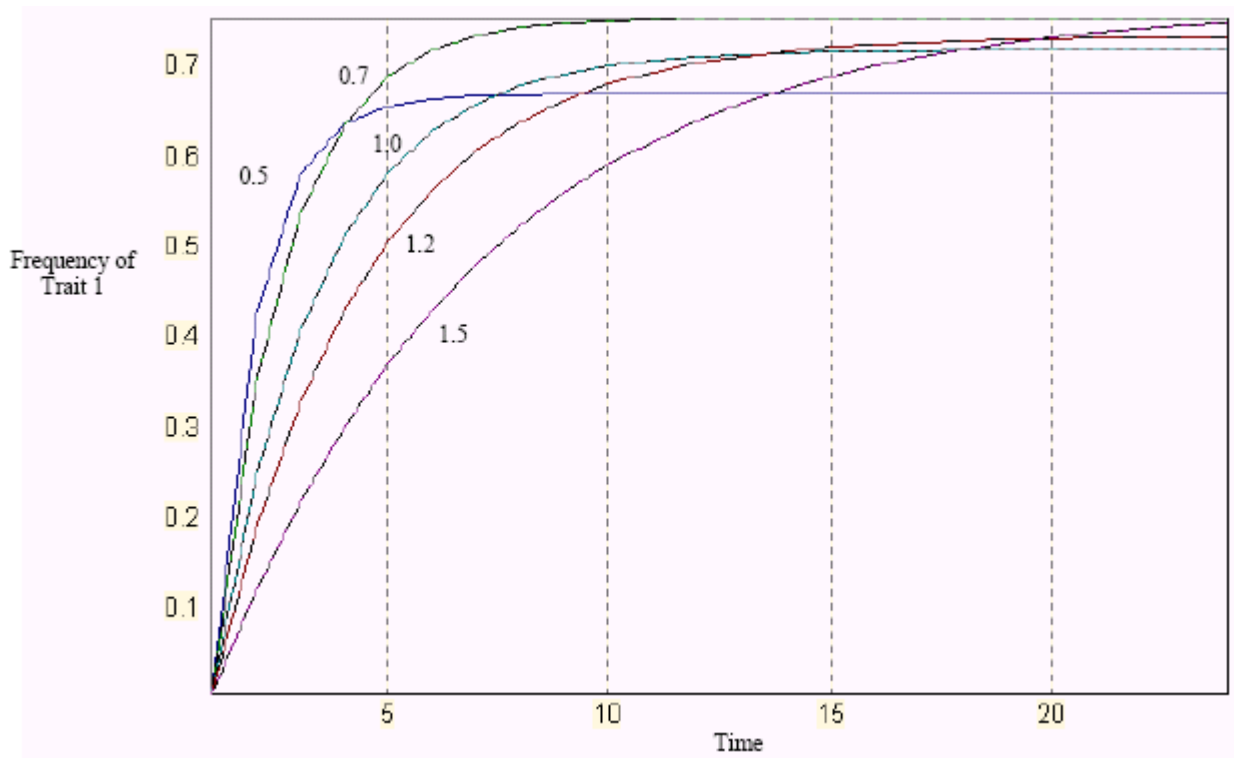
$$q' = P_1 + Lq \quad (11.2)$$

Rewriting (11.2) we obtain

$$\Delta q = q' - q = P_1 - q(1-L) \quad (11.3)$$

And it easy to show that this process leads to concave adoption curves depicted on figure 11.2.

Figure 11.2. Dynamics of environmental learning for different values of d .



As we can see this environmental learning usually doesn't converge to only one trait, usually small proportion stays at the inferior one. On the other hand R-shaped curves are in contradiction with most of empirical studies.

The other form, biased cultural transmission, is based on the theory of social cognitive learning which says that agents rely on observational learning in majority of their behaviors and they imitate not randomly, but more likely successful agents (this is the same conclusion as in Alchian, 1950). This imitation of successful patterns leads to biased transmission and Henrich (2001) distinguish between three types of biases:

- *Direct bias* – habits, norms, values, culture etc. lead to preference of some kinds of behavior.
- *Prestige bias* – successful agents are imitated and many times imitation concerns also features, which are in fact irrelevant for success or failure in a given situation.
- *Conformist bias* – copying of behavior expressed by the majority of people.

