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MODELS OF WILLINGNESS TO PAY FOR SUSTAINABLE DEVELOPMENT

Introduction

Growing consciousness of dangers that overexploatation and overpollution of natural environment bring to the human beings causes growing careness of natural resources, involving increasing interest in the questions of sustainable development. According to the definition of World Commission on Environment and Development (better known as Brundtland Commission), sustainable development is such one that "(…) meets the needs of the present without compromising the ability of future generations to meet their own needs" [United Nations 1987].

From economic point of view one of the problems is, that these natural goods have no obvious price and are difficult to be involved into economic accounts. Thus instead of asking about price of clear water or fresh air, economists rather ask people, which amount of money are they ready to pay for obtaining some defined desired state. This is called a *willingness to pay*, and has to be estimated in any attempt to introduce changes, that will lead to the better state of natural environment. It is obvious, that new "clear" technologies will cost more than traditional ones, at least in the early stage of their introduction. Thus, there are needed tools for investigating whether the society is ready to bring additional costs for introducing new technologies – and the level of these acceptable additional costs.

In this paper a certain simple model of willingness to pay for public ecological goods will be proposed.

1. Utility function and willingness to pay

There are two approaches to modeling willingness to pay [Haab and McConnell 2003]. One is based on the random utility function. The other one,

which is possible only in the case of a binary choice, is to model willingness to pay directly, not through the medium of utility function. Both approaches have advantages: the first one is more universal while the second enables to model a bounded willingness to pay. Let s briefly summarize both of these approaches.

Within approach based on a random utility function it is assumed, that each individual has a defined utility of each possible scenario. The utility of scenario i for individual j, u_{ij}, depends on a vector of individual preferences and characteristics of an individual j, $\bar{z}_j$; his/her income, y_j (this particular characteristic of an individual is excluded from the vector $\bar{z}_j$ for reasons, which will become obvious soon); and also on a random variable, ε_{ij}:

$$u_{ij} \equiv f_i(y_j, \bar{z}_j, \varepsilon_{ij}). \tag{1}$$

Mostly, it is assumed, that deterministic and random parts of utility function are additive:

$$u_{ij} = v_i(y_j, \bar{z}_j) + \varepsilon_{ij}. \tag{2}$$

Individuals are assumed to choose this option, of which his/her utility has greater value. Thus, if an individual j is proposed to pay a certain sum of money, t_j, for a scenario 1 to be realized, he/she will agree conditioned that:

$$v_1(y_j - t_j, \bar{z}_j) + \varepsilon_{1j} > v_0(y_j, \bar{z}_j) + \varepsilon_{0j}. \tag{3}$$

Note, that within scenario 1 the income of an individual is lessen by a proposed sum of money t_j – and that is a cause of excluding income from the vector of individual characteristics and taking it explicitly into regard.

As utility function involve a random term, also the decisions of individuals will have a probabilistic character. Denoting a difference of random variables of two scenarios by ε_j:

$$\varepsilon_j \equiv \varepsilon_{0j} - \varepsilon_{1j}, \tag{4}$$

the probability, that an individual j will agree on a proposed payment t_j (what will be denoted by $\omega_j = 1$, while $\omega_j = 0$ will mean answer "no") may be expressed in terms of cumulative distribution function of this random variable ε_j:

$$\Pr(\omega_j = 1) = \Pr\left(\varepsilon_{0j} - \varepsilon_{1j} < v_1(y_j - t_j, \bar{z}_j) - v_0(y_j, \bar{z}_j)\right)$$
$$= F\left(v_1(y_j - t_j, \bar{z}_j) - v_0(y_j, \bar{z}_j)\right), \tag{5}$$

where:

$F(x) = \Pr(\varepsilon_j < x)$.

Parameters of functions v_0 and v_1 may be estimated by means of maximizing the likelihood function:

$$L = \prod_j \left[F\left(v_1(y_j - t_j, \bar{z}_j) - v_0(y_j, \bar{z}_j)\right) \right]^{\omega_j}$$
$$\left[1 - F\left(v_1(y_j - t_j, \bar{z}_j) - v_0(y_j, \bar{z}_j)\right) \right]^{1-\omega_j} \tag{6}$$

The willingness to pay of an individual j for scenario 1, WTP_j, is defined as such a sum of money, for which utility of scenarios 1 and 0 are equal:

$$v_1(y_j - WTP_j, \bar{z}_j) + \varepsilon_{1j} = v_0(y_j, \bar{z}_j) + \varepsilon_{0j}. \tag{7}$$

Transforming (7) one may obtain an expression for willingness to pay:

$$WTP_j(\varepsilon_j) = y_j - v_1^{-1}(v_0 - \varepsilon). \tag{8}$$

In general, it may be a complicated function of a random variable ε_j. However, if ε_j has an infinite distribution (like normal or logistic ones) also WTP_j has an infinite distribution.

There are at least two problems with random utility function approach. The first is the possible infinity of distribution of willingness to pay, mentioned already. In some cases it may turn out, that the probabilities of willingness to pay less than zero or exceeding income are quite significant. In special situations it may be so, that an individual will accept a proposed scenario only conditioned that he/she will be paid for it (willingness to pay less than zero), however, the willingness to pay exceeding income still makes sense in no circumstances.

