

# MODELING THE IMPACT OF CORRUPTION ON THE ECONOMIC INDICATORS' DYNAMICS

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## Pidkhomnyi Oleg M. Modeling the Impact of Corruption on the Economic Indicators' Dynamics

This article examines the phenomenon of corruption in the context of relationships with a number of important economic indicators. The problems of evaluation methodology and features of volumes and directions of development of corruption at the country level were shown. In addition to the subjective measurement methods the model of corruption interrelations was proposed, unemployment, competence, productivity. It was shown that competence can be characterized as a constructive activity of society members and also as distribution activities of unproductive individuals. It was found that a high proportion of incompetent corrupt officials adversely affect the level of unemployment, and their ability to allocate goods illegally reduces the level of motivation for productive work. With the cooperation of experts in economics, sociology, and criminology to form respective expert assessments, the model discussed in the article, can help analyze the impact of corruption on the dynamics of important economic indicators more precisely.

**Keywords:** corruption, modeling, unemployment, productivity, competence.

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### Підхонний О. М. Моделювання впливу корупції на динаміку економічних показників

У статті досліджується явище корупції в контексті взаємозв'язків із низкою важливих економічних показників. Висвітлено проблеми й особливості методології оцінки обсягів і напрямів розвитку корупції на рівні країни. У доповнення до методів суб'єктивних вимірювань запропоновано модель взаємозв'язків корупції, безробіття, компетентності, продуктивності праці. Вказано, що компетентністю може характеризуватись як конструктивна діяльність членів соціуму, так і розподільча діяльність непродуктивних індивідів. Виявлено, що висока частка некомпетентних корумпованих чиновників негативно впливає на рівень безробіття, а їх можливості нелегально розподіляти блага знижують рівень мотивації до продуктивної праці. За умови співпраці фахівців у галузі економіки, соціології, кримінології для формування відповідних експертних оцінок розглянута у статті модель дає змогу точніше аналізувати вплив корупції на динаміку важливих економічних показників.

**Ключові слова:** корупція, моделювання, безробіття, продуктивність, компетентність.

**Рис.:** 8. **Табл.:** 3. **Бібл.:** 15.

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### Підхонный О. М. Моделирование влияния коррупции на динамику экономических показателей

В статье исследуется явление коррупции в контексте взаимосвязей с рядом важных экономических показателей. Освещены проблемы и особенности методологии оценки объемов и направлений развития коррупции на уровне страны. В дополнение к методам субъективных измерений предложена модель взаимосвязей коррупции, безработицы, компетентности, производительности труда. Указано, что компетентностью может характеризоваться как конструктивная деятельность членов социума, так и распределительная деятельность непродуктивных индивидов. Обнаружено, что высокая доля некомпетентных коррумпированных чиновников негативно влияет на уровень безработицы, а их возможности нелегально распределять блага снижают уровень мотивации к производительному труду. При условии сотрудничества специалистов в области экономики, социологии, криминологии для формирования соответствующих экспертных оценок рассмотренная в статье модель позволяет точнее анализировать влияние коррупции на динамику важных экономических показателей.

**Ключевые слова:** коррупция, моделирование, безработица, производительность, компетентность.

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Numerous national and international studies confirm the relevance of the corruption problem. Acemoglu D., Agapova O., Andvig J., Antoci A., Asilis C., Basu K., Becker G., Beenstock M., Besley T., Bhattacharya S., Bicchieri C., Bliss C., Cadot O., Chander P., Feichtinger G., Hillman L., Juan-Ramon V., Katz E., Lambert-Mogiliansky A., Liew L., Lui F., McLaren J., Mikhailov A., Mishra A., Moene K., Mookherjee D., Murphy K., Png I., Rose-Ackerman S., Rovelli C., Sacco P., Savvatyeyev A., Shleifer A., Tella R., Tirole J., Vasin A., Verdier T., Vishny R., Wilde L., Wirl F. and others belong to the scientists who have made outstanding contributions to the modeling of corruption.

Practical problems of the economy and the results of studies of corruption, including modeling of its economic correlations, have actualized forming and testing of hypotheses about the correlations of such phenomena as corruption, un-

employment, competence, productivity. First of all, we should pay attention to the corresponding correlations on the level of qualitative analysis. The development of quantitative models for more accurate analysis of the problem should be the next step of the research. In this paper we will discuss mainly about state corruption, although in some cases those ideas can be generalized and interpreted for the corporate sector.

Broadman H. and Recanatini F. [3], Chang E. [4], Heidenheimer A. and Johnston M. [7], Heffernan W. and Kleinig J. [6], Hellman J., Jones G., Kaufmann D., Schankerman M. [8], Kawata J. [11], Montinola G. and Jackman R. [13], Pandey S. [14], Philp M. [15] and others belong to modern scientists who are developing the conceptual foundations for the study of corruption.

