Proc. Estonian Acad. Sci. Humanities and Social Sciences, 1996, 45, 1, 1–12
https://doi.org/10.3176/hum.soc.sci.1996.1.01

ON ADAPTIVE IMPLEMENTATION OF ECONOMIC SYSTEMS: A BAYESIAN NASH ANALYSIS

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Received 12 April 1995, accepted 7 November 1995

> "Economic actors are concerned not only about the form of the economic system today, but about its form tomorrow."
>
> B. Weingast (1993, p. 287)

The paper provides a Bayes–Nash two-stage model for describing the process of step-by-step adaptively changing economic systems in the environment of a high amount of uncertainty and asymmetric information. An important factor of this model is that the government (also in the role of the central bank) and the parliament are among the economic agents in the model.

On the basis of heuristic analysis of this model the problems of adaptive implementation possibilities of a socially desirable economic system are discussed. This analysis applies the Bayes–Nash equilibrium concept with the anticipated information of agents about the economy including the decisions of other agents. It is shown that the long-run implementation is almost surely impossible in the traditional sense. First of all, the target, the socially desirable system, is adaptive or not motionless. Secondly, the implemented systems are not fully known and adaptive either. Thirdly, the noncooperative players seeking different interests may not coordinate asymmetries of information, and the high amount of uncertainty is causing *status quo* biases. Thus, it is rational to discuss admissible implementation errors and to study the properties of the implementation mechanisms which are working within the limits of these errors.

1. INTRODUCTION

The most significant change in economics for our case is the fact that the theory rapidly extends to take into account the state of economic systems and their developments. This trend has also been regarded as Wicksellian approach. As Buchanan (1987) puts it: "The Wicksellian approach concentrates on reform of the rules, which may be in the potential interests of **all** players, or opposed to improvement in strategies of play for particular players within defined or existing rules."

Under the above-mentioned rules we consider economic systems, that is institutions (organizations and arrangements) and mechanisms (admissible strategies and solution or outcome rules). The extension of economic theory with these elements has many implications.

The first of them is that some extra-market agents with their strategic behaviour connected with the development of economic systems should be integrated into the theory. These are the parliament, the government, the central bank, labour unions, etc. Consequently, the model should be with heterogenous agents, noncooperative, and hierarchic or coordinative.

Another is that the system reorganization cannot be accomplished in one-step and short-range designs due to its complicatedness. So the realistic studies should concern the sequential nature of these processes and the problem of sequencing the decision about systems, especially the adaptivity of the designs. We use here the term 'adaptivity' in the meaning of taking new information into account in decision-making. This new information should also involve the Hayekian theory of 'hitherto unknown' events (Kirzner, 1992).

Here another important issue arises. That is the question of additional transitional uncertainties connected with the reforms in the economic systems. So, if these processes are studied in the context of deterministic or complete information, models may give utterly distorted results.

According to Schmiedling (1993) Keynesian and traditional neoclassical theories are ill-suited for studying the transformation in emerging market economies. They abstract from the institutions and mechanisms for coordination of economic activities. However, it is in these elements that the fundamental changes evolve in these economies. Moreover, along with the institutions specific human capital is changing in these transition processes. So system-specific considerations and arguments are the most important in the transition processes and their description by the means of the game-theoretic approach may be well suited.

Given these standpoints we are going to provide a model for describing the processes of sequential economic systems. This is the two-stage Bayes–Nash model with heterogenous agents. In addition to common economic agents (producers and consumers) these include the parliament and the government.

In our treatment we borrow heavily from the equilibrium theory, especially from the temporary equilibrium theory (Grandmont, 1982), from the mechanisms design theories (Marshak, 1986; Hurwicz, 1986; Chander, 1986), and from the sequential equilibrium theories (Kreps & Wilson, 1982; Kreps & Ramey, 1987; Bergin, 1989).

There are a number of results in this field, from which we are trying to integrate. Among these are the works by Buchanan (1994), Harris & Townsend (1981), Vercelly (1991), Pomery (1990), Hicks (1979), Kirzner (1992), Edwards (1992), Hettich & Winer (1988), Kornai (1993), Dewatripont & Roland (1992), Rubinstein (1991), and Ennuste (1970).