The second problem is in comparing utilities. Most of ecological goods belong to the classes of so-called common-pool resources and public goods (according to Elinor Ostrom classification [Ostrom 2009]). Both these classes are characterized by a "high difficulty of excluding potential beneficiaries" [Ostrom 2009]. In the context of this kind of goods there appear a problem of "free riding" [Wiser 2007; Champ and et al. 1997]. Paying for any "private good", e.g. food or clothing, one always gets what he/she has paid for. On the

contrary, due to high difficulty of excluding potential beneficiaries, one can be never sure of the effect of his/her paying for any common-pool resource or public good. Thus it may seem more adequate to take into regard the willingness to pay in such cases, instead of the utility of scenario which may never be realized. The general form of willingness to pay function reads:

$$WTP_j \equiv WTP_j(\bar{z}_j, \varepsilon_j), \tag{9}$$

where $\bar{z}_j$ denotes a vector of individual preferences and characteristics (may also include income – note, that here there is no necessity of including it explicitly as a function variable), and ε_j is a random variable with a distribution to be specified.

In attempts to model willingness to pay directly, one should take also the first of the problems mentioned above into regard and choose the model function so to assure, that willingness to pay will range from zero to income:

$$0 \leq WTP_j \leq y_j.$$

The natural form of such function will in general read:

$$WTP_j(\bar{z}_j, \varepsilon_j) = G_j(\bar{z}_j, \varepsilon_j)y_j, \tag{10}$$

with $0 \leq G_j(\bar{z}_j, \varepsilon_j) \leq 1$.

Estimation of parameters of function G proceed as usually, by means of finding maximum of likelihood function.

Later on we will propose a simple definite form of willingness to pay function. First, let us ground the choice of key variables that will appear in the proposed function.

2. Social interactions and altruism

A common sense and life knowledge have never negated the fact, that people's behavior strongly depend on the behavior of the others. This is the base of so-called "social norms" (which may differ from society to society), without which the social harmony wouldn't be possible. Moreover, in the context of modern knowledge the "herd behavior" of individuals – no matter whether judged positively or negatively – cannot be denied [Aronson 2003]. However,

economists for a long time tried to get around, treating all social interactions as mediated by the market. This approach has turned out to be unsatisfactory in explanations of phenomena of real social world, and thus there are arising consecutive models, that are taking social interactions explicitly into account [Ostasiewicz et al. 2008; Blume 1995; Brock and Durlauf 2001].

Some of them are based on the concept of Mark Granovetter, who was the author of widely known threshold model [Granovetter 1997]. The main idea of the threshold model is that a given individual will join a certain action ($\omega_j = 1$) conditioned that a certain percent of the others has already joined it:

$$P(\omega_j = 1) = \begin{cases} 1 & \text{if} \quad m \geq Th_i \\ 0 & \text{if} \quad m < Th_i \end{cases}. \tag{11}$$

This percent, Th_i, may be different for different individuals (in particular, it may equals 0), and is called a threshold of the individual. For the action to be initialized there must exist at least one person with the zero threshold.

Dependence of choices of individuals on the choices of the others implies a dynamical character of the model. This dynamics may be called a kind of a "domino effect", as action of some individuals results in actions of some other individuals and so on. The percent of participants of the action changes from time step to next time step according to the following expression:

$$m(t) = F_{Th}(m(t-1)), \tag{12}$$

where F_{Th} denotes distribution of thresholds across the whole population.

Stationary states, that is, such states that are reached within long enough time and do not evolve in time any more, denoted by m^*, may be obtained from:

$$m^* = F_{Th}(m^*). \tag{13}$$

In the quasi continuous version expression (12) takes the form:

$$\frac{dm}{dt} = F_{Th}(m) - m, \tag{14}$$

while stationary state condition remains the same, see (13).

The evolution of percent of participants of an action and finding a stationary state may be easily pictured, as on an exemplary graph below.
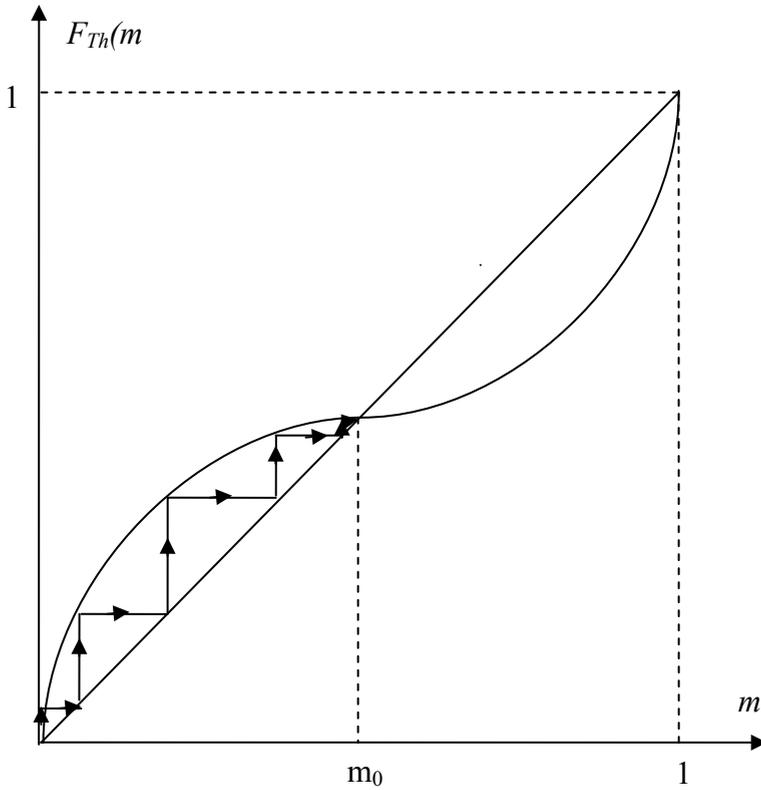
Fig. 1. An example of evolution of percent of participants and obtaining a stationary state in threshold model