Regarding research methodology of corruption, experts recognize that, except of subjective perception, there are no other sources of information about corruption, which would

meet the requirements of the study at the level of state and inter-state comparison. This is fundamental aspect for Corruption Perceptions Index's determination and for other studies. In addition, a feature of some countries, including Ukraine, is the lack of reliable information about macroeconomic indicators such as gross domestic product, unemployment etc. Babbie E. [2, p. 121 – 129], Kaufmann D. [10], Knack S. [12] and some others have examined the relevant issues thoroughly.

In our view, for developing countries, relevant is the hypothesis about the correlation of corruption with unemployment and labor productivity. These indicators depend on the level of economic and political systems of the society.

Contrary to the dominant view, Huntington S. [9] states that corruption is an effective social practice during the process of modernization. According to this researcher, corruption is a testament to the lack of effective political institutions [9, p. 253 – 263]. Corruption spreads significantly in periods of economic transformation and intensive modernization. The difference in the level of corruption in various countries actually reflects the difference between the processes of political modernization and political development. Modernization involves a change in the fundamental values of the society. Corruption in the modernized society is not primarily deviation from accepted norms of behavior; but vice versa – deviation of norms from the accepted behavior patterns [9, p. 253]. New standards and criteria lead to recognition of some traditional patterns of behavior as corrupt.

The problem of political modernization of society is directly related to the structural reform of the economic system. Contrary to the view of Huntington S., we suppose that corrupt officials can not make effective use of resources, including labor.

The institutional and structural unemployment, in our view, belong to the types of unemployment which are most dependent on the level of corruption in the country. The structural reforms in the economy require the making of a number of competent management decisions and willingness to take risks. Incompetent and corrupt officials have negative attitude to both of these circumstances. Also, structural reforms may be hindered by lack of public funds due to corruption in taxation. Corruption factors of institutional unemployment may include, for example, the employment only with a bribe, acceptance at job only incompetent persons by incompetent boss etc. The impact of corruption on productivity has such basic forms as reducing incentives of quality professional training in corrupt institutions, reducing of the incentive to invest energy and time for the production of goods in an unjust system of remuneration.

Our model involves the division of society members by two features: 1) the willingness of an individual to public benefit activities (competence or incompetence, constructive or destructive position), 2) belonging to the administrative sector. Productive administrators make decisions that generally increase the efficiency of the different resources' use. Unproductive corrupt bureaucrats consider their positions only as a source of personal goods. To not overload the model we don't include children, senior citizens, students etc. in this classification. Unproductive individuals (excluding administrators) are persons who are prone to parasitic lifestyle through theft, fraud and other lucrative crimes. However, some people who are committed to work, may be unemployed due to the inefficiency of the administration. But even if bureaucrats are fully incompetent, the productive party of society can not become fully unemployed. To express the level of employment of pro-

ductive individuals that is even in the situation of complete incompetence of bureaucrats, there is used "factor of productive individuals' self-organization" in model.

The division of society members on these groups is fairly relative because the activities of some individuals can be constructive or destructive as well. But such a simplification of the model enables to disclose the contents of the relevant issues much better. It resembles the "Hawks and Doves" model from game theory, in which members of the population are clearly divided into groups according to the types of behavior (aggressive and peaceful), although the reality may be more complicated. Andvig J. and Moene K. [1] also used a simplified approach to model where shares of bureaucrats and bribers "infected" by corruption are considered.

Each group of participants in our model gets a share of public goods. The goods' distribution affects the level of economic efficiency. The amount of goods received by a certain group depends on several factors:

- ✦ potential productivity for a some level of society development;
- ✦ actual productivity which depends on the motivation of working people;
- ✦ shares of representatives from each of the groups in society;
- ✦ revenue of administrators formally established;
- ✦ capabilities of distribution of unproductive individuals.

This study deals with some fundamental methodological problems. On the one hand, the experts have agreed that, except subjective perception, there is no other source of information about the level of corruption in the country as a whole. Also, there is an acute problem of reliability of macroeconomic statistics in some countries, such as Ukraine. On the other hand, the specification of some factors' impact and taking into account their recursive interdependencies are possible only by using a mathematical model. For example, to be based on solely qualitative assessments it is impossible to justify exactly what influence on the economy is stronger – the share of corrupt officials in public bodies or level their of competence in the case of goods' illegal distribution; who and under which circumstances destroy the economy more – corrupt officials or unproductive individuals (excluding administrators). Quite clearly answers for these and some other questions we can obtain using mathematical model.

We consider four important nonlinear dependencies at the model. First, the higher the share of productive administrators among public officials and the higher level of their competence in the mobilization of human resources are, the larger share of productive individuals is involved in the goods' production above level which is provided by self-organization. In other words, the unemployment rate is inversely dependent on the share of productive administrators among officials and their level of competence. Second, the share of goods that is illegally appropriated by unproductive individuals (excluding administrators) depends on their share in society and distributing capabilities. Third, the relationship which applies to corrupt administrators is similar to the second. Fourth, the actual production of goods, relative to potential output, depends on the share of goods that is distributed legally and on the factors of organizational and technological capabilities. A high share of goods that are distributed legally has positive effect on the motivation of productive individuals.

