

# Social Inclusion and Economic Uncertainty: The Reflection in Public Policy

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## Abstract

The considered study is based on the idea of the relationship between social inclusion and economic uncertainty. The way these phenomena relate to each other should be reflected in the choice of public policy model. Although social inclusion has various manifestations, it is primarily manifested in the stratification of society by income. The initial generalizations are made on the basis of the analysis of empirical data regarding the relationship between two indicators of differentiation. The authors interpret social inclusion as a phenomenon that implies a decrease in income differentiation against the background of economic indicators improvement. Certain public authority influential factors should be identified to make social inclusion public authority strategic target. A set of endogenous variables has been analyzed according to the Ukrainian data. Neural Networks tools have been used to assess their impact on income differentiation indicators. The differentiation of income in Ukrainian society has been influenced by obvious and hidden variables. The effects of the identified variables on income differentiation have appeared to be multilevel. These variables combined into nodes of interaction. Awareness of these links and nodes of interaction is an important prerequisite for the formation of a public policy model which can ensure social inclusion.

## Keywords

Social Inclusion, Economic Uncertainty, Public Policy, Policy Uncertainty

## JEL Classification

E61, E62, G28, I22, I30

## Introduction

At the beginning of the XXI century economic uncertainty was formed against the background of man-made, environmental and epidemiological threats. This highlights the issue of social inclusion. After all, alienated and excluded from social processes citizens and communities of people, as a rule, adapt worse under extreme and unexpected conditions. They need additional social expenses, which are in short supply in slow economic growth and in a condition of recession. Alienated citizens and communities are becoming the center of even greater economic uncertainty. Their response to changes in society, public authorities events etc. is more difficult to predict. Therefore, the research regarding the relationship between social inclusion and economic uncertainty is becoming relevant. It is significant that social inclusion is an urgent issue not only for countries with a lower level of development, but also for countries with a high level of development.

For the Ukrainian economy and society, the urgency of inclusion issue research under conditions of uncertainty has increased in connection with the ongoing Russian-Ukrainian war. Hundreds of thousands of people are currently in a condition of social exclusion and alienation due to the loss of homes, property, jobs, income, social ties etc.

Social inclusion and certainty (stability) of the national economy are not achieved automatically, but only under a certain model of public policy. The scientific issue of this research refers to discovering changes which public authority may need to appropriately respond to a social exclusion / inclusion in general and under economic uncertainty in particular. The article discovers not the whole complex set of public authorities necessary changes and measures. One of the important aspects of this response became the subject of analysis in this article. This is the identification and clarification of the targets of public authorities which seek to ensure social inclusion, considering the economic uncertainty.

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This study is based on the hypothesis that social inclusion is related to the general condition of the economy, namely, to its greater or lesser economic uncertainty. At the same time, social inclusion has the opposite effect on the condition of the economic sphere. This relationship should be taken into account when formulating relevant public policy.

## Literature Review

A review of the literature on the issue presented in the title of this article addresses three fundamental theories, namely, social inclusion, economic uncertainty, and public policy. The term "theories" is used here in the sense of a set of related and established views, which are presented through categories and theoretical constructions (models).

**Social inclusion theory.** Among the provisions of the theory of social inclusion which are important for our study, we single out the following. First, social inclusion is regarded as a phenomenon associated with "equal opportunities and resources among people with and without disabilities" (Social Inclusion, 2020). Thus, the quintessence of social inclusion consists in overcoming inequalities which arise from constraints and unequal opportunities. Second, social inclusion is a prerequisite for sustainable economic growth. Therefore, it is recognized as the target of social policy in modern societies (Hujo & Yi, 2015). Third, social inclusion has not always been a target of social policy. The research of the evolution of policy models from the end of the XIX to the beginning of the XXI century provides grounds for concluding that the importance of inclusion as a target of public policy is gradually increasing (Filgueira, 2014). It is an indisputable fact that the social inclusion theory foundations are embedded in the works of S. Kuznets, in particular, in those relating to the so-called "Kuznets hypothesis" (Kuznets, 1955).

**The theory of economic uncertainty.** It is crucial for our research to identify three concepts related to the phenomenon of uncertainty. These are the concepts of Economics of uncertainty, Policy-related economic uncertainty, Policy uncertainty.

"Economics of uncertainty" is a part of the general economic theory, which explains the causes, consequences and mechanisms of economic relations reproduction with signs of uncertainty. In fact, the boundaries of economic uncertainty can either narrow or, conversely, expand under the influence of government policy. Therefore, the science uses a related concept, namely: "Policy-related economic uncertainty" and "Policy uncertainty".