Let us also define a so-called "potential", $V(m)$, which is a counterpart of physical potential. Let us define it as follows:

$$\frac{dm}{dt} = -\frac{dV(m)}{dm}. \tag{15}$$

This construct is very useful for determining the character of stationary points (there may be stable or unstable stationary states). The properties of potential defined by (15) are as follows:

1) it has an extremum in the stationary point, what follows from the condition:

$$\frac{dm}{dt} = 0 \Rightarrow \frac{dV(m)}{dm} = 0;$$

2) this extremum is a minimum for stable stationary point and maximum for unstable one.

Thus, having a potential one may easily decide, which solutions of stationary state condition are stable and which are unstable ones, imagining a ball, rolling in the valley of the shape of potential. On the other hand, apart from the definition (15) the potential may be expressed as follows (by substituting (14) to definition (15)):

$$V(m) = \frac{m^2}{2} - \int_0^m F_{Th}(m')dm'. \tag{16}$$

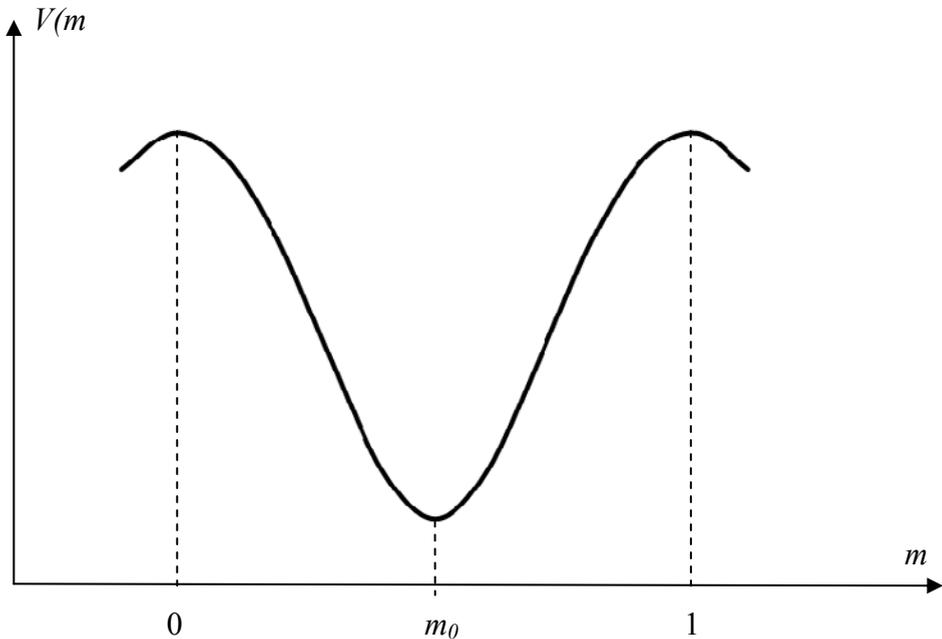As an example, the shape of the potential for the system shown on Figure 1 is presented below.

Fig. 2. Potential corresponding to the system presented on Fig. 1

The second key variable in the model that will be presented in next sections is a degree of altruism. It may be a matter of discussion, whether an altruist feelings are an artifact of social interactions (inner social norms), product of mirror neurons or even something transcendental. Anyway, it is the fact, that in many situations many individuals behave altruistically, even if sometimes it may be perceived as not a "pure" altruism but rather a reciprocal one or forced by social pressure. Otherwise, no cooperation would be possible and all common-pool re-

sources would be already destroyed, as forecasted by Garrett Hardin [Hardin 1968]. However, as Elinor Ostrom has definitely proved [Ostrom 2009], there are many circumstances in which people are willing to cooperate and behave not accordingly to their sole economical profit. This kind of altruism may be viewed as a "long-range" rationality. However, there are also many situations, when individuals behave altruistically not having in perspective a reciprocity of long-time economical gain. Daniel Kahneman [Kahneman and Knetsch 1992] stated, that people are willing to pay not only for measureable economical goods but are willing also to "buy" a moral satisfaction of behaving "good".

The degree of altruism may be measured by some standard questionnaires of this feature of human character, and will be taken in what follows as ranging from 0 to 1. It will be also assumed, that that greater degree of altruism the less temptation of free riding of an individual.

3. Willingness to pay model

Taking social nature of human beings and temptation of "free riding" into account, the general form of model of willingness to pay for public ecological goods will be as follows:

$$WTP_j \equiv WTP_j(\bar{z}_j, m, a_j, \varepsilon_j), \tag{17}$$

where m denotes a percent of the whole population which is also willing (or is thought/expected by a given individual j to be willing) to pay; a_j denotes the degree of altruism of an individual j (as measured by some standard questionnaires for measuring this feature), $a_j \in \langle 0,1 \rangle$; $\bar{z}_j$ is a vector of measures of other characteristics of an individual and ε_j is a random variable.