We argue that the model should explicitly consider the economic system design decisions of the agents and the impact of these decisions on other agents' decisions as conditions or restrictions. Here parliamentary and governmental policies are the most important. On the latter grounds P. Haaparanta (pers. comm.) suggested the author to call this approach the "meta-implementation".

In fact it is extremely difficult to integrate these policies into a rigorous stochastic competitive allocation model, where also dynamics is a vital aspect. To avoid these insurmountable difficulties we base our model on heuristic assumptions and procedures, and partly on purely verbal trains of thought.

We use here the term 'heuristic' also in the sense of Vercelly, "This general framework, which gives unity and overall meaning to the set of specific models characterizing a certain theory, will be called the *heuristic model* of that theory" (Vercelly, 1991, p. 5).

In this paper economic transition is understood as the process of an economic system passing adaptively through a sequence of environments and changing organizational mechanisms from one alternative class of organizations to another (e.g. from a centrally planned to a competitive economy).

It is considered that the information of the agents is asymmetric and sequentially changing. The decisions of the agents are strategic, that is they take into account that their choice of policy (concerning the economic system) will affect the expected behaviour of other agents, who have also some influence on forming the system.

In the case of preferences we have also to consider short- and long-term effects as *ex ante* and *ex post* effects. The activities of the agents also include communication.

Now the crucial problem is adaptive implementation of the socially desirable transitions of the system. Is the implementation at all (in principle) possible under democracy or are the uncertainties, asymmetries, and *status quo* biases too strong (Fernandez & Rodrik, 1991)?

As a matter of fact, now transitional uncertainties or magnified uncertainties will be added to the ordinary (endogenous and exogenous) uncertainties. These are due to the structural changes in the real economy and in the economic system and new information flows and their rapid changes which the agents are not able to absorb. At the same time the agents are not capable of learning from some conventional sources of their information. For example, in the period of structural changes the macroeconometric models lose their credibility because a fixed economic structure belongs to the assumption of *ceteris paribus* in these models. With these issues in mind, we pose the implementation question in a different perspective: the mechanism is implementing when the errors (on the basis of hitherto known information) of the mechanism design are in the admissible limits compared with the socially desirable design. Our results show that to be implementive the mechanism has to fulfil communicativeness and optimization conditions. This finding is used to analyse the implementation problem in the general environment.

The paper is organized as follows. Section 2 describes the general framework of the model and an adaptive implementation theory in the asymmetric information conditions. The results of the analysis of the model are presented in Section 3. The paper concludes with some modest proposals.

2. THE GENERAL FRAMEWORK OF THE MODEL AND IMPLEMENTATION POSSIBILITIES

2.1. Bayes–Nash adaptive model

In this subsection the conceptual framework underlying the sequential adaptive Bayes–Nash model is presented. This model is the foundation of the decision-making of the noncooperative agents. The agents' information, expectations, and adaptivity are of paramount importance here (for a review of Bayesian Nash theory see Gibbons, 1992). At the first reading of the paper Subsection 2.1 may be omitted.

Consider an agent (we omit the index of an agent) at date t. Let i_t denote the information the agent has at date t, $i_t \in I_t$, where I_t is the admissible information set for the agent at date t. This information determines the probability space of the world for the agent (S_t, C_t, P_t). Let s_t denote the elementary state of the world $s_t \in S_t$ at date t and $t+1$, C_t is the σ-field and P_t is the agents' probability measure.

In our model the state of the world describes all the relevant phenomena (resources, technologies, economic systems, decisions of other agents, preferences, etc.) at this date and expectations about the date $t+1$. At the date $t+1$ the agent will get new 'hitherto unknown' information i_{t+1}, which will determine a new probability space.

Let the set of all the agent's possible decisions (the actions in this period and the plans for the next period) be A_t, and let $a_t = (a_t^t, a_{t+1}^t)$ be the decisions the agent makes at the time t, where a_t^t is the action at t, and a_{t+1}^t is the action plan for the time $t+1$. The action plan may be contingent, that is the plan is valid if the state of the world in the next period realizes as such. Note that the contingent plan here does not necessarily mean a point plan (a pure strategy).

The results of the agent's choices a_t^t and a_{t+1}^t will be represented by $\gamma_t(a_t, s_t) \in Q_t$. These will induce a Bayes-consistent probability distribution, say $\mu_t(a_t, s_t)$ on possible results Q_t in this and the next period.