Each of the specified dependency involves consideration of one quantitative and one qualitative factor. It is presented in *table 1* in more details.

It is important to consider some more restrictions. The sum of goods' share that illegally appropriated by unproductive individuals (excluding administrators) and the share of goods that is appropriated by unproductive administrators through corruption can not exceed 1. Also, the sum of the share of the unproductive individuals (excluding administrators) and the share of unproductive corrupt administrators in the general population should not be greater than 1.

Some issues are related to the form of functional dependencies for modeling of the relationships described in *table 1*, and to the method of quantitative expression of qualitative factors. Obviously, those dependencies are non-linear. The growth of competence or motivation does not provide a proportional increase in output. It meets the principle of diminishing mar-

ginal efficiency taking into account additional involvement of certain factors. If quantitative factors are fixed, dependence of the results on qualitative factors for all four cases should have the form shown in the *figure 1*.

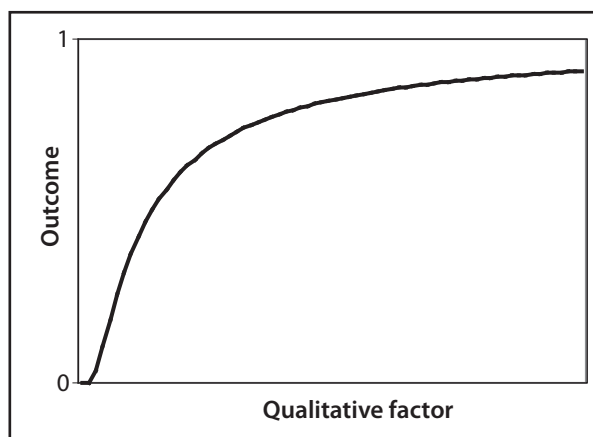
A line of graph can not exceed 1 and with the approximation to this level it should grow slower. Qualitative factors of investigated dependencies can be expressed by points, given by experts on the basis of evidence. The using of points allows to investigate the situation in dynamics by setting different value of qualitative indicator growth. Line of graph generally matches the shape of a well-known learning curve. As to our model, there may be constructive and destructive skills such as competence in the human resources' involving, the ability to distribute goods illegally. Interestingly, Collier D. proposed a model based on similar ideas about the spread of corruption through a process of social learning under adverse S-curve [5, p. 430 – 451].

**Table 1**

**The main factors of the model**

Nº	Outcome	Theoretical limits of outcome's values	Quantitative factor	Theoretical limits of quantitative factor's values	Qualitative factors
1	Share of productive individuals (excluding administrators) involved in the production of goods due to administrators' activities	0 – 1	Share of productive individuals in the total number of administrators	0 – 1	Competence of administrators to mobilize labor resources
2	Actual production of goods relative to potential output	0 – 1	Share of goods that are distributed legally	0 – 1	The level of motivation to produce goods in comparison with the maximum possible volume
3	Share of goods that illegally appropriated by unproductive individuals (excluding administrators)	0–1	Share of unproductive individuals (excluding administrators) in the general population	0 – 1	Competence of unproductive individuals (excluding administrators) related with goods' distribution
4	Share of goods appropriated by unproductive administrators with help of corruption	0 – 1	Share of unproductive corrupt administrators in the total population	0–1	Competence of unproductive administrators at the goods' corruptional distribution

Source: own study.



**Figure 1. Relationship between qualitative factor and outcome**

Source: own study.

To express all these four dependencies we propose to use a general formula:

$$O = S^{1/Q},$$

were  $O$  – outcome,  $S$  – quantitative factor (share),  $Q$  – quality factor.

It is necessary to take into account some features of substituting the appropriate values into the formula. Some of productive individuals are involved in the process of producing goods due to self-organization factor which is expressed by corresponding coefficient. For example, if the coefficient is 0.5, half of productive individuals of society (excluding administrators) will be involved in the production of goods on the basis of self-organization, without the help of officials. Officials' competence determines how the rest of productive individuals will be involved in the goods' production.

The other important dependencies accounted in the model are expressed as follows.

$$\begin{aligned}
 & \text{The actual amount of goods produced per productive individual (excluding administrators)} = \text{The potential value of goods produced per productive individual (excluding administrators)} \times \text{The actual production of goods relative to potential output} \\
 & \text{The actual amount of goods' production during the period} = \text{The number of productive individuals (excluding administrators)} \times \text{The actual amount of goods produced per productive individual (excluding administrators)} \\
 & \text{The amount of administrators' official income} = \text{The number of administrators} \times \text{Average official income per administrator}
 \end{aligned}$$

Other indicators that are easy to calculate using the model, but the formulas of which are not presented for compact representation of a material, include:

- ✦ the amount of productive administrators' incomes;
- ✦ the amount of unproductive administrators' official income;
- ✦ the amount of goods that is unofficially appropriated by unproductive individuals (excluding administrators);
- ✦ the amount of goods that is appropriated by unproductive administrators due to corruption;
- ✦ the amount of goods that remains for productive individuals (excluding administrators);
- ✦ the share of productive individuals' goods (excluding administrators);
- ✦ the share of productive administrators' goods;
- ✦ the share of goods that is unofficially appropriated by unproductive individuals (excluding administrators);
- ✦ the share of goods that is appropriated by unproductive administrators;
- ✦ the amount of goods per member of the society;
- ✦ the amount of goods per productive individual (excluding administrators);
- ✦ the amount of goods per productive administrator;
- ✦ the amount of goods per unproductive individual (excluding administrators);
- ✦ the amount of goods per unproductive administrator.