The dependence of willingness to pay on the percent of others that are also willing to pay enables reinterpreting this model in terms of threshold model [Ostasiewicz et al. 2008]. Indeed, conditioned that:

$$\frac{\partial WTP_j(\bar{z}_j, m, \varepsilon_j)}{\partial m} \geq 0$$

and

$$\frac{\partial WTP_j(z_j, m, \varepsilon_j)}{\partial \varepsilon_j} \geq 0$$

the probability that the willingness to pay will exceed a proposed sum of money t_j, may be expressed in terms of probability that the percent of participants will exceed a certain number, which may be called a threshold:

$$P\big(WTP_j \geq t_j\big) = P\left(m \geq Th_j\big(t_j, \varepsilon_j\big)\right) = \begin{cases} 1 & \text{if} \quad m \geq Th_j\big(t_j, \tilde{\varepsilon}_j\big) \\ 0 & \text{if} \quad m < Th_j\big(t_j, \tilde{\varepsilon}_j\big) \end{cases},$$

where $\tilde{\varepsilon}_j$ denotes a realization of a random variable ε_j.

However, one has to keep in mind that this similarity of willingness to pay model to threshold model (11) holds only in the probabilistic sense and not in all situations. Note, that within WTP model the threshold is a random variable itself and decision of even a single one individual has a probabilistic character. On the other hand, within the simple version of threshold model presented in the previous section, a value of threshold of a given individual is constant and there is no uncertainty. Probabilistic approach may be applied to this threshold model only in the case of a large population and values of thresholds that may be treated as realizations of some random variable. Then, if random variables of different individuals within willingness to pay model are identical, $\varepsilon_j \equiv \varepsilon$, but characteristics of individuals are different, it is possible to treat both kinds of models as equivalent in probabilistic sense. Then dynamical equations (12,14) and stationary state condition (13) may be applied to describe willingness to pay model.

In the case of so-called mean-field approach, that is, such approximation, within which each individual is "replaced" by an "averaged" one (or in the case, when all characteristics of all individuals are in fact identical) there may not be a real dynamics. If all individuals are the same, then all of them should make the same decision – any differences in decisions will be only a result of a randomness, which will cause fluctuations around some state. Nevertheless, the condition for stationary states (13) will still holds and graphical way of obtaining them is still valid. Potential (16) may be still used to examine stability properties of obtained stationary states.

4. An example

Let us propose a simple example. We want to investigate the properties of the model (17) with the willingness to pay function dependent only on the percent of the population which is willing to pay, m, the degree of altruism, a_j, and

income, y_j, as characteristics of an individual. We want to find a function that will have the following properties:

1) the values of the function range from zero to income of an individual, $0 \leq WTP_j \leq y_j$;
2) it is an increasing function of m, a_j and ε_j;
3) for zero altruism and $m \neq 1$ it tends to zero, $\lim_{a_j \to 0} WTP_j = 0$;
4) for maximum altruism it does not depend on percent of population, $WTP_j(m, 1, \varepsilon) \equiv WTP_j(1, \varepsilon)$.

It may be checked, that the following function is fulfilling all the required properties:

$$WTP_j\left(m, a_j, \varepsilon\right) = \frac{y_j}{1+\exp\left[\alpha m^{\beta \ln a_j} - \varepsilon\right]} \tag{18}$$

conditioned that $\alpha > 0$, $\beta > 0$. Note, that random variables are assumed here to be identical for all individuals.

1) As $\exp(x) \geq 0$ for $x \in \langle -\infty, +\infty \rangle$ thus:

$$\left[1/\left(1 + \exp\left[\alpha m^{\beta \ln a_j} - \varepsilon\right]\right)\right] \in \langle 0, 1 \rangle$$

and:

$$0 \leq WTP_j \leq y_j.$$

2) For $\frac{\partial WTP_j(m, a_j, \varepsilon)}{\partial m} \geq 0$ it is sufficient $\frac{\partial \exp\left[\alpha m^{\beta \ln a_j}\right]}{\partial m} \leq 0$ to be fulfilled. Then:

$$\frac{\partial \exp\left[\alpha m^{\beta \ln a_j}\right]}{\partial m} = \exp\left[\alpha m^{\beta \ln a_j}\right] \alpha \beta \ln a_j m^{\beta \ln a_j - 1}.$$

As $\exp(x) \geq 0$ for any x, for $m \in \langle 0, 1 \rangle$: $m^x \geq 0$ for any x, and for $a_j \in \langle 0, 1 \rangle$: $\ln a_j \leq 0$, thus for $\alpha > 0$, $\beta > 0$ condition $\frac{\partial \exp\left[\alpha m^{\beta \ln a_j}\right]}{\partial m} \leq 0$ indeed holds, and the function (18) increases with increasing m.

Similarly, for $\frac{\partial WTP_j(m, a_j, \varepsilon)}{\partial a_j} \geq 0$ it is sufficient $\frac{\partial \exp\left[\alpha m^{\beta \ln a_j}\right]}{\partial a_j} \leq 0$ to be fulfilled. As

$$\frac{\partial \exp\left[\alpha m^{\beta \ln a_j}\right]}{\partial a_j} = \alpha \beta \frac{\exp\left[\alpha m^{\beta \ln a_j}\right]}{a_j} m^{\beta \ln a_j} \ln m \leq 0 \text{ for } 0 \leq m \leq 1$$

thus the function (18) increases with increasing a_j.

As for ε it is obvious, that $\exp[-\varepsilon]$ is a decreasing function of ε and thus WTP_j an increasing function of ε.