Biased Cultural Transmission can be then represented with equation (11.4) where the term $B = (r_1 - r_2)$ means difference in the replicatory propensities of both traits.

$$\Delta q = q' - q = (1 - q)q(r_1 - r_2) = (1 - q)qB \quad (11.4)$$

Generally $B = b(1 - \alpha) + \alpha(2q - 1)$, the first part stays for direct and prestige bias and the latter for conformist bias, additionally $-1 \leq B \leq 1$.⁴⁵ If $B < 0$, trait 2 would be favored and trait 1 would not spread.

However in the reality we can expect combination of both types of transmission and we know that environmental learning produces R-shaped curves, on contrary biased transmission leads to S-shaped curves. As far as observed are mostly S-shaped, we want to find such proportions of both types necessary for S-shaped curves. Let ξ be a proportion of environmental learning and γ proportion of biased transmission. Then from equations (11.3) and (11.4) we get:

$$\frac{dq}{dt} = \xi(P_1 - (1 - L)q) + \gamma Bq(1 - q) \quad (11.5).$$

This process generates S-shaped adoption curves if Δq is maximized for $q > 0$, because maximal value of Δq is at the inflection point. After some simple calculus⁴⁶ we obtain condition (11.6)⁴⁷

$$B > \frac{\xi(1 - L)}{\gamma} = \Phi(1 - L) \quad (11.6)$$

Adoption curves resulting from this process are at figure 11.4.

45 Biases are derived from following equations:

$$r_1 = b_1(1 - \alpha) + \alpha(q - 1/2)$$

$$r_2 = b_2(1 - \alpha) + \alpha(1 - q - 1/2)$$

$$r_1 - r_2 = (b_1 - b_2)(1 - \alpha) + \alpha(2q - 1) = b(1 - \alpha) + \alpha(2q - 1)$$

46 Differentiation of Δq with respect to q , obtaining q which maximizes Δq and if S-shaped, than this $q > 0$.

47 This condition holds if both biased cultural transmission and environmental learning favor trait 1. If biased transmission favors trait 2, B is negative and resulting curves are R-shaped, if biased transmission favors trait 1, it depends on values L and B if the effect of environmental learning would be overcome.