We consider the idea of explaining economic uncertainty, through the conditions in which an unstable economy may be, methodologically important (Pettinger, 2016). These are the conditions of high inflation and significant price volatility, low rates of economic growth and economic recessions, excessive unemployment, financial imbalances and defaults etc. In a comprehensive quantification of the economic uncertainty level, researchers typically use a set of macroeconomic indicators (Jackson, Kliesen & Owyang, 2019).

"Policy-related economic uncertainty" is actually caused by uncertainty in the policy, which is given by the appropriate term - "Policy uncertainty". The latter may have such manifestations as imperfection of economic legislation, lack of clear targets and strategies for development, unfounded and inconsistent actions of national regulators, errors in communication between government and society etc.

"Policy uncertainty" is an important aspect of public management. Quantitative assessment of its level has become not only a theoretical but also a practical task. One of the practical approaches to such an assessment is the use of the Economic Policy Uncertainty (EPU) index (Baker, Bloom & Davis, 2015). Importantly, in the construction of the EPU index, the phenomenon of uncertainty is fragmented into individual components, using the criterion of belonging to fiscal, monetary or regulatory (administrative) instruments. This makes it possible to assess the contribution of each group of instruments to the improvement / deterioration of the economic situation.

**Theory of public policy.** Proceeding from fundamental researches on public policy analysis (Thissen & Walker, 2013; Weimer & Vining, 2017; Birkland, 2019; Dunn, 2011), we highlight only those methodological provisions which are important for our study. First of all, this refers to the theoretical value of such two ideas. The first idea: the public sector of the economy is recognized as a direct object of public policy as science and a sphere of management (Bevir, 2012). The scope of the public sector is defined by the production of public goods in the field of health care, education, social protection, internal and external national security etc. Therefore, these boundaries do not cover the entire national economy. Although, it is an indisputable fact that public policy, which is directly aimed at the public sector, indirectly affects the stability and overall balance of the whole economy. It is also important that the scope of the public sector can change under the influence of many technical, economic and even socio-psychological factors. That is, the scope of this public management object is not "frozen" and "inviolable". The researches of the public sector phenomenon and the public policy goals in the public sector functioning context are presented in the works of prominent analysts. We mean the works of D. Armeij, J. Buchanan, J. Olson, R. Wagner (Armeij, 1995; Buchanan, 1975; Olsen, 1972; Wagner & Weber, 1977).

The second idea: the strategic planning becomes the public authority defining function in public policy implementation. It involves the identification of values and justification of the current targets of society for each stage of development. Relevant mechanisms of particular actions and public authority institutions can be created on the basis of such identification and substantiation. It is significant that the representatives of different schools of public management theory in general agree with the idea of responsibility of public policy stakeholders for the strategic targets of society. These are Rational choice theory (Neimun & Stambough, 2005), Institutional theory (Pettes & Zittoun, 2016), Interpretive theory (Sullivan, 2016).

## Methods

The fundamental provisions of the three theories mentioned earlier, namely: social inclusion, economic uncertainty and public policy form the methodological basis of this research. The three mentioned theories are at different stages of completeness and perfection. But these levels are, in our opinion, quite sufficient to solve the scientific issue explored in this article.

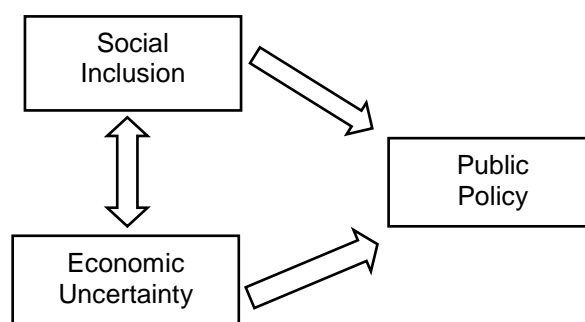
Neural Networks theoretical and applied tools became the methodological basis of our study. We rely on the idea that this toolkit is the most relevant in the study of phenomena under conditions of economic uncertainty. After all, under the conditions of uncertainty there is a need for information which is not obvious and concerns the effects of unexpected factors. Uncertainty actualizes the study of relationships which do not "lie on the surface", which are difficult or impossible to explain on the basis of traditional (classical) approaches.

The experience and research results of using Neural Networks tools in the analysis of macroeconomic processes and phenomena are becoming important in the context of the scientific issue of this article. These are the analysis of GDP dynamics, macroeconomic shocks, "turning points" in economic cycles (Tkacz, 2001; Vishwakarma, 1994), inflation dynamics (Moshiri & Cameron, 2000; Mitra, Rupak, Seema & Mondal, 2016). Equally important for our study is the experience of using Neural Networks in macroeconomic policy analysis. In particular, it concerns the research founded on agent-based modeling in economics and policy-making (Hoog, 2017; Chakraborty & Joseph, 2017).