3) $\lim_{a_j \to 0} WTP_j(m, a_j, \varepsilon) = \lim_{a_j \to 0} \frac{y_j}{1+\exp[\alpha m^{\beta \ln a_j} - \varepsilon]} = 0$

as $\lim_{a_j \to 0} \ln a_j = -\infty$

and thus $\lim_{a_j \to 0} \exp[\alpha m^{\beta \ln a_j} - \varepsilon] = \infty$.

4) $WTP_j(m, 1, \varepsilon) = \frac{y_j}{1+\exp[\alpha m^{\beta \ln 1} - \varepsilon]} = \frac{y_j}{1+\exp[\alpha - \varepsilon]} = WTP_j(1, \varepsilon)$.

Let us examine the stationary states of the system in the mean-field approximation. Within this approximation each individual is replaced by an "averaged individual", that is: $y_j \equiv \bar{y}$, $a_j \equiv \bar{a} = a$. Within this approximation the condition for stationary states reads:

$$m = 1 - F\left(-\ln\frac{1-t}{t} + \alpha m^{\beta \ln a}\right) \tag{19}$$

where F is a cumulative distribution function of a random variable ε and t proposed percent of an income to be paid.

If distribution of a random variable ε is symmetrical, then $F(x) = 1 - F(-x)$ holds and the condition (19) may be rewritten as:

$$m = F\left(\ln\frac{1-t}{t} - \alpha m^{\beta \ln a}\right). \tag{20}$$

Let us assume as a distribution of a random variable a logistic one with standard values of parameters:

$$F(x) = \frac{1}{1+\exp\left(-\frac{x}{\sigma}\right)}. \tag{21}$$

Substituting (21) into (20) one gets a stationary state condition:

$$m = 1 \Big/ \left[1 + \left(\frac{t}{1-t}\right)^{\frac{1}{\sigma}} \exp\left(\frac{\alpha}{\sigma} m^{\beta \ln a}\right)\right]. \tag{22}$$

Let us examine the existence and numbers of stationary states defined by the condition (22). In order to shorten notation let us introduce functions $g(m)$ and $h(m)$ defined as a right-hand-side and left-hand-side, respectively, of condition (22), i.e.:

$$g(m) \equiv 1 \Big/ \left[1 + \left(\frac{t}{1-t} \right)^{\frac{1}{\sigma}} \exp \left(\frac{\alpha}{\sigma} m^{\beta \ln a} \right) \right], \qquad (23a)$$

$$h(m) \equiv m. \qquad (23b)$$

As $m \in \langle 0,1 \rangle$ we are interested in the crossing of the curve $y = g(m)$ and a line $y = m$ within this range of variable. In the lower limit $g(m)$ starts from zero, $g(0) = 0$ and then it is increasing to the value of the upper limit,

$$g(1) = 1 \Big/ \left(1 + \left(\frac{t}{1-t} \right)^{\frac{1}{\sigma}} \exp \left(\frac{\alpha}{\sigma} \right) \right) \in (0, 1\rangle.$$

As $h(0) = 0$ there always exists at least one intersection of curves $g(m)$ and $h(m)$, for $m = 0$. As $h(1) = 1 \geq g(1)$ thus there may exists only this one intersection. On the other hand, the maximum possible number of intersections equals three. The actual number of solutions of stationary state condition depends on the values of parameters α, β and σ, as well as on the proposed fraction of income, t, and degree of altruism, a.

Let us present a simple (and artificial) example of dependence of stationary states on average altruism and proposed percent of income to be paid. Here we will take $\alpha = 1$, $\beta = 18$, $\sigma = 1$.