Figure 11.3. Biased cultural transmission dynamics for two values of B

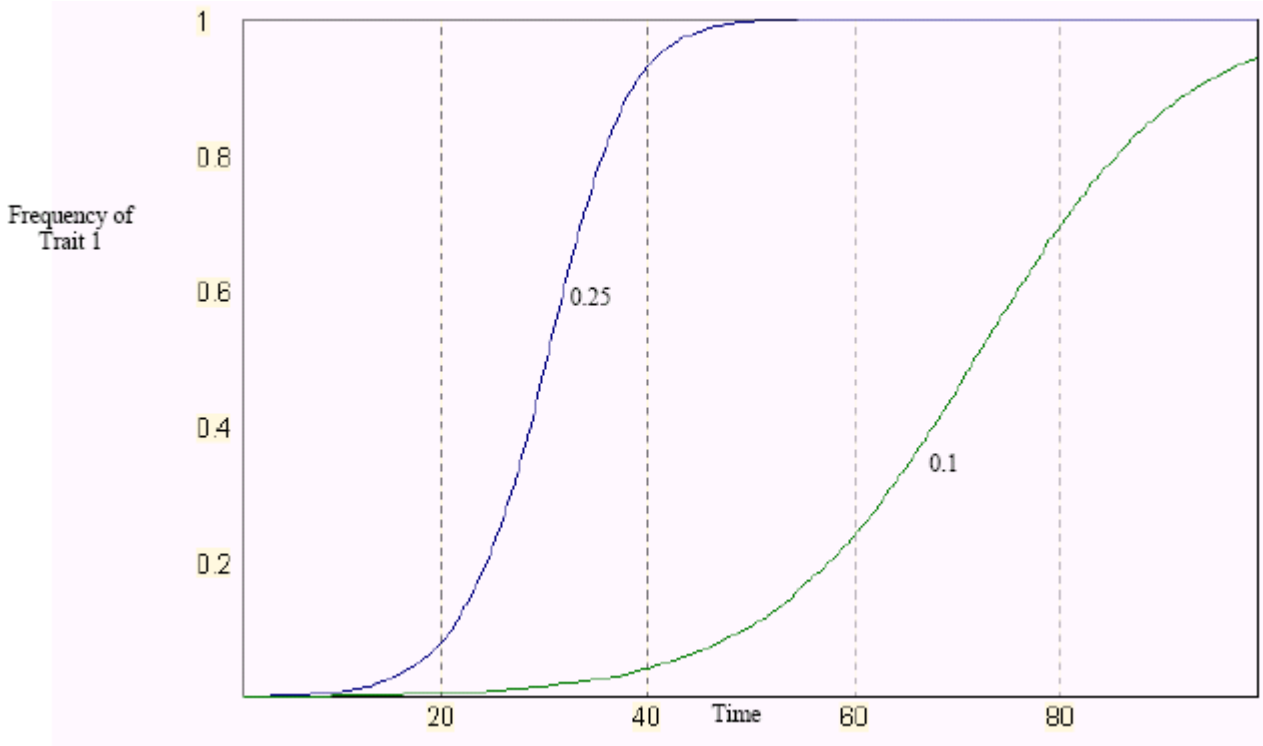
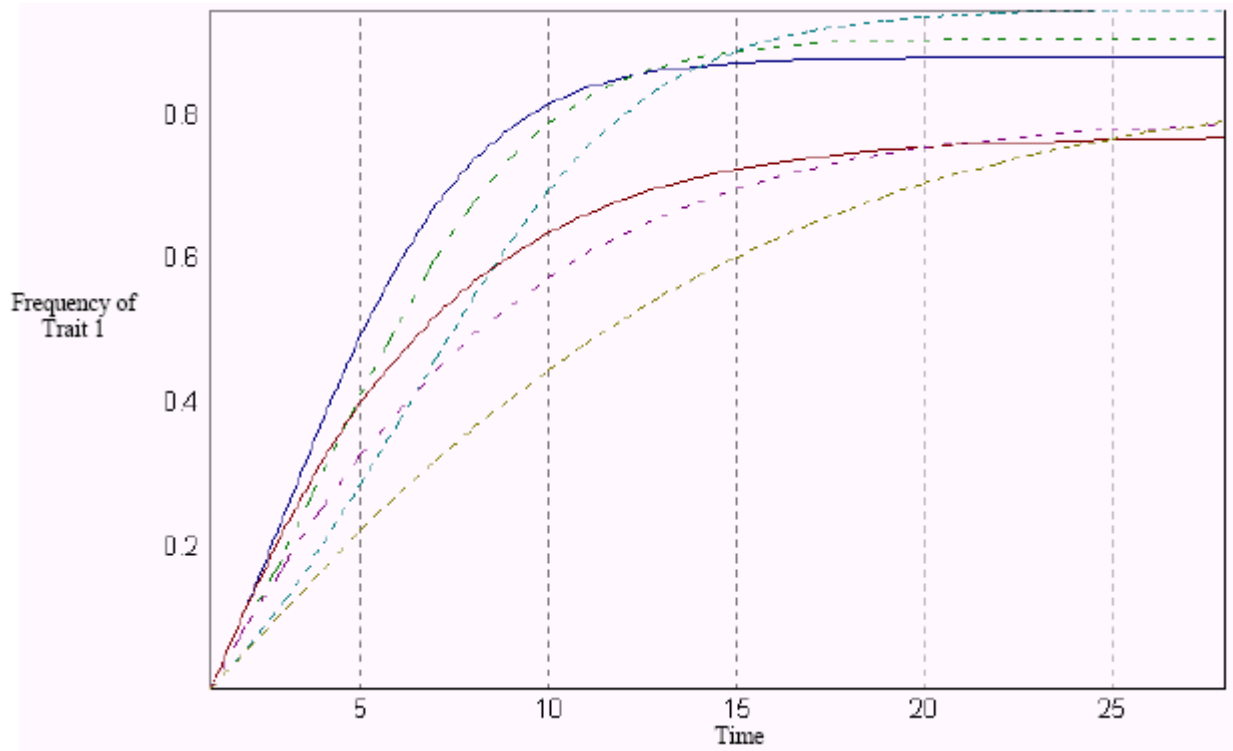


