Financial University under the Government of Russian Federation
Economics of Organization Chair

Georgiy V. Kolesnik

MODELING OF ENDOGENOUS FORMATION OF INDIVIDUALS' UTILITY FUNCTIONS IN SOCIO-ECONOMIC SYSTEMS

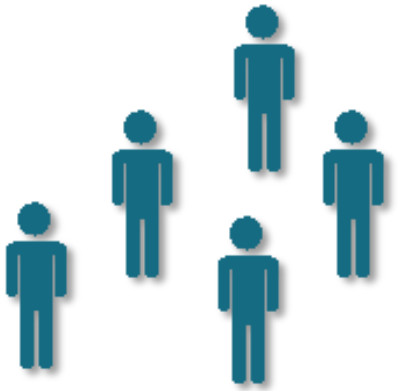
THREE WAYS TO MAKE A CAT EAT MUSTARD

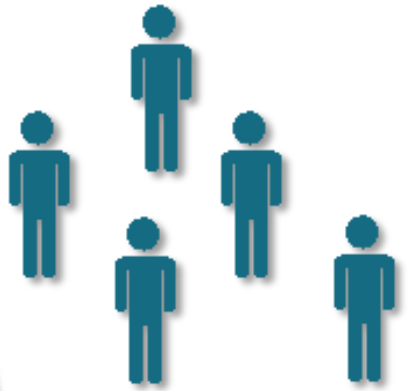
Forcibly

Gently

Voluntarily and with a song

HOW TO GET OTHERS TO DO WHAT WE NEED?





Enforcement

Motivation

Persuasion –
direct modification of the utility function

APPLICATIONS OF PERSUASION MECHANISM IN HUMAN SOCIETY

- Ideology
- Advertising
- Traditions
- Standards of corporate conduct
- Cults and different kind of addiction

BEHAVIOR MODIFICATION OUTSIDE OF HUMAN SOCIETY

Lomechusa strumosa

Ophiocordyceps unilateralis

Toxoplasma gondii

MODELING INDIVIDUALS' BEHAVIOR WITH SUPRA-INDIVIDUAL UTILITY

Germeyer-Vatel Model (1974) – description of the behavior of agents with common interests in the utility functions:

$$g_j(B_j, \mathbf{c}) = \Psi\left(u_j(B_j), F(\mathbf{c})\right)$$

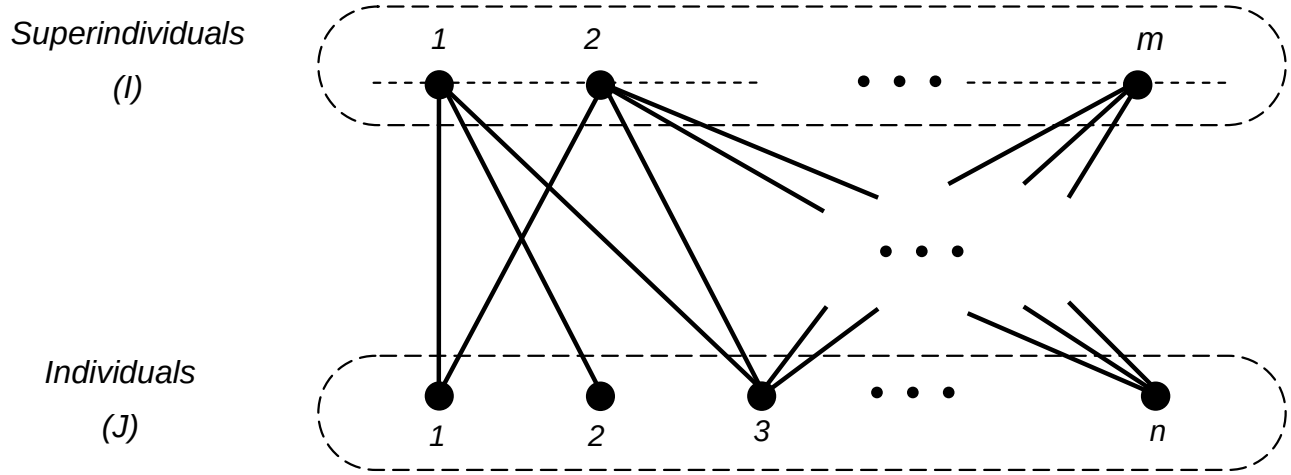
Dawkins R. (1976) – the concept of meme as a modifier of individual behavior. Evolutionary approach to the memes development.