First, let us fix the proposed percent of income to be paid, $t = 0.01$. For average altruism less than 0.6 there are no stable stationary states apart from zero. For values of altruism greater than 0.6 there appear a second stationary and stable state with $m > 0$ (see Figure 3 for intersections of curves $g(m)$ and $h(m)$ – and thus existence of stationary points – and Figure 4 for corresponding potentials to examine stability of existing stationary points). The stability of this stationary state and the value of final percent of participants that are willing to pay are growing with growing value of a (see Figure 4 for degree of stability – the depth of the well of potential corresponding to the given stationary point, and Figure 5 for the value of m within this possible final state).
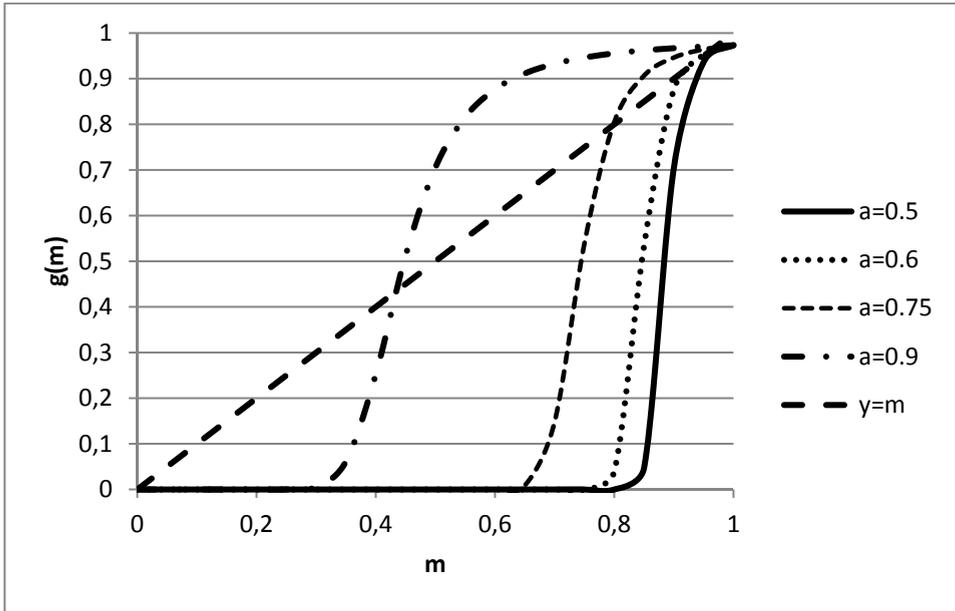
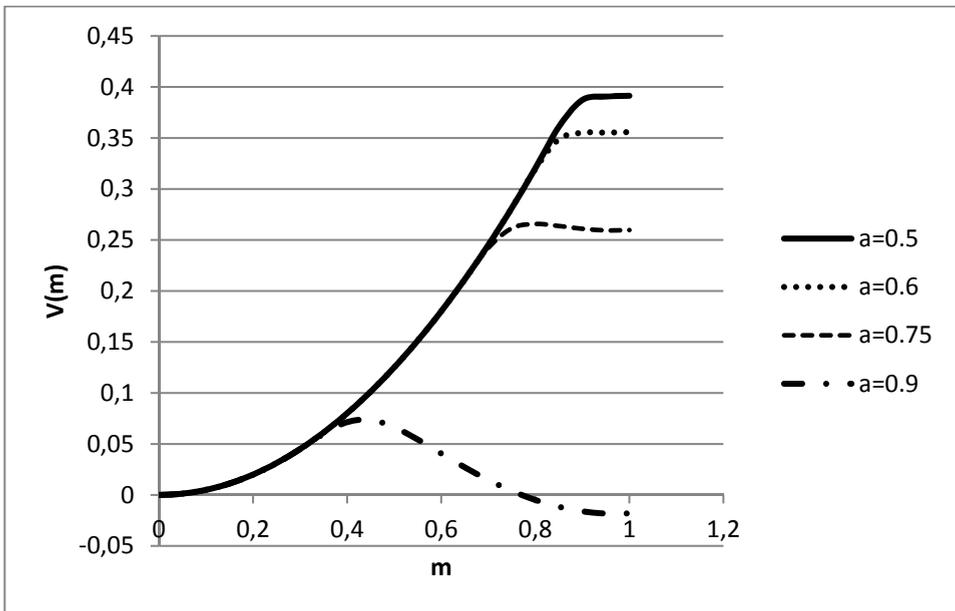Fig. 3. Plots of $g(m)$ and $h(m)$ for different values of average altruism

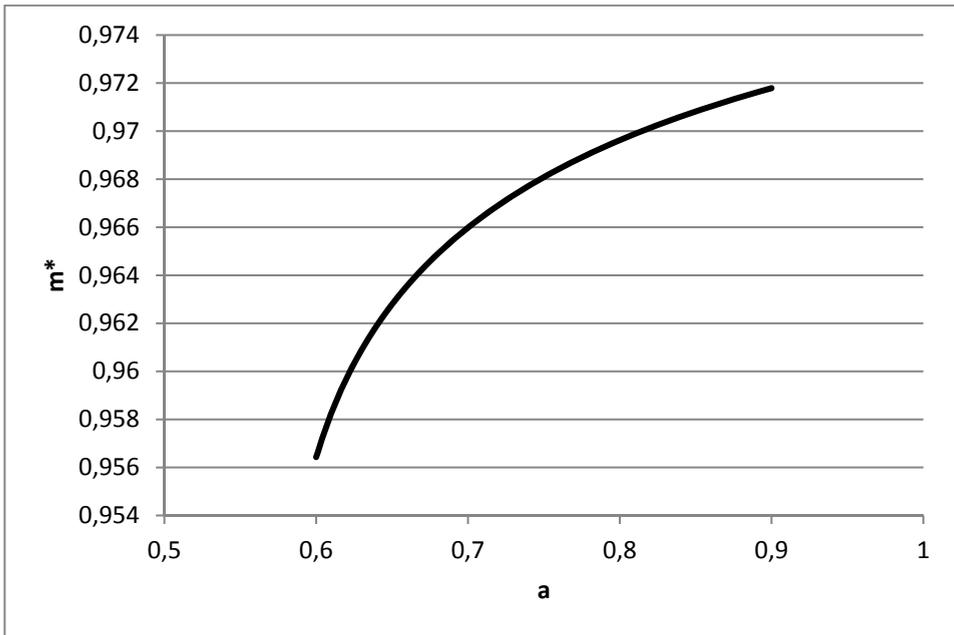Fig. 4. Potential of the system for different values of average altruism, corresponding to Fig. 3

Fig. 5. Dependence of nonzero stable stationary state on average degree of altruism