Figure 11.4. The combined model



Finally we can introduce also conformist bias into equation (11.5) and together with general form of biases and we get equation (11.7):

$$\Delta q = \xi(P_1 + (L-1)q) + \gamma q(1-q)[b(1-\alpha) + \alpha(2q-1)] \quad (11.7)$$

Generally α should be relatively small because if the conformity is high ($\alpha > 0.5$), nothing can ever spread. Similar condition holds for B:

$$B = b(1-\alpha) + \alpha(2q-1) > 0 \quad , \quad (11.8)$$

again if $B < 0$ trait 1 would not spread. Now resulting adoption curves have long tails (if they are S-shaped, see Figure 11.5.), the intuitive explanation is simple: the conformist component α decrease the level of Δq at the beginning of diffusion process and after critical mass is overcome, the process becomes self-sustaining and α accelerates the diffusion. The critical mass is derived from (11.8) and it is every time lower than $\frac{1}{2}$.

$$q_{sp} = \frac{1}{2} - \frac{b(1-\alpha)}{2\alpha} \quad (11.9)$$

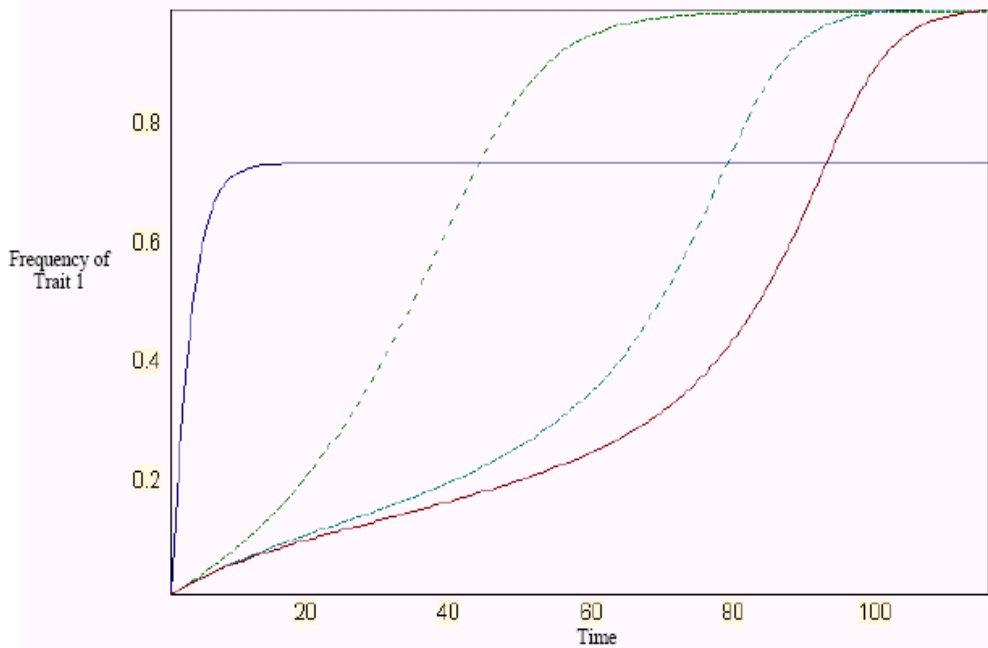
After similar procedure as before – maximizing Δq – we get again condition for S-shaped adoption curve:

$$b > \frac{\xi(1-L) + \gamma\alpha}{\gamma(1-\alpha)} = \frac{\Phi(1-L) + \alpha}{1-\alpha} \quad . \quad (11.10)$$

Resulting adoption curves are on Figure 11.5.