It is also important to note that the average amount of goods per member of society in general or a specific group should not fall below subsistence level because it threatens social upheavals.

We consider the behavior of the model's indicators by changing some input parameters. At this stage of the study, data relating to a particular economy are not used, but some common patterns of model's behavior are revealed and it is described its using. Configuring of the model for a specific economic system requires teamwork and expert assessments from different fields of economics, sociology, and criminology. Cost indicators are expressed in conditional monetary units. Basic conditional set of factors is as follows (Table 2).

For a hypothetical example we assume that the share of administrative staff (officials) in society is 1% of the population. According to statistics, in Ukraine it is about 0.8%, in Russia – 1.1%. From the input data of table 2 we obtain the following indicators of model with the above functional dependencies where cost indicators expressed by conditional monetary units (Table 3).

According to Huntington S., corruption has a collective character as concealment of corruption and involvement in corrupt activities are much less expensive than publishing corruption and conflicts [9, p. 419]. Collusion among individuals quickly develops into systematic interaction between colleagues, partners, assistants, administrators and patrons. The manifestations of corruption can develop a huge network and eventually degenerate into institutionalized corruption in large

**Table 2**

**Basic values of the factors substituted in the model**

Factor	The value of the factor
The total number of members in society	1000000
The potential value of goods produced per productive individual (excluding administrators)	10
Living minimum wage level	1
Average official income of one administrator	20
Competence of management to mobilize manpower, points	1
Motivation to produce goods in comparison with maximum possible volume, points	1
Competence of unproductive individuals (excluding administrators) related to distribution of goods, points	1
Competence of unproductive administrators in corruptional distribution of goods, points	1
The coefficient of productive individuals' self-organization	0,5
Share of unproductive individuals in society (excluding administrators)	0,1
Administrator's (official's) share in society	0,01
Share of unproductive individuals (corrupted) in the total number of administrators	0,1

Source: own study.

Outcome indicators of the model

Indicator	Value
The actual amount of goods produced per employed productive individual (excluding administrators)	9
The actual amount of goods' production during period	7618050
The amount of administrators' official income	200000
The amount of productive administrators' income	180000
The amount of unproductive corrupt administrators' official income	20000
The amount of goods that unofficially appropriated by unproductive individuals (excluding administrators)	754187
The amount of goods that is appropriated by unproductive administrators due to corruption	7618,05
The amount of goods that remains for productive individuals (excluding administrators)	6656245
Share of the goods of productive individuals (excluding administrators)	0,8737466
The share of productive administrators' goods	0,0236281
The share of goods that unofficially appropriated by unproductive individuals (excluding administrators)	0,099
The share of goods that is appropriated by unproductive administrators	0,0036253
The amount of goods per member of society	7,61805
The amount of goods per productive individual (excluding administrators)	7,4705331
The amount of goods per productive administrator	20
The amount of goods per unproductive individual (excluding administrators)	7,61805
The amount of goods per unproductive corrupt administrator	27,61805

Source: own study.

volumes. According to how corruption spreads, its social acceptance may vary. Living in a corrupt environment leads to strengthening the belief that corruption is inevitable.

Therefore it is necessary to examine the effect of increasing in the share of destructive individuals in society on the production and distribution of goods. If there are the baseline values from table 2 and share of unproductive individuals (excluding administrators) growing at 15% per year with the constant share of corrupted administrators, the economic situation will change as follows (Figure 2).

The economy under such conditions may hold no more than 17 periods. Dynamics of income for one representative of each group is shown in figure 3.

Productive individuals' income (excluding administrators) holds above the living minimum wage level 13 periods.

Along with the dynamics of economic indicators, shown in figure 3, there are changes in the structure of society, as shown in figure 4.