According to the hypothesis of expected utility the agent's Bayes–Nash decision problem will now be: there exists a utility function $u_t: Q_t \times C_t \to R$, and the problem is to find the decision a_t that maximizes the expected utility subject to the possible decision constraint:

$$\max_{a_t} \int_{C_t} u_t(\gamma_t(a_t, s_t), s_t)\, \mu(a_t, s_t)\, ds_t ,$$

subject to $a_t \in A_t$ almost surely. We take that the maximal solution $a^* = a^*(s_t)$ is unique, and in the context of all agents we call it an equilibrium decision.

Let us note here that the next period's part of σ-algebra in C_t is a forecast and at date $t+1$ this forecast will be corrected according to the next period's information. The important point here is that taking the decision in time t the agent considers the possible new information in the next period, that is he considers the possible correction of decisions or their adaptivity. We will discuss this problem later.

The above-defined agent's decision problem contains the given space of possible decisions at this date. We assume that this space is fixed by the state of the world, which means that it is not influenced by the activities of the agents at this date.

In our model the agents are taking two principally different kinds of decisions: first of all they take decisions concerning the economic system, and second, they take decisions concerning the real economic activities and resources. Thus the decision space may be decomposed into two parts: space of system's decisions and space of economic decisions. The volumes of these spaces characterize the decision-making powers of the agents in both fields. In our analysis we are interested in the decision selection and the spaces in the first field, and only in the evolution of decision spaces in the second field.

2.2. On asymmetric information adaptive Bayes–Nash implementation

The traditional implementation conditions

In the traditional implementation literature different frameworks have been used for describing the agent's information sets and states of the nature. Postlewaite and Schmeidler (1986) and Palfray and Srivastava (1989) used the common set of economic states as the basic element. An agent's information is represented by a partition of this set. In this framework the Harsany Doctrine (Aumann, 1987) is sometimes used, that is there is also a common prior assumption.

In Jackson (1991) the basic element is the agent's set of states and the common set of states is the multiplication of these sets. An agent's information is a partition over this common set and the priors over these partitions. The partition over the agent's own set is complete.

In our approach (as in Ennuste, 1992), to stress the asymmetricity of information, each agent has its own private set of the states and accordingly the priors. Both of them are modelling the information the agent has got at that date. Sequentially, at the next date, the agent will get new information, which will be modelled by a new set of states and priors.

Notice that in this framework the common description of the space of states is abandoned, and each agent may have a basically different set of states. Notice also that the agent's information structures may be without any 'grain of truth' (Kalai & Lehrer, 1993).

The agents are Bayes rational and they maximize their expected utilities. The utilities in each state depend on the state and the allocations (results). The allocation in its turn depends on the states and the decision of the agent. Notice that the state here describes also the beliefs of the agent about the other players' decisions.

Understandably in our asymmetric information framework different agents may have different beliefs about social choice functions and about allocation (result) functions. This fact decomposes the traditional common implementation problem into agents' individual implementation problems. Now we have to discuss the implementation only from the point of each agent's information. In the following we do it from the point of the best informed agent, and so the traditional implementation theory will work again.

According to this theory (e.g. Jackson, 1991) the social choice correspondence must satisfy the incentive compatibility condition to be implementable. The intuition of this necessary condition is that the agent believes that in the case of the direct mechanism with social choice correspondence deception is not preferable.

Indeed, if the social choice correspondence is implementable, then, according to the Revelation Principle, there is always a direct mechanism to which truth is an equilibrium. However, social choice correspondence will then be a direct mechanism with the same outcome.

Another necessary condition is the Bayesian monotonicity. About the proof of this theorem and the theorem of incentive compatibility see Postlewaite and Schmeidler (1986), Palfray and Srivastava (1989), and Matsuhima (1993).

The implementability problem concerns only the characteristics of the social choice correspondence. Yet implementation also demands certain characteristics from the mechanisms. It is easy to see that the necessary condition for the implementation is the Paretian property of the applied mechanism.

Indeed, according to the definition, social choice correspondence has the quality of Paretian optimality. As the outcome of this correspondence and the implementing mechanism are equivalent, so the outcomes of the mechanism have to satisfy the Paretian optimality condition.