The most important implication from this model is that some kind of bias is necessary in order to obtain S-shaped adoption curves, which correspond to observed ones. This means that change of behavior of individuals does not result only from their own analysis of situations and problems (this part can be explained using the framework of the cognitive psychology) but it is influenced by strong biases, which can be either direct, prestige or conformist one. So observational learning is, according to results of this model, much more important determinant of human behavior than individual learning. In comparison with previously discussed models this model of cultural transmission is the only one with some consistent theory behind.

Figure 11.5. Conformist tradition and long tails



However several questions remain still unsolved. First using framework of biased cultural transmission can be criticized again, because benefits of any particular attitude, norm or rule cannot be simply evaluated, so biased transmission and observation of others can explain change of institutions only partially (Opp, 1994). This is obvious, however as far as evolution of routines concerns biased transmission approach gives theoretical background to many conclusions about the importance of imitation for behavior (like Alchian, 1950 and others).

Other aspect concerns impact of incentive structure resulting from new law system or from change in relative prices. Incentives can either facilitate change of behavioral regularities or prevent from them. What effect prevails will depend on complex set of whole law system and on subjective perception of it. Also behavior of other agents like from financial sector will shape incentive structure as they control financial resources. Established norms of lending financial resources will play crucial role in adjustment processes influencing accessibility of them. As far as change of behavior caused by incentives concerns we can only repeat basic conclusions from the second section, that new routine is adopted if incentive is strong and if it has direct impact to outcomes of behavior so it is easily recognizable.

Conclusion

Cognitive psychology tells us that such routines are based on subjective mental models at the individual level. Evolution of behavior can be now understood as evolution of those routines and mental models, and thanks to their nature routines have high propensity to long persistence despite changing environment. Other reason for persistence of routines is nature of learning process itself. In accordance with psychology I deal with two types of learning, not only with learning-by-doing, which is very often used in economics, but also with so called observational learning – learning according to expectations of future development and learning through imitation. The later prevails in case at risk-averse population and is more common in situations where costs of possible mistakes are too high. So learning depends not only on economic environment but also on social environment, on experience and knowledge how to find what is important and what is not and so learning processes are highly path dependent and everything else than instantaneous. Such knowledge and experience necessarily differ through population as well as available set of information and this leads to divergence in behavioral regularities. If consequent process of adaptation through imitation and learning leads to convergence is not clear and we suppose that no universal law exist.

Cognitive approach to behavior based on rule-following behavior, learning through both own experience and observation of other agents together with interpretation of institutions as a consequence of shared mental models allows us to describe their evolution as diffusion of new behavioral regularity in the society. Success of such diffusion depends on character of new one, which can be either in conflict or in harmony to current institutional framework, and on expected profit of adoption. Such expectations are formed upon own experience of each agent and observed benefits of adoption at those agents, who have already adopted. Both own cognitive capabilities and social environment (existing interpersonal network of communication) determine perception of information about novelty. Obviously if the new regularity is beneficial enough, adoption of new rule can be much faster and easier because related information of its advantage spreads rapidly and it is easily recognized and so imitated by other agents.

Such perspective on evolution of informal institutions corresponds well to biased transmission of norms, an approach of cultural anthropology. Process of biased transmission at least implicitly deals with comparison of alternative patterns of behavior and subsequent choice of them and from this point of view it can be likened to dynamics of diffusion of innovative technologies and differences among agents lead to different times of switch from one technology (or behavioral regularity) to another. Hence the rate of cultural change, the level of agents with changed behavior, depends on the variability in the population and adoption curve is mostly S-shaped.