It should be noted that the collapse of the economy occurs sooner than would disappear entirely productive individu-

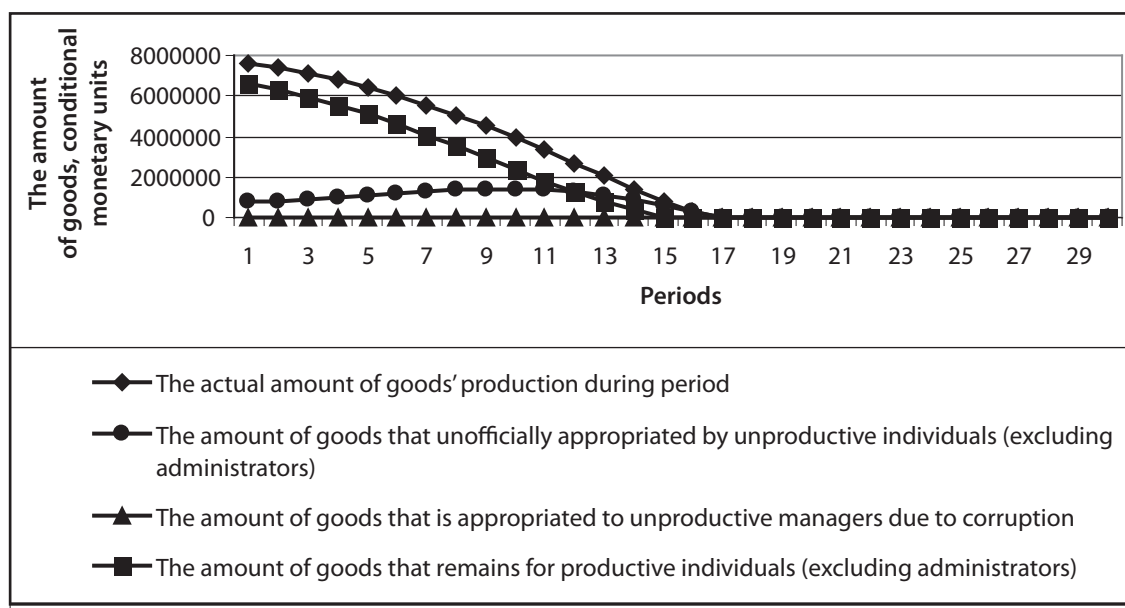


Figure 2. Creation and distribution of goods with increasing of unproductive individuals' share in society

Source: own study.

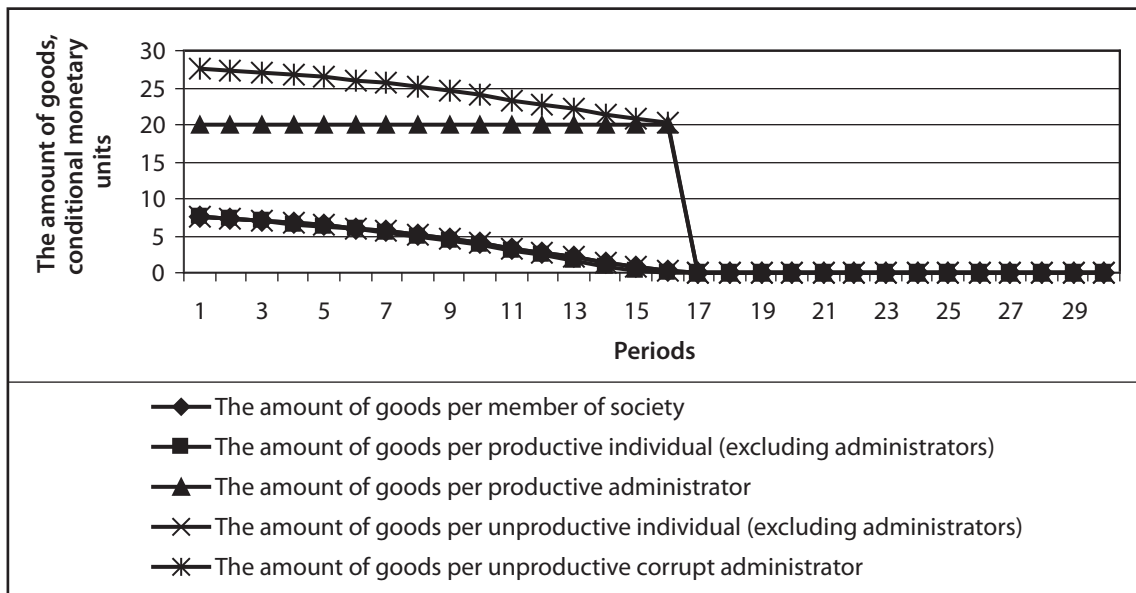


Figure 3. Dynamics of different social groups' income with an increase in the share of unproductive individuals

Source: own study.