This obvious truth enables us to easily discern mechanisms or elements that make implementation impossible or do not guarantee it.

Adaptive implementation

The problem considered in the adaptive approach of implementation arises from the fact that the designs made at the given date will be subject to correction at the next dates, the conditions of which are 'hitherto unknown'. This approach will change the understanding of implementation considerably.

In the traditional implementation theory a mechanism (A, γ) implements a social choice function x if there is a unique equilibrium of all agents a^* with $\gamma[a^*(s)] = x\ (s)$, where γ is also a result for all agents. In our treatment we may reformulate the last condition as follows: $\gamma_t [a^*_t (s_t | i_t)] = x_t (s_t | i_t)$.

In case of adaptive implementation, we have the social choice function $x_t(s_t, s_{t+1}|i_t, i_{t+1})$, and the implementation function $\gamma_t[a^*_t(s_t, s_{t+1}|i_t, i_{t+1})]$, where the information $i_{t+1} \in I_{t+1}$ is 'hitherto unknown'. In other words, in the adaptive treatment the social choice function and the implementation function are partly (concerning information i_{t+1}) unknown or uncertain and the condition of their equality is here not applicable.

A convenient implementation criterion may be based now on Marschak's (1986) maximum possible error idea. We narrow our approach again to 'hitherto known' information, and in this case this criterion is

$$\|\gamma[a^*(s)] - x(s)\| \leq r,$$

where the symbols $\|$ denote Euclidian distance, and r is the maximum possible error.

A study of such an implementation criterion shows that the type of social choice function is not any longer crucial for the implementation like in the traditional theory. The crucial factor is that the implementing mechanism should work in the right direction and give the solution within the limits of the maximum error (on the basis of the existing information).

There is also another reason why the importance of the type of the social choice function is absorbed in this treatment. As a matter of fact, in the sequential and adaptive games the agent's private information will be partly verifiable for other agents. According to Green and Laffont (1986), in this situation, which makes some messages of the agents incredible, the class of implementable social choice functions will be enlarged.

Some implementation conditions for mechanisms

Following our previous claim that for adaptive implementation the properties of the design mechanism are crucial, we are formulating two necessary conditions for the mechanisms to be implementive.

First, the mechanism is implementive if it satisfies communicativeness conditions. The meaning and reason of this condition is as follows. The social choice function is working with information available for all the agents. It is assumed that the agents are 'sincere and obedient' and give their information to find the socially desirable solution.

It is reasonable to assume that to reproduce this solution with the help of the game the players also have to transmit their information to each other (Forges, 1990; Ennuste, 1992). In our model we describe the transmission of information with the help of the activities of the agents.

The communicativeness conditions may be not fulfilled in the cases of exorbitant aggregation of data, distortion of information, or then distortive activities are not made incredible.

Secondly, the mechanism is implementive if it satisfies the optimization condition. The reasons behind this condition come from the optimization theory. The solution of the social choice function is optimal or at least Pareto-optimal. This means that the implementing mechanism also has to work out optimal solutions.

It is easy to see that this condition will be breached if some agents or their coalitions exert excessive blocking and dictatorial powers in the game, because the socially optimal solutions are always compromising Pareto-optimal solutions. Whether these two conditions can be fulfilled in the mechanism and whether it is possible to eliminate the breaching factors are still open questions which should be analysed in concrete environments.

3. THE BEHAVIOUR OF THE AGENTS AND SOLUTIONS

3.1. Specification of the behaviour

According to their power to influence the decision-making structures we distinguish three classes of agents: the parliament, the government, and the economic agents. In each class we distinguish different submechanisms.

The behaviour of the parliament

The parliament has the position of the principal over the government and economic agents, and may change its own decision structure for the next date. In selecting the economic institutional and mechanism policies it is constrained by its own former policies and international agreements and conditions.

The parliament acts on the basis of its members' voting results, which are determined by the members' expected utility estimates about the alternative economic system policies.

Say, a member has his or her information about economic system policy bill. This information contains expectations about the behaviour of separate interest groups, the impacts of different sequencings of bills, etc. Given this information the expected utility of policy is estimated and the probability of the members voting for the bill is influenced by this expected utility (Hettich & Winer, 1988).