There are various approaches explaining reasons, why S-shaped adoption curves prevail and what is the theory behind. The most prominent examples are models of information contagion or sophisticated dynamic models of adoption of innovation in a population of autonomous firms, in which S-shaped adoption curve is generated thanks to different prior beliefs, and last but not least models of cultural transmission of knowledge from one generation to another. Models of information contagion are simple illustration of dynamics leading to S-shaped adoption curve but they do not say anything about adoption of new behavioral regularity, which is supposed to be automatic – if agents get a new information they simply adopt with some a priori given probability. As far as dynamic models of optimal adoption rule concerns, S-shaped adoption curve is consequence of different prior beliefs about advantage of innovative behavior. However these models have often to strict assumptions, namely concerning following ones: firms without innovation can exist further with the same profit as before, so there is no strategic advantage for innovative firms and furthermore this cannot deal with unanticipated consequences of decisions, if their outcomes depend on fraction of population which either adopts or not and this fraction is uncertain. Many of those objections were overwhelmed in social learning model of adoption developed by H. Peyton Young, in which deals only with different prior beliefs and observation of outcomes of adopters. Model of cultural transmission by Joseph Henrich works only with observational learning and assumption of statistically significant different priors is omitted (they are approximately the same in the whole population). Not surprisingly if observation is perfect diffusion is so fast that we can observed strict concave diffusion curve. However adding biases into model – as for example assumption that people

imitate successful patterns more likely than only the average ones – leads to S-shaped adoption curves, too. The most important implication from Henrich's model is that some kind of bias is necessary in order to obtain S-shaped adoption curves, which correspond to observed ones. This means that change of behavior of individuals does not result only from their own analysis of situations and problems (this part can be explained using the framework of the cognitive psychology) but it is influenced by strong biases, which can be either direct, prestige or conformist one. So observational learning is, according to results of this model, much more important determinant of human behavior than individual learning.

However several questions remain still unsolved. First using both parallel with diffusion of innovations and framework of biased cultural transmission can be criticized as benefits of any particular attitude, norm or rule cannot be simply evaluated, so biased transmission and observation of others can explain change of institutions only partially. Although biased transmission approach is the leading one in nowadays cultural anthropology and detailed description of evolution of various types of informal rules by Chrysostomos Mantzavinos is compatible with it. On the other hand both framework of social learning and cultural transmission model are suitable for modeling heterogeneous adjustment path in a population of agents following abrupt and unanticipated change in their environment.

Other aspect concerns impact of incentive structure resulting from new law system or from change in relative prices. Incentives can either facilitate change of behavioral regularities or prevent from them. What effect prevails will depend on complex set of whole law system and on subjective perception of it and these models can be hardly used for evaluation of alternative scenarios. Also behavior of other agents like from financial sector will shape incentive structure as they control financial resources. Established norms of lending financial resources will play crucial role in adjustment processes influencing accessibility of them. As far as change of behavior caused by incentives concerns we can only repeat basic conclusions from the second section, that new routine is adopted if incentive is strong and if it has direct impact to outcomes of behavior so it is easily recognizable.

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Projekt diplomové práce

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Téma: Behavior and Institutional Change

Cíl práce: The aim of my thesis is to explain why there is strong persistence in institutions and in behaviour after institutional change and why previous development affect future institutional set, behaviour and performance of the economy. Previous research led us to conclusion that it is appropriate to use evolutionary approach to behaviour based on routines, limited cognitive skills and subjective mental models. Using such view we explained institutions as a consequence of shared mental models and institutional change was described as an effect of social-cognitive learning. This approach of rule-following behaviour is very useful to study micro-effects of technological and economic change and for explaining adjustment processes, which are assumed to be instantaneous and costless in traditional view.

Práce by měla přinést odpovědi zejména na tyto otázky:

- Improving the explanation of evolution of routines, shared mental models and characteristic features of social cognitive learning.
- Incorporation of findings of evolutionary economics about routines into analyses.
- Improving the relationship with empirical findings – to show that this approach to behavior and economic or institutional change does matter, that it makes a difference between traditional and evolutionary view and that specific knowledge and skills plays an important role for both behavior and economic performance.

Předběžná osnova práce:

- 1) Uncertainty, Bounded Rationality and Rule-following Behaviour
- 2) Evolution of Routines and Shared Mental Models
- 3) Evolutionary Approaches to Institutional Change
- 4) Conclusions.

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