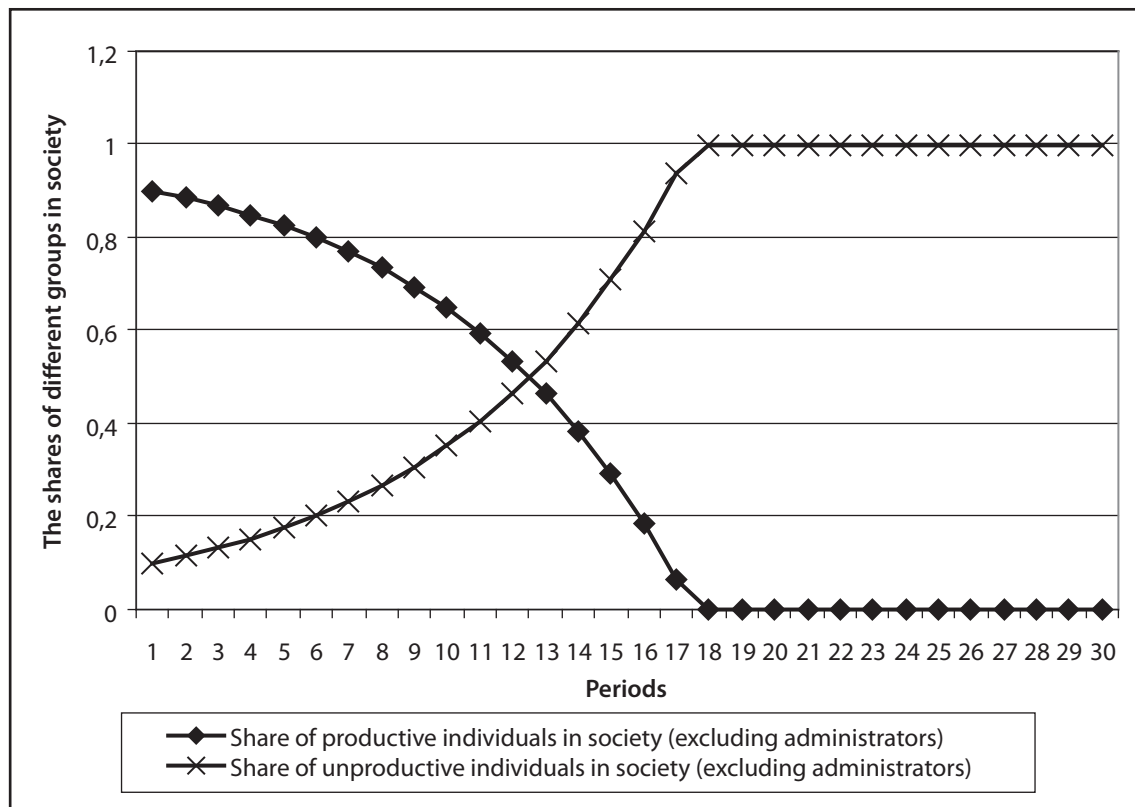


Figure 4. Dynamics of society structure

Source: own study.

als in society, according to figure 4. This is because the productive individuals had previously deprived of livelihood.

If the share of corrupt persons among administrators is growing at the same rate (15% for the period), the production and distribution of goods change as follows (Figure 5). Under such conditions economic activity reach the minimum level after 18 periods, but it does not disappear utterly when productive administrators vanish completely. This is due to the self-organization factor of productive individuals, through which

the population continues to make some goods even with the complete incompetence of the officials. Interestingly, the corrupt officials do not receive significant amounts of goods, but unemployment has increased and production has decreased significantly because of poor management.

Income's dynamics per representative of different social groups for this scenario is shown in figure 6.

Average income of productive individuals stabilize at 3.74.