It is easy to understand that the majority voting rule may not be a guarantee against passing Pareto inferior or socially undesirable laws. Also, Pareto optimal or socially desirable laws can be blocked by the opposing coalition on the basis of different information (Fernandez & Rodrik, 1991). Pareto optimal means here a law which cannot be improved upon by the set of all members of the parliament.

The operations of the government

The government operates in the framework of the parliamentary laws and is active in preparing these laws. The central bank operates in the same way. So, for convenience we consider in our treatment a government that includes also the operations of the central bank.

Unlike the parliament, the government's operations involve direct economic interventions and are partly directed to the extra-market activities for fixing governmental decrees about economic system elaboration for the economic agents in the framework of the parliamentary laws. Since both of these operations influence the decision-making power of the economic agents, we are going to explain the government's activities in both fields.

At every date the government forecasts its environment as a function of its information, in order to choose its operations in this period and plans for the next period, which maximize its expected utility. The constraints of these operations depend mainly on the existing and expected parliamentary policies.

The most common interventions of the government are the collection of taxes and allocation of tax revenues, and, as the central bank, the government undertakes open market operations. It also may determine deficit, exchange rates, and interest rate. The government's actions may also include temporary fixing of prices and tariffs and determination of quantity rationing.

These extra-market interventions of the government are symptomatic of the economic system's failure or disfunctions. There are at least four categories of typical disfunctions (Pomery, 1990): monopoly-power, incomplete market structures, importing of economic distortions, and informational asymmetries.

With the above listing we meant to stress that the competitive market is not the main issue in the problem of governmental interventions. Special issues are the uncertainties and asymmetric information, which rationalize the direct governmental interventions. The deterministic analysis may be misleading here for a number of reasons.

One of them is the implicit need for the risk-policy markets, which do not exist (Pomery, 1990) and whose lack distorts the implementation of socially optimal developments, unless there are no governmental interventions.

The governmental decrees that are directly aimed at the reforming of the economic system are constrained by the parliamentary laws, and are mainly meant for elaborating these laws. The crucial point here is that the government may have in this elaboration process a big range of decision alternatives and their sequencing and combination possibilities, and is making the final decision according to its utilities and targets. We assume that these utilities and targets may be much more influenced by bureaucracy and producers' interest groups than in the parliament and so may substantially differ from the parliamentary utilities and tasks. Having this in mind we have to add that the government or the agenda setter may be interested in distorting information in preparing the bills for the parliament (Niskanen, 1971).

The behaviour of economic agents

In order to keep our explanation simple we are not always going to distinguish consumers and producers explicitly. To choose their activities and plans, both of them make forecasts in the form of probability distributions on the basis of information they have at that date.

These forecasts contain in addition to other environmental data the decisions of the parliament and the government, their direct intervention activities, and decisions on economic system designing. All of them serve as basis for the compilation of the economic agent's decision model.

At this level the model contains mainly direct economic activity and resource allocation decisions, but also some pure economic system decisions of economic agents. These are mainly the issues concerning management and incentive systems, principal agent problems, and lobbying in the parliament and in the government. However, making also direct activity decisions (mergers, fusions, integrations, divestitures, entries, etc.) the agents realize the economic system and these realizations may differ from the intentions of the parliament and government (e.g. depending on the loopholes in the laws etc.).

The important part of this model is the forecasted real space of the agent's possible decisions. This space is constrained among other factors by the decisions of the government and the parliament, and the gaps in the legislation, etc. Considering the impact of these constraints on the stochastic volume of the possible decisions' space or the decision-making power of the agents, we are able to define one indicator for the measurement of economic liberty. In the process of economic liberalization the space of possible decisions for the agent is expanding and vice versa. This expansion has an optimal value, which is maximal in the case of a perfect private market system with only necessary and sufficient rational central restrictions and interventions. Taking this completely liberalized decision space as a unit, there is a possibility to measure the economic liberalization processes, and discuss its expected optimal value.

A few remarks are still in order. In determining the performance of the economic system it is still necessary to consider that the quality of information the agents have may also depend on the economic system. There may be efficient information markets and announcement mechanisms or these may be absent. To include these in the discussion would involve considerable complications, and so we avoid these problems here (about these problems see also Tirole, 1991).