Now let us fix the value of average altruism on $a = 0.9$ and examine the dependence of stationary states on proposed percent of income to be paid. For $t > 0.056$ there does not exist a stationary state apart from $m^* = 0$. For $t = 0.056$ there appears second stable stationary state, which stability and value of m^* within it increases with decreasing t (see Figure 6 for existence of stationary states, Figure 7 for stability properties of these eventual states and Figure 8 for dependence of value of $m^* > 0$ on proposed payment t).
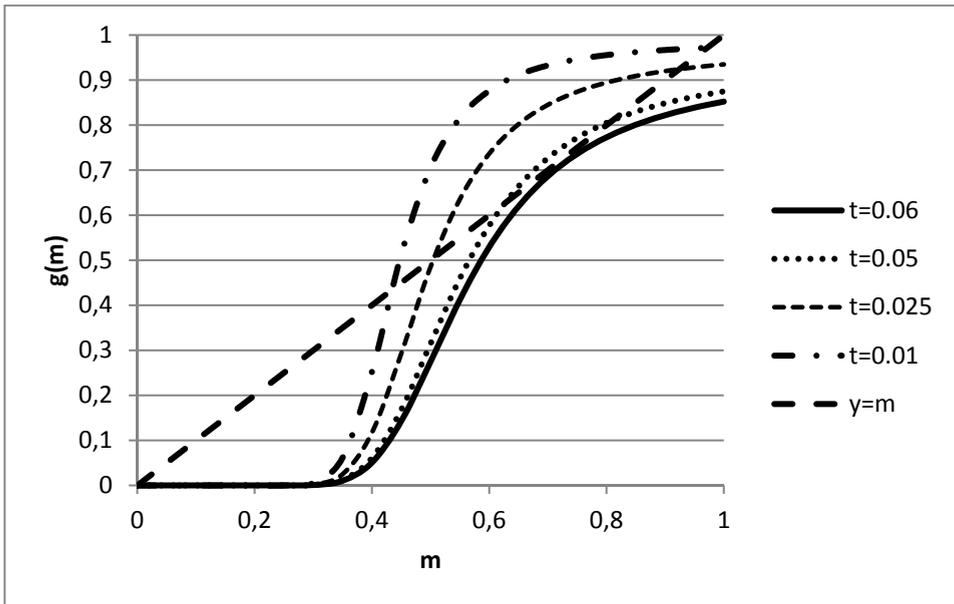
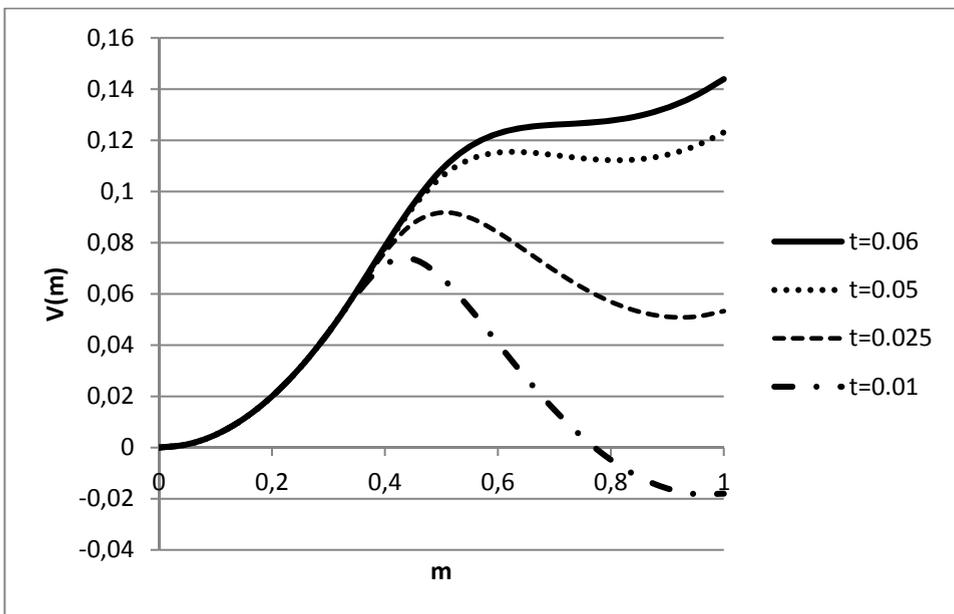Fig. 6. Plots of $g(m)$ and $h(m)$ for different values of proposed payment

Fig. 7. Potential of the system for different values of proposed payment, corresponding to Fig. 6
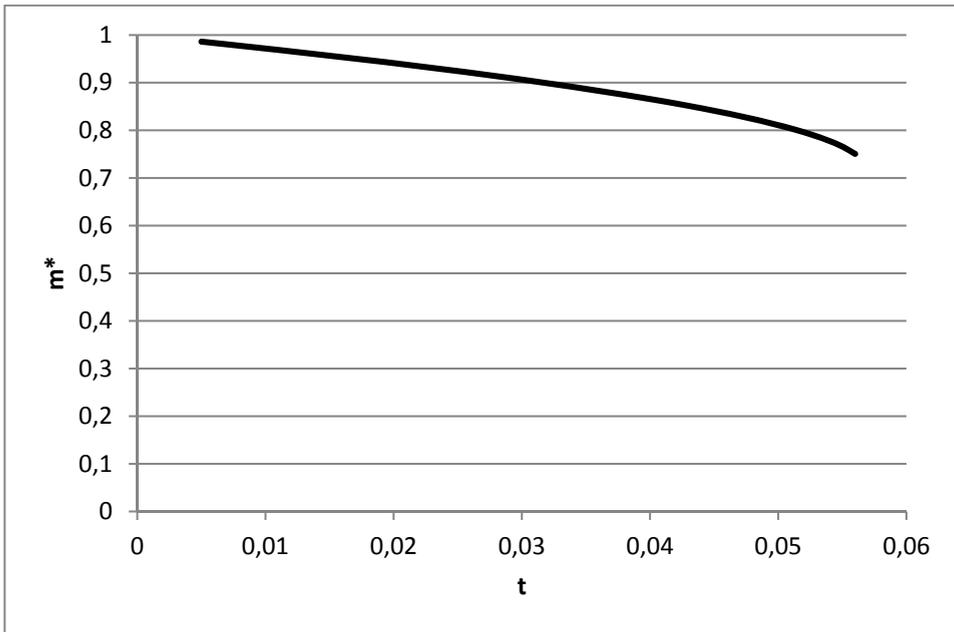
Fig. 8. Dependence of nonzero stable stationary state on proposed payment

The above results are intuitive ones, as one expects, that percent of donators for any public good will increase with increasing altruism and decrease with increasing sum of donation.