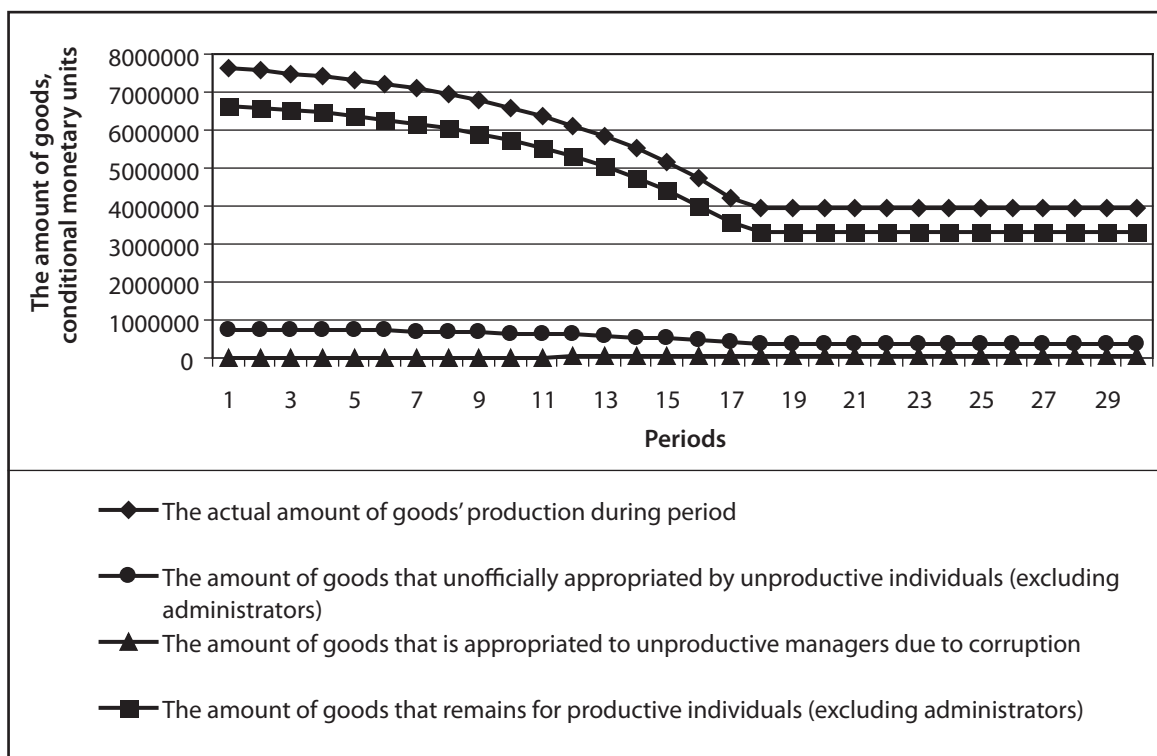


Figure 5. Production and distribution of goods with increasing of corrupt administrators' share

Source: own study.

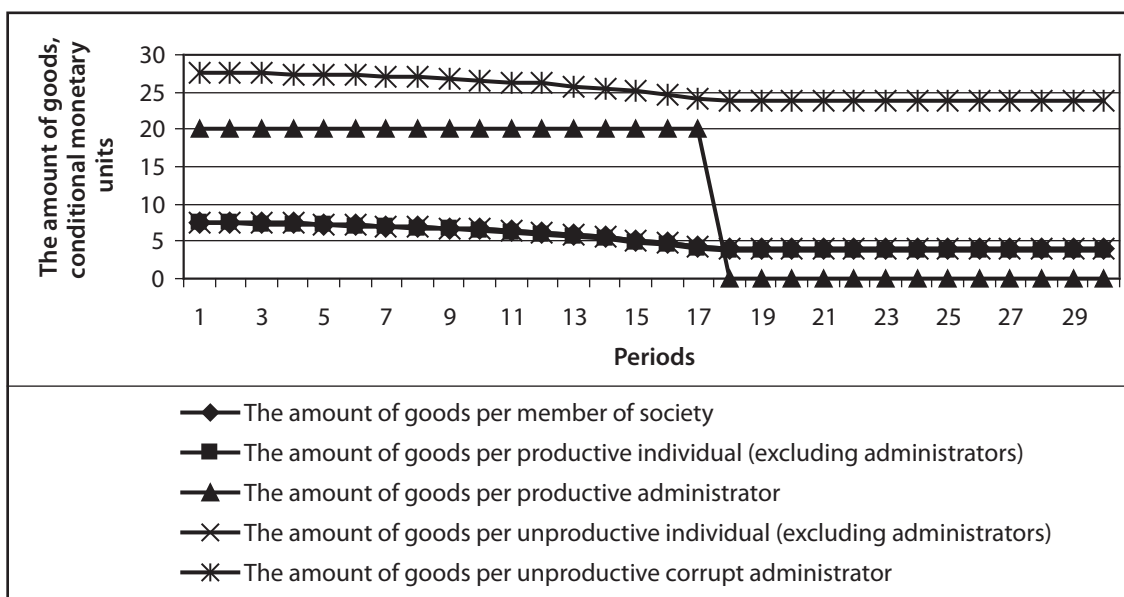


Figure 6. Dynamics of income per member different society groups with an increase in the share of corrupt administrators

Source: own study.

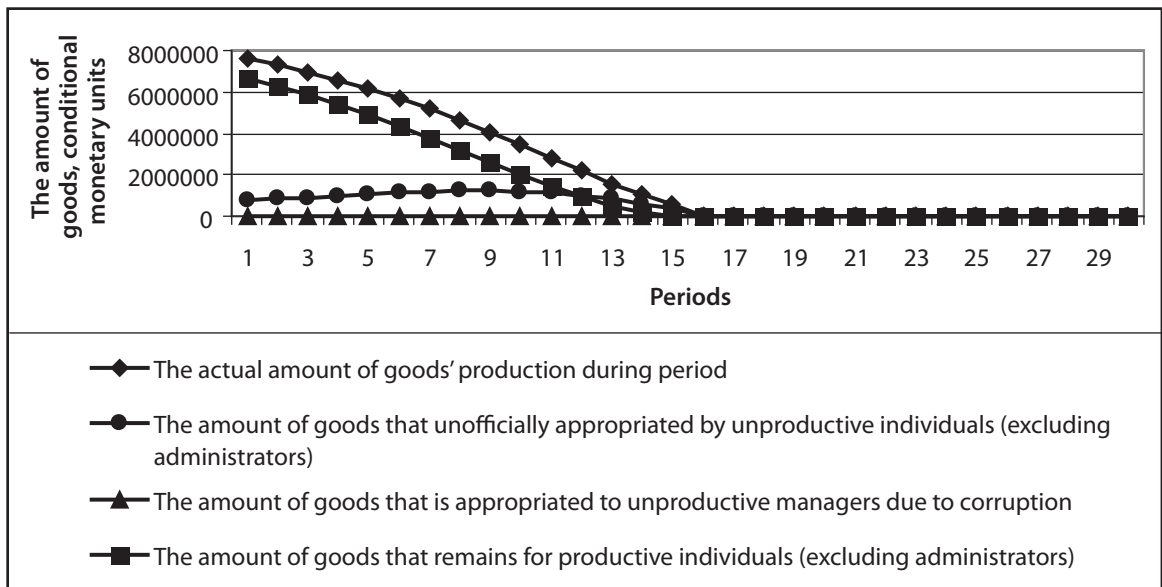
If the negative effects of the growing share of unproductive individuals in society and the growing share of corrupt administrators by 15% per period are combined, the economy is destroyed not later than 16 periods (Figure 7).