Insurmountable difficulties are also faced in getting empirical evidence about the efficiency of the economic systems. These systems are evolving comparatively slowly, not in one step, and often under the conditions of environmental turmoil and in the environments of high amounts of uncertainty. So the use of ergodic parameters in these cases is not justified (see Hicks, 1979; Davidson, 1990). As Georgescu-Roegen put it (1971, p. 339): "The validity of statistical tests, even the nonparametric ones, requires conditions which a rapidly changing structure such as the economic process may fulfil only by sheer accident."

3.2. Temporary solutions and long-run developments

Here we make comments on the short- and long-run changes of the economic system and explain their properties. For this we borrow parallel ideas from the temporary equilibrium theory and sequential equilibrium theory, although the study of the equilibrium issues is not the point here.

First the solutions reached at each date are temporary in the sense that they may be corrected at the following dates and the long-run development of the economic system is a succession of these temporary solutions.

The solutions at each date in our model where the parliament, the government, and the economic agents act are strategic. That is the agents take into account that their choice of policy will affect the choices of others and forecast the last choices in the form of probability distributions.

It is easy to see that the Bayes–Nash outcomes of this game depend heavily on two elements: the extent of uncertainties about the central agents' decisions and the sequencing and timing of these decisions.

The parliament and the government are sequentially making decisions about the implementation of new elements and dissolving some old ones in the institutional and mechanism structures of economy, and in the direct interventions into economic activities and resource allocations.

The former are longer-term tasks and the most important among them are the changes in the property rights and laws on the liberalization of economic activities. The central agents' decisions in the field of mechanisms restructuring that comprise the changes of information flows and incentives and the microeconomic governing principles and direct intervention are shorter-term ones.

Let us consider now the economic agents. In making their decisions the agents face in addition to the uncertainties in the real sphere the changes in the control sphere, which may not only add but also magnify the uncertainties. So, in the end it may be hard to predict which agents are gaining or loosing. This can make the system's *status quo* more preferable and arise wait-and-see strategies and suspend the reform process (Fernandez & Rodrik, 1991) or even paralyze the economic activity.

Consequently, to achieve effective short-term changes of the economic system the central agents have to provide the agents with sufficient credible information on their decisions and these decisions should also be concrete enough.

Considering the long-term developments the crucial issue is an effective sequentiality and timing of the reform decisions (Roland, 1992). The wrong sequence of changing the economic system could lead to the wrong development path. For example, if the credit and voucher systems are not sufficiently arranged before privatization the resulting ownership structure will be undesirable, etc.

There is also the problem of sequencing the decisions according to their popularity and unpopularity. If unpopular decisions are heaped up the next step in the policy course may be easily blocked in the parliament or the agents may start looking for loopholes in the laws to avoid unpopular measures.

In the long run there is always the problem of the election of the new parliament and the probable change in the system's policy course. According to our decision model the previous parliament and the government should forecast also the next parliament's and government's intentions in this field to guarantee sound system policy decisions.

To complete this issue, we have to specify the way the expectations are formed and their consequences for the forecasting of the economic system's development.

Consider an agent at any date. The information he has received before that date is given. This given information contains not only signals about the economy under study, but also about the outside world or the external environment. This outside information evidently influences the behaviour of the agents and the development of the system and the economy as a whole. Consequently, the forecasts of the economic systems and the economy should explicitly take into account this outside information and its influence on the agents' expectation formation. In this respect the signals of the opinion polls of the agents may prove to be even more valuable than statistical data about the economy's past development.

4. CONCLUSIONS

The novel features of our heuristic implementation model are that it describes an adaptive economic system design and includes among the economic agents the parliament and the government. The noncooperative model blends the features of Bayes–Nash two-stage game, the principal-agent theory, and the parliamentary decision procedures.

Our approach of adaptivity reacts especially to the problem of the arrival of new information. For example, if the development of the system has moved in time yielding some unforeseen outcomes, the planned target system should be corrected respectively. Following this line of reasoning has lead us to the complicated issues of knowledge in the manner of the Hayekian theory (Kirzner, 1992) involving the discovery of hitherto unknown attractive opportunities and unpleasant impossibilities.

On the basis of the analysis of the model we have shown that the Bayesian outcomes of that model may implement in traditional sense the socially desirable economic system transition 'only by sheer accident'. This is due to the problematical nature of the adaptive target, uncertain nature of the implemented design, different objective functions of the heterogenous agents, asymmetric information of the agents, parliamentary decision procedures, the loopholes in laws, etc.