Due to the lack of certain data in some years, we were forced to limit ourselves to 19 years, namely: 1992-1993, 1995-1996, 2002-2016 (World Development Indicators, 2021; Kravchuk, 2002; The official site of the State Statistics Service of Ukraine).

## Results

The main idea behind this study regards the relationship between three phenomena – social inclusion, economic uncertainty and public policy. This idea can be visualized as follows (Fig. 1).



**Fig.1.** Research main ideas visualization

**Source:** Authors' own

The main content of what is presented in Fig.1 is revealed in two provisions, namely:

- there is a correlation between social inclusion and economic uncertainty;
- the level of social inclusion / exclusion and economic certainty / uncertainty objectively influences the formation of public policy, so it should be reflected in this policy model.

Social inclusion as a social sphere phenomenon and economic uncertainty as an economic sphere phenomenon are interconnected for such objective reasons.

On the one hand, economic reasons become the most important grounds for inclusion/exclusion. Undoubtedly, such reasons include output (GDP) and national wealth, labor productivity, economic growth etc. It is clear that

under the conditions of economic uncertainty, the quantitative parameters of these indicators are deteriorating. Most often it results in output, productivity and economic growth rate decline. Against the background of these economic indicators deterioration, there is usually a slowdown in social inclusion, and respectively, an increase of social exclusion.

On the other hand, inclusion/exclusion, first of all, is manifested in socio-economic indicators. We mean, for example, the differentiation of incomes of different segments of society, the division of citizens into employed and unemployed, their belonging to the "middle class", formed by small and medium-sized businesses etc.

We realize that not only economic reasons influence the level of people's involvement in the life of the whole society. In other words, the level of social inclusion is determined not only by economic circumstances. In our opinion, other reasons for inclusion, in addition to economic ones, include technological (communication), educational, cultural, political, etc.

It is indisputable that the manifestations of social inclusion are not limited to economic ones. In our opinion, the non-economic manifestations of inclusion include those that show the maturity of civil society and the quality of the political system. These are, for example, the level of trust in central and local authorities, the level of citizens participation in government and self-government, the general level of political, legal and economic education of citizens. But, despite the fact that both the causes and manifestations of social inclusion / exclusion are not exclusively economic, it is economic processes that form the social inclusion process core.

Since social inclusion has an economic core, the study of the relationship between inclusion and economic uncertainty should begin with an analysis of dependence, the importance of which is recognized in economic theory. There is a link between the differentiation of incomes and wealth of citizens, on the one hand, and indicators which show the level of macroeconomic stability, on the other.

General considerations about the relationship of social and economic phenomena acquire scientific weight when based on the factual data evaluation. Numerous examples of such assessments concerned the answers to two related questions.

The first question is: does the uneven distribution of income and wealth harm economic growth?

The second question is: how does the achieved level of GDP (GDP per capita) correlate with the level of income differentiation?

As it is known, one of the most popular works, which answered the formulated questions, is an article by a prominent economist of the twentieth century. S. Kuznets (Kuznets, 1955). Based on the article by S. Kuznets and others closer to our time (Persson & Tabellini, 1994; Stewart, 2000; Cingano, 2014; Krasota & Melnyk, 2020), we have identified several important statements for our study, namely:

- on the existence of numerous pieces of evidence, obtained on the basis of many countries statistical data regarding higher rates of economic growth with a more even distribution of income;
- on the lack of the "Kuznets hypothesis" reliable evidence as regards income distribution inequality reduction after economic development higher level achievement. There is an increase in income distribution inequality in both developed countries and countries with lower levels of development, when they achieve better economic performance, i.e. with economic growth. These facts have become an argument in this case.
- on the public social policy successfulness in those countries where governments are not limited to the income redistribution through taxes and transfers, but provide more equal conditions for citizens through access to education, culture, medicine, etc.

Despite the facts that allegedly contradict the "Kuznets hypothesis", in our opinion, this theoretical construction remains an important tool of analysis. First, because the "Kuznets hypothesis" refers to the objective relationship between income differentiation, which we associate with inclusion, and GDP per capita, which is associated with economic certainty / uncertainty. Second, the "Kuznets hypothesis" assumes a nonlinear relationship. This means that the differentiation raise occurs against the background of productivity increase only up to a certain limit. And after reaching this limit, on the contrary – productivity starts to decrease.