Vasin A.A. (2010) – description of a supra-individual component of utility function based on the interests of superindividuals involving the subject:

$$g_j(B_j, \mathbf{c}) = u_j(B_j) + \sum_{i \in S} F_i(c_{ij})$$

B_j – personal consumption;
$\mathbf{c}$ – vector of public costs.

HIERARCHICAL SYSTEM «SUPERINDIVIDUALS – INDIVIDUALS»



- Each individual $j \in J$ has an amount r_j of certain resource which is allocated among personal consumption and support of superindividuals :

$$r_j = B_j + \sum_{i \in I} c_{ij},$$

- The utility function includes personal consumption and the superindividual component:

$$g_j(\mathbf{c_j}, \mathbf{w}) = u_j(r_j - \sum_{i \in I} c_{ij}) + \sum_{i \in I} \lambda_{ij}(\mathbf{w}) v_{ij}(c_{ij})$$

THE FORMATION OF A SUPRA-INDIVIDUAL UTILITY

- λ_{ij} – significance coefficient of superindividual $i \in I$ in the utility function of individual $j \in J$ – is determined by the amount of resource spent on the utility function modification w_i:

$$\lambda_i(\mathbf{w}) = \frac{w_i}{1 + \sum_{k=1}^{m} w_k}$$

- The utility function of the subject's participation in a superindividual $v_{ij}(\mathbf{c})$ depends on the «credibility» of the superindividual determined by the amount of collected funds, as well as individual's «involvement» determined by the amount of resource spent personally:

$$v_{ij}(\mathbf{c}) = \ln C_i + \ln c_{ij}$$

SUPERINDIVIDUAL UTILITY FUNCTION FORMATION

- Each superindividual $i \in I$ is controlled by an individual (manager), which distributes the collected resources:

$$R_j = r_j + \sum_{i \in I_j} C_i$$

- The manager allocates part of the resources for the activity of individuals' utility functions modification, and the remaining part is spent on personal consumption:

$$B_j = R_j - \sum_{i \in I_j} w_i$$

Manager's opportunistic behavior losses

ACTION SEQUENCE

- Managers $j \in J^*$ choose the values w_i for the superindividuals controlled $i \in I_j$, solving the problem:

$$g_j^*(\mathbf{w}) = g_j(\mathbf{c}_\mathbf{j}^*(\mathbf{w}), \mathbf{w}) \to \max_{\mathbf{w}}.$$

The choice

$$w_i > \sum_{l \in J \setminus \{j\}} c_{il}$$

corresponds to the case when the manager spends own resources to support superindividual *i*, the reverse inequality – the use of funds allocated by other individuals to support superindividual *i*, to increase personal consumption.

- All individuals $j \in J$ choose the amount of resources they are willing to spend on supporting superindividuals they do not manage, solving the problem for a fixed **w** :