To overcome this dead end we have shown that a reasonable implementation criterion in the adaptive case is to stay within the limits of admissible implementation errors. Under this approach the crucial problem of implementability is not any more the type of the socially desirable system but the properties of the implementing mechanisms. Our finding is that there are two necessary conditions for the implementing mechanisms: communicativeness and optimization.

As we have already mentioned the solution of the described model may not guarantee the fulfilment of these conditions at least in the parliamentary voting procedures. First we have mentioned that the majority voting may pass Pareto inferior laws or reject Pareto efficient ones (Harris & Townsend, 1981). And later we have shown the possibility of deforming information or blocking the socially optimal decisions in the government and by economic agents. To avoid some such non-implementability problems we have just used Tirole's (1991) recipe: "Strong safeguards must be put in place to prevent governments from serving the interest of specific groups."

To improve the implementations a few modest proposals are in order. First, in the parliamentary decisions the condition of Paretian optimality should be strictly followed. Second, the transitional uncertainties should be minimized in making the decisions (specification of time limits and other necessary conditions and avoiding loopholes in the laws). And third, the biased influence of certain interest groups in working out the governmental decisions should be avoided.

ACKNOWLEDGEMENTS

The author would like to acknowledge Pertti Haaparanta and Karl O. Moene for helpful suggestions and corrections. All the errors remain mine.

The support from the EU Commission's PHARE ACE Programme (Project 94-0004-C) and from the Estonian Science Foundation (Grant 1564) is gratefully acknowledged.

REFERENCES

Aumann, R. 1987. Correlated equilibrium as an expression of Bayesian equilibrium. – Econometrica, **55**, 1, 1–18.

Bergin, J. 1989. A characterization of sequential equilibrium strategies in infinitely repeated incomplete information games. – Journal of Economic Theory, **47**, 1, 51–65.

Buchanan, J. 1987. The constitution of economic policy. – The American Economic Review, **77**, 3, 243–250.

Buchanan, J. 1994. Lagged implementation as an element in constitutional strategy. – European Journal of Political Economy, **10**, 1, 11–26.

Chander, P. 1986. The design of efficient resource allocation mechanisms. – In: Samuelson, L. (ed.). Microeconomic Theory. Kulwer-Nijhoff Publishing House, Boston, 139–157.

Davidson, P. 1990. Shackle and Keynes vs. rational expectation theory and the role of time-liquidity and financial markets. – In: Frowen, S. (ed.). Unknowledge and Choice in Economics. Proceedings of the Conference in Honour of G. L. S. Shackle. Macmillan, London, 64–80.

Dewatripont, M. and Roland, G. 1992. Economic reform and dynamic political constraints. – Review of Economic Studies, **59**, 4, 703–730.

Edwards, S. 1992. The Sequencing of Structural Adjustment and Stabilization. International Center for Economic Growth, Occasional Papers, No. 34, San Francisco.

Ennuste, Ü. 1970. On the principle of economic effectiveness of a planning system. – ENSV TA Toimetised. Ühiskonnateadused, **XIX**, 4, 415–425.

Ennuste, Ü. 1992. A market-like implementation example. – Proc. Estonian Acad. Sci. Humanities and Social Sciences, **41**, 2, 61–70.

Fernandez, R. and Rodrik, D. 1991. Resistance to reform: *Status quo* bias in the presence of individual-specific uncertainty. – The American Economic Review, **81**, 5, 1146–1155.

Forges, F. 1990. Universal mechanics. – Econometrica, **58**, 6, 1341–1364.

Georgescu-Roegen, N. 1971. The Entropy Law and the Economic Process. Harvard University Press, Cambridge, Massachusetts.

Gibbons, R. 1992. Game Theory for Applied Economists. Princeton University Press, Princeton, New Jersey.

Grandmont, J.-M. 1982. Temporary general equilibrium theory. – In: Arrow, K. and Intrilligator, M. (eds.). Handbook of Mathematical Economics, Vol. III, North-Holland, Amsterdam, 879–922.

Green, J. and Laffont, J. J. 1986. Partially verifiable information and mechanism design. – Review of Economic Studies, **LIII**, 447–456.