To obtain results with any reference to a certain real society one has to estimate the parameters of willingness to pay function and random variable basing on real data collected from empirical studies.

In order to estimate values of parameters α, β and σ one has to construct a likelihood function and then maximize it. In what follows we assume, that random variables are independent and identical for all individuals, and that each individual may be proposed to pay different percent of his/her income than the others individuals. The probability, that an individual j will agree on a proposed payment t_j reads (having in mind that t_j denotes a percent of income):

$$P\big(WTP_j \geq t_j y_j\big) = P\left(\frac{y_j}{1 + \exp[\alpha m^{\beta \ln a_j} - \varepsilon]} \geq t_j y_j\right) =$$

$$= P\left(\varepsilon \geq \ln \frac{t_j}{1-t_j} + \alpha m^{\beta \ln a_j}\right). \tag{24}$$

As ε is a symmetric distribution (a logistic one) thus (24) may be rewritten as:

$$P\big(WTP_j \geq t_j y_j\big) = P\left(\varepsilon \geq \ln\frac{t_j}{1-t_j} + \alpha m^{\beta \ln a_j}\right) = F\left(-\ln\frac{t_j}{1-t_j} - \alpha m^{\beta \ln a_j}\right). \quad (25)$$

Substituting (21) for $F(x)$:

$$P\big(WTP_j \geq t_j y_j\big) = \frac{1}{1+\exp\left[\frac{1}{\sigma}\ln\frac{t_j}{1-t_j}+\frac{\alpha}{\sigma}m^{\beta \ln a_j}\right]}. \quad (26)$$

Thus the likelihood function reads:

$$L(\alpha,\beta,\sigma) = \prod_i \left[\frac{1}{1+\exp\left[\frac{1}{\sigma}\ln\frac{t_j}{1-t_j}+\frac{\alpha}{\sigma}m^{\beta \ln a_j}\right]}\right]^{\omega_j} \left[\frac{1}{1+\exp\left[-\frac{1}{\sigma}\ln\frac{t_j}{1-t_j}-\frac{\alpha}{\sigma}m^{\beta \ln a_j}\right]}\right]^{1-\omega_j}. \quad (27)$$

Maximizing this function basing on collected real data will allow to get a final form of the model, which can be used to predict behavior of a given society stated in front of decision of paying or not for a certain ecological innovation.

Conclusions

As the challenge of slowing down degradation of our natural environment is a very short-time one, we need tools for investigating the state of minds of participants of our community, whose agreement for some steps toward this aim is needed in the democratic society. A standard willingness to pay approach seems insufficient unless it takes into regard the dependence of choices of individuals on the choices of the others. Including percent of participants as a variable of willingness to pay function impose an inner dynamics on the model. That is rather realistic, as ecological thinking seems to spread across populations like fashions (what does not necessarily suggest that believes and attitudes are nothing more than fashions or conformist acting).

In this paper general arguments and approach to including dependence individuals on the others is presented and a simple concrete model is proposed. Its properties has been shortly investigated within a mean-field approach. However, it is possible to go beyond this approximation and get more realistic (and much

more complicated) dynamical equations. Further analysis would reveal detailed dependence of behavior of the model on a specific distribution of degree of altruism and incomes across the population.

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MODELOWANIE GOTOWOŚCI DO PŁACENIA NA RZECZ ZRÓWNOWAŻONEGO ROZWOJU

Streszczenie

Postępująca degradacja środowiska naturalnego jest palącym problem współczesności. Jednym z elementów koniecznych do jego rozwiązania jest ekologiczna świadomość obywateli. Z tego względu, istotne jest badanie postaw ludzi wobec dobrowolnego

ponoszenia zwiększonych kosztów działań zachowujących środowisko naturalne w dobrym stanie. Standardowe modele skłonności do płacenia na rzecz ekologii wydają się niekompletne, gdyż nie uwzględniają zależności postaw jednostek od postaw ich otoczenia. Dbałość o ekologię jest bowiem nastawieniem szerzącym się w społecznościach na podobieństwo innych wzorców kulturowych i zachowań społecznych. Włączenie mechanizmu naśladownictwa do modelu nadaje mu zatem automatycznie charakter dynamiczny.

W pracy zaprezentowano ogólny model gotowości do płacenia, uwzględniający zależność wyborów jednostek od wyborów innych osób. Następnie, jako przykład, został zaproponowany i poddany analizie bardziej szczegółowy model. Omówiono jego właściwości zarówno w przybliżeniu średniego pola, jak i w ujęciu dynamicznym. Pokazano zależność rezultatów od rozkładu osobniczego stopnia altruizmu oraz dochodów.