$$g_j(\mathbf{c}_\mathbf{j}, \mathbf{w}) \to \max_{\mathbf{c_j}}.$$

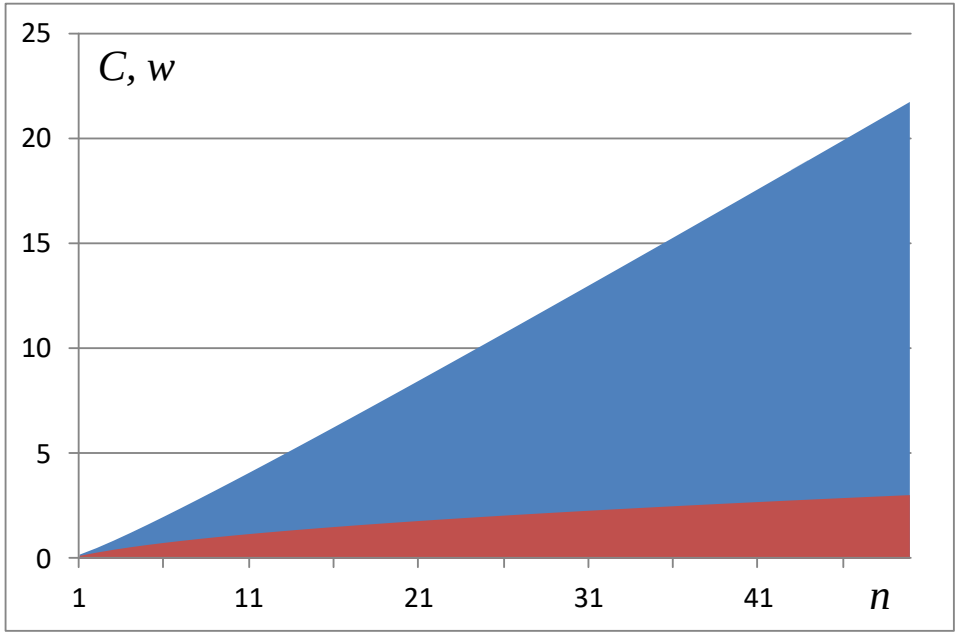
EQUILIBRIUM STRATEGIES IN THE SYSTEM

- Case $m = 1$
- Personal consumption utility:

$$u_j(\mathbf{c}) = \ln(1 - c_j)$$

- The optimal amount of resources allocated to support superindividual:

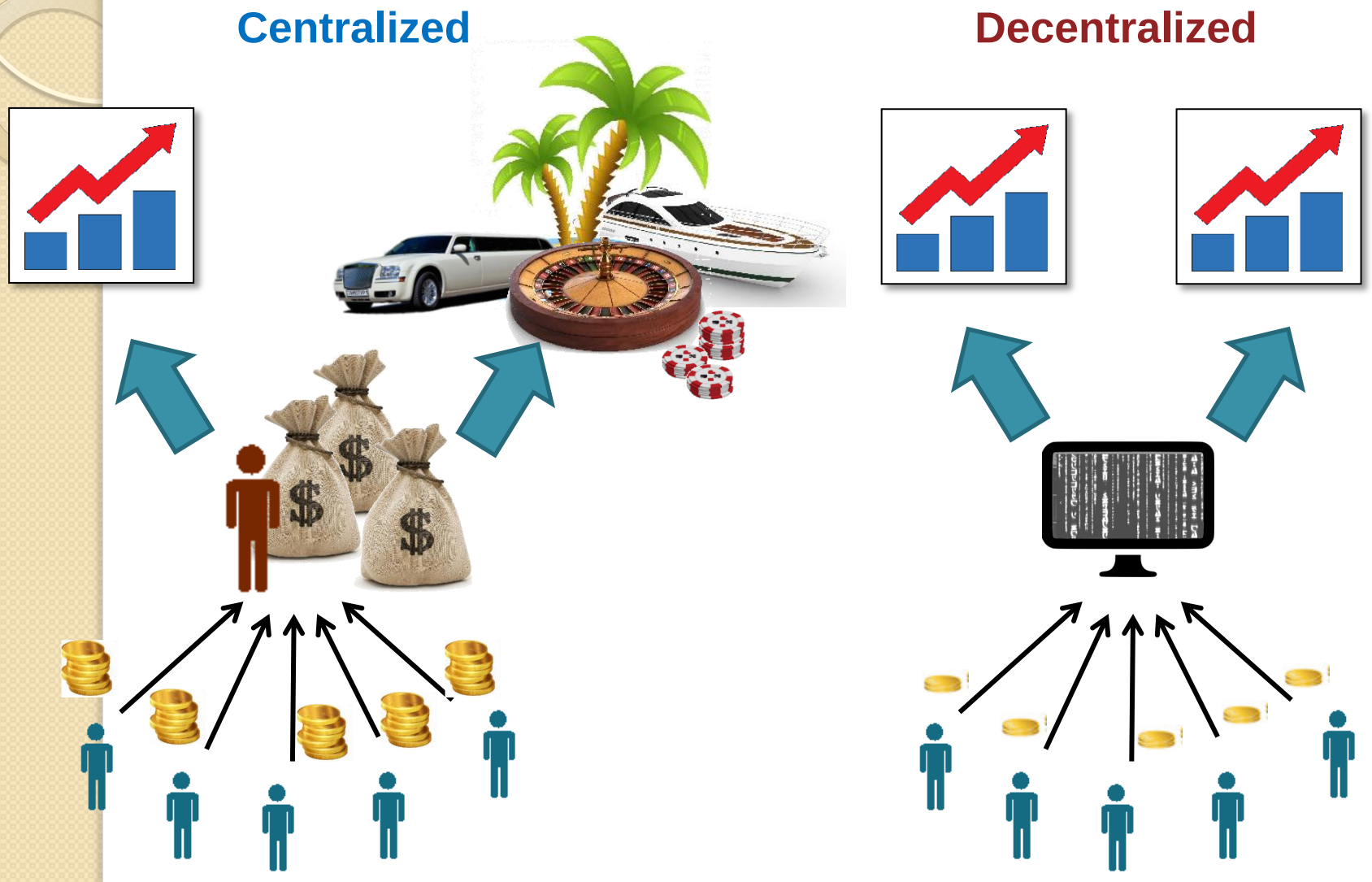
$$c_j^*(w) = \frac{(n+1)w}{w(2n+1)+n}$$



- Resources allocated by manager to expand the influence of superindividual:

$$w^* = \frac{n(\sqrt{n+1}-1)}{2n+1}$$

CENTRALIZED vs. DECENTRALIZED FINANCING MECHANISMS



SUPERINDIVIDUAL DECENTRALIZED FINANCING PROBLEM

- Each individual $j \in J$ allocates resource c_{ij} on the support of superindividual $i \in I$.
- Resources are fully spent in accordance with a certain algorithm of decentralized financing:

$$w = \sum_{s \in J} c_s$$

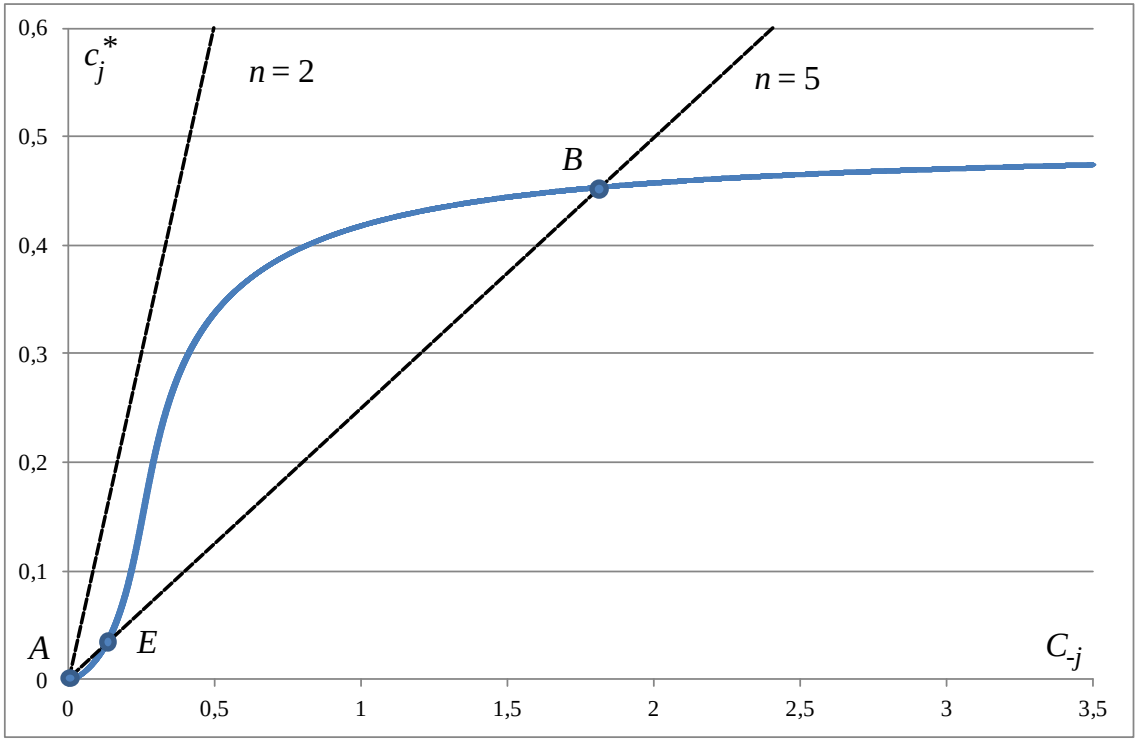
- The amount of funds allocated is defined as an equilibrium in the public good financing game:

$$g_j(\mathbf{c_j}, \mathbf{w}) \to \max_{\mathbf{c_j}},$$

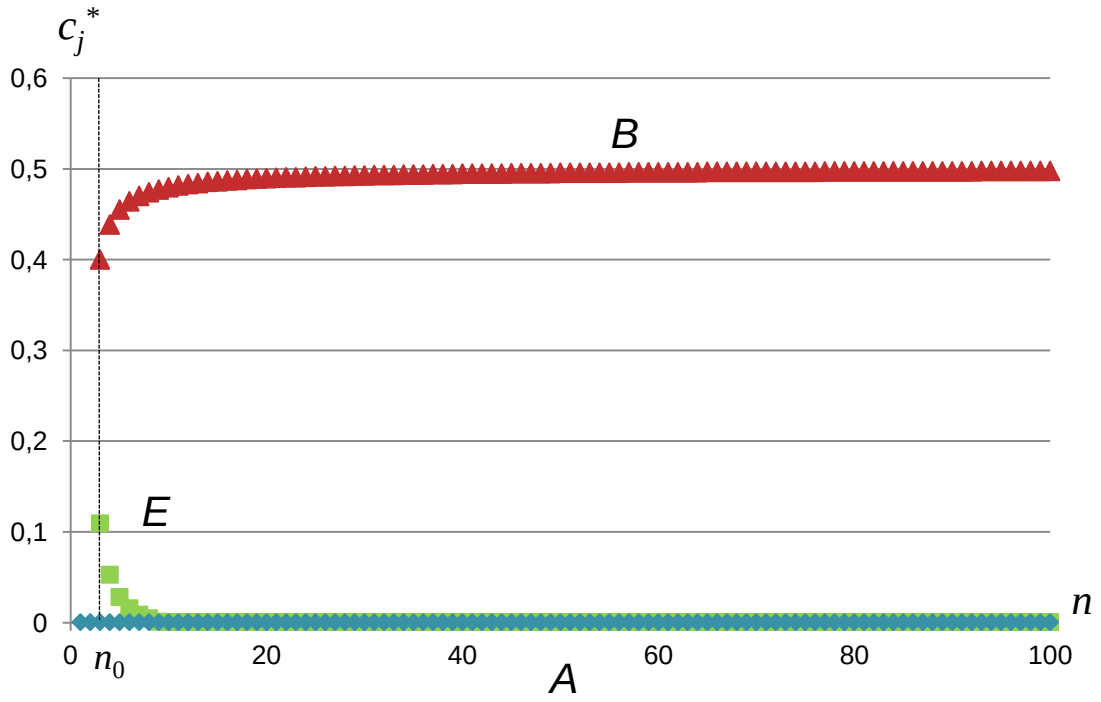
Free-rider problem

BEST RESPONSE IN THE SUPERINDIVIDUAL DECENTRALIZED FINANCING PROBLEM

$$c_j^*(C_{-j}) = \arg\max_{c_j} \left\{ g_j(\mathbf{c}, w) \right\}, \qquad C_{-j} = \sum_{k \neq j} c_k$$