Harris, M. and Townsend, R. 1981. Resource allocation under asymmetric information. – Econometrica, **49**, 1, 33–64.

Hettich, W. and Winer, S. 1988. Economic and political foundations of tax structures. – The American Economic Review, **78**, 4, 701–712.

Hicks, J. 1979. Causality in Economics. Basic Books, New York.

Hurwicz, L. 1986. Incentives aspects of decentralization. – In: Arrow, K. and Intrilligator, M. (eds.). Handbook of Mathematical Economics, Vol. III, North Holland, Amsterdam, 1441–1482.

Jackson, M. 1991. Bayesian implementation. – Econometrica, **59**, 2, 461–477.
Kalai, E. and Lehrer, E. 1993. Rational learning leads to Nash equilibrium. – Econometrica, **61**, 5, 1019–1045.
Kirzner, I. 1992. The Meaning of Market Process. Essays in the Development of Modern Austrian Economics. Routledge, London and New York.
Kornai, J. 1993. Postsocialist transition: An overall survey. – European Economic Review, **1**, 7, 53–64.
Kreps, D. and Ramey, G. 1987. Structural consistency, and sequential rationality. – Econometrica, **55**, 6, 1331–1348.
Kreps, D. and Wilson, R. 1982. Sequential equilibria. – Econometrica, **50**, 4, 863–894.
Marshak, T. 1986. Organization design. – In: Arrow, K. and Intrilligator, M. (eds.). Handbook of Mathematical Economics, Vol. III, North Holland, Amsterdam, 1359–1440.
Matsuhima, H. 1993. Bayesian monotonicity with side payments. – Journal of Economic Theory, **59**, 107–121.
Niskanen, W. 1971. Bureaucracy and Representative Government. Chicago, Aldin-Atherton.
Palfray, T. and Srivastava, S. 1989. Implementation with incomplete information in exchange economies. – Econometrica, **57**, 1, 115–134.
Pomery, J. 1990. Uncertainty in trade models. – In: Johnes, R. and Kenen, P. (eds.). Handbook of International Economics, Vol. 1, International Trade. North-Holland, Amsterdam, 419–465.
Postlewaite, A. and Schmeidler, D. 1986. Implementation in differential information economies. – Journal of Economic Theory, **39**, 1, 14–33.
Roland, G. 1992. Issues in the political economy of transition. Paper for CEPR Conference on "The Economic Consequences of the East", held on 20/21 March in Frankfurt am Main, CEPRE Bulletin, 50/51, April/June, 13.
Rubinstein, A. 1991. Comments on the interpretation of game theory. – Econometrica, **59**, 4, 909–924.
Schmiedling, H. 1993. From plan to market: On the nature of the transformation crisis. – Weltwirtschaftliches Archiv, **129**, 2, 216–253.
Tirole, J. 1991. Privatization in Eastern Europe: Incentives and the economics of transition. – In: Blanchard, O. and Fischer, S. (eds.). NBER Macroeconomics Annual. The MIT Press, Cambridge, Massachusetts, 221–295.
Vercelly, A. 1991. Methodological Foundations of Macroeconomics: Keynes and Lucas. Cambridge University Press, Cambridge.
Weingast, B. 1993. Constitutions as governance structures: The political foundations of secure markets. – Journal of Institutional and Theoretical Economics, **149**, 1, 286–311.

MAJANDUSSÜSTEEMIDE ADAPTIIVSEST RAKENDAMISEST: BAYESI–NASHI ANALÜÜS

Ülo ENNUSTE

Artiklis on kaheetapilise mängu abil selgitatud sotsiaalselt sobivat majandussüsteemi adaptiivselt rakendava mehhanismi tarvilikke omadusi kooskõlatu vaegteabe korral. Osutub, et see mehhanism peab kindlasti rahuldama teadustamise ja optimeerimise tingimusi.

ОБ АДАПТИВНОМ ПОСТРОЕНИИ ЭКОНОМИЧЕСКИХ СИСТЕМ: АНАЛИЗ БАЙЕСА–НЕША

Юло ЭННУСТЕ

В статье проанализированы необходимые предпосылки для эффективной работы механизма, адаптивно строящего экономическую систему. Оказывается, что для этого механизм должен удовлетворять двум условиям: сообщению и оптимизации.