Average income of different society groups' members changes, as shown in figure 8.

In this case, the average income of the productive individual rests above the subsistence level 13 periods.

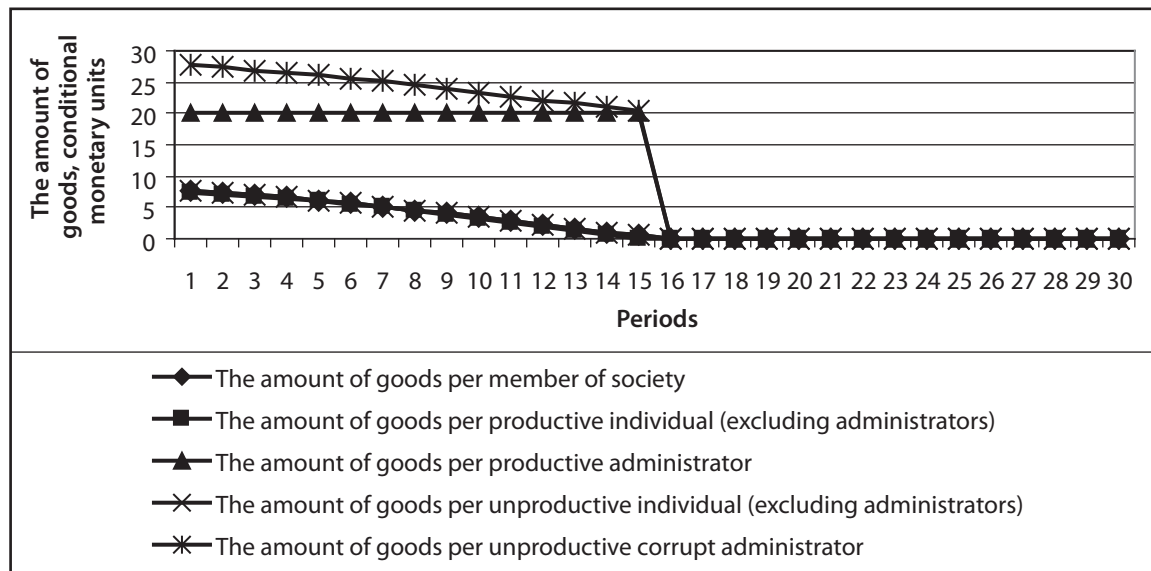
The analysis makes it possible to argue that the increase in the share of unproductive individuals in society (excluding administrators) at a fixed distributional competence of unproductive individuals has a greater negative impact than the increase in the share of corrupt administrators.

This is because of the increase in the share of unproductive individuals (excluding administrators) reduce the share of those who produce goods. A spread of corruption among administrators degrades the organizational level of the economy, however, due to the factor of productive individuals' self-organization the production does not vanish completely. However, it is worth remembering that the increase in corruption may be an important factor in the demoralization of society and in the growth of unproductive individuals' share (excluding administrators). Distributional com-



**Figure 7. Production and distribution of goods with increasing the shares of unproductive individuals in society and corrupt administrators**

Source: own study.



**Figure 8. Dynamics of different social groups' income with an increase in the shares of unproductive individuals in society and corrupt administrators**

Source: own study.

petence of corrupt officials may be much more important reason for the decline in the production, compared to their share among administrators. This is also confirmed by our model.

**CONCLUSION**

Researchers have to study corruption in the absence of precise information about it. Also, reliable information on important macroeconomic indicators may be absent in some countries. Therefore, an important role in these studies belong to subjective evaluation. The main characteristics of corruption in the country include the share of corrupt officials and their capabilities for illegal distribution of goods. In addition, people who do not hold administrative positions also can make illegal distribution of goods. A high share of incompetent and corrupt officials in government leads to high unemployment. Significant

amounts of illegal distribution of goods reduce labor productivity by weakening the motivation of employees. Correlations between corruption, unemployment, competence, productivity are complex and nonlinear. Corresponding mathematical model helps in their research. Configuring of the model for analysis of the situation in a particular country requires cooperation and expert assessments of professionals with a fairly wide range of subjects including economics, sociology, criminology. ■

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