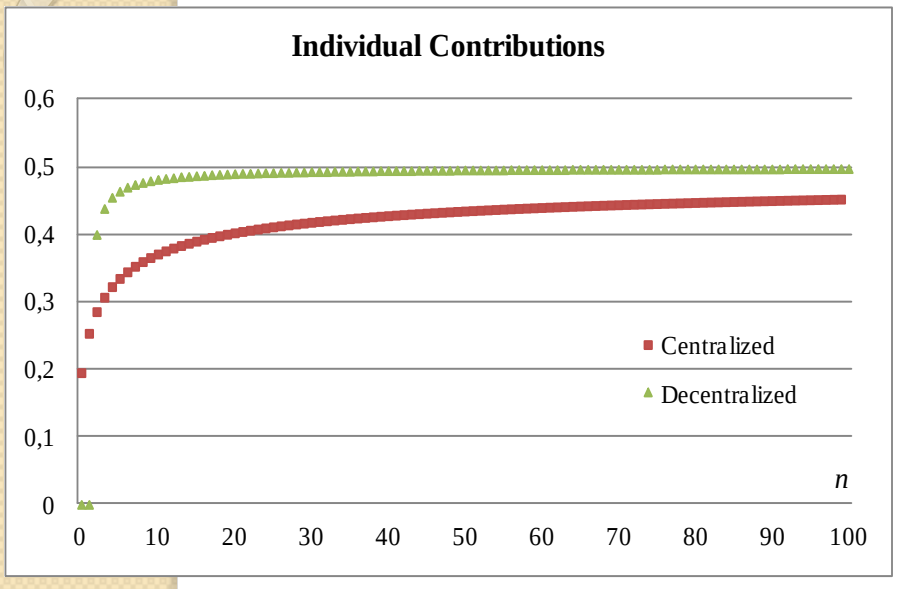
DECENTRALIZED FINANCING EQUILIBRIA

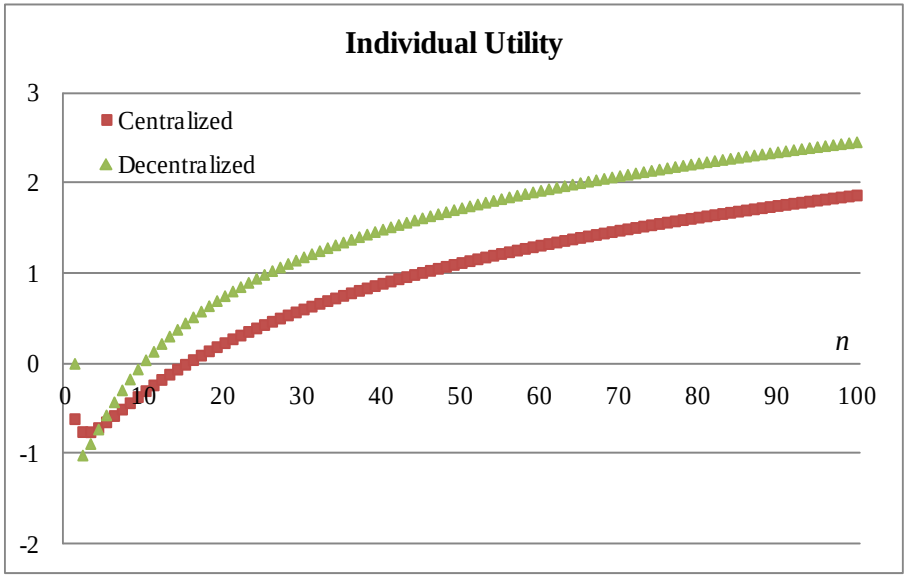


m	n_0
1	3
2 – 5	4
6 – 16	5
17 – 59	6
60 – 254	7

- *A* – a degenerate equilibrium in which resources are not allocated to superindividuals by anyone;
- *B* – internal equilibrium with strictly positive superindividuals financing;
- *E* – unstable internal equilibrium.

COMPARATIVE ANALYSIS OF THE MECHANISMS





- Centralized financing is more effective from the point of view of maximizing the individuals' welfare only when n is sufficiently small (in our case $n < 4$).
- For larger systems, the manager's opportunistic behavior leads to inefficient equilibria, where social losses exceed the costs associated with the "free-rider problem" in decentralized financing.

FURTHER DEVELOPMENT

- Study of the strategies for modification of utility functions used in modern society (ideology, fashion, advertising, etc.).
- Analysis of “non-economic" behavior of subjects caused by supra-individual components in the utility function (addictions, cults, etc.).
- Investigation of the mechanisms of evolution of superindividuals in a competitive environment.