Assuming that the relationship between average productivity (GDP per capita) and income differentiation is described by a nonlinear quadratic function that has optimal (equilibrium) values, it can be represented as an equation:

$$y - y^* = -\beta(k_{opt}^d - k^d)^2 \quad (1)$$

where

$(y - y^*)$  gap of actual and optimal productivity;

$(k_{opt}^d - k^d)$  gap of optimal and actual values of income differentiation;

$\beta$  the elasticity coefficient of changes in productivity by changes in income differentiation.

Importantly, the nonlinear communication function assumes the existence of a "return point". Before it is achieved, there is no optimal, that is, the most appropriate combination of values of income differentiation and productivity yet. After reaching the "return point", such most appropriate combination no longer exists.

What can the assumption of a nonlinear relationship between productivity and differentiation be based on? First of all, on the realistic idea about motivating higher or, conversely, lower productivity by the income distribution. The assumption that high productivity and the wealth of society may lead to a more even income distribution also looks rather realistic.

The hidden presence of the idea of the so-called "automatism" in our arguments about the nonlinearity of communication is regarded as a certain limitation (disadvantage) of them. After all, it seems that the limit of differentiation, i.e. a kind of a "return point", is formed by self-regulation on the "let it be" principle. In fact, as the experience of different countries shows, the public authority institutions have a decisive role in shaping this scope. They form the vision of social justice and an acceptable level of well-being. It is these institutions that are responsible for implementing a social policy model which is in line with this vision. Instead, so-called "automatism" seems to play a relatively smaller role in the formation of a relationship between income differentiation and productivity.

Our examination of the relationship between GDP per capita, on the one hand, and two indicators of income differentiation, on the other, based on the data from the EU member Lithuania and the data from Ukraine for the period of 15 years (2002 - 2016), yielded the results presented in Table 1. This is discussed in detail in one of the previous studies (Radionova, 2020). We emphasize that we proceeded from the fact that it is possible to form an idea of the level of inclusion through income differentiation indicators. Despite the fact that the manifestations of inclusion are not limited to income differentiation, in the absence of integrated indicators of inclusion, it is advisable to use data on income differentiation.

The choice to compare Ukraine with Lithuania has been made due to the following circumstances. Lithuania belongs to the group of the so-called "post-Soviet countries" as well as Ukraine. At the initial stage of transformations in the mid-1990s, economic differences between countries were not significant. Lithuania's GDP per capita exceeded Ukraine's GDP per capita by only 25% in 1995. In fact, having become the part of the EU in 2004, Lithuania, along with other Baltic countries, has shown significant progress in economic and social development. Ukraine's progress is much smaller. Therefore, the socio-economic indicators and the model of Lithuanian Governance in the social sphere are an important reference point and model for Ukraine. The argument of a certain mental closeness of the citizens of the two countries can also serve in favor of the validity of the comparison between Ukraine and Lithuania.

**Table 1.** Income differentiation indicators and GDP per capita indicators relationship parameters in Lithuania and Ukraine.

Variables between which the relationship is investigated	Parameters that characterize the relationship	Lithuania	Ukraine
GDP per capita (thousands US dollars) – y and Gini coefficient (%) - $k_G$	Trend line equation	$k_G = 9E-08 y^2 - 0,0022y + 47,154$	$k_G = -0,0014y^2 + 30,127$
	Type of function	Nonlinear	Linear descending
	Significance of relationship	$R^2 = 0,2807$	$R^2 = 0,4983$
GDP per capita (thousands US dollars) – y and Quintile coefficient (Income share ratio - times) - $k_{dif}$	Trend line equation	$k_{dif} = 3E-08 y^2 - 0,0007y + 10,679$	$k_{dif} = -0,0003y + 4,514$
	Type of function	Nonlinear	Linear descending
	Significance of relationship	$R^2 = 0,1745$	$R^2 = 0,5043$

**Source:** Authors' own

Table 1 shows the equations of trend lines obtained by selecting those functions for which the significance of the relationship ( $R^2$ ) was the highest. Assuming that the used approach is acceptable, it gives grounds for such generalizations:

- the data on Lithuania confirm the existence of a non-linear relationship between output and income differentiation. Instead, according to the Ukrainian data, a linear inverse relationship was found, in which the reduction of income differentiation occurs against the background of economic productivity indicator improvement;
- the significance of linear inverse relationship indicators, according to the Ukrainian data, is higher (about 50%) than the significance of nonlinear relationship indicators, according to the Lithuanian data (about 30%).

How can the social inclusion phenomenon be interpreted on the basis of information about the relationship between income differentiation and the economic development level? In our view, no matter what function may describe this relationship, inclusion is associated only with that (function) segment within which the reduction of differentiation occurs against the background of economic indicators improvement. In other words, income differentiation reduction alone does not mean inclusion.

Is it possible to determine what public policy should be based on a study of the relationship between social and economic indicators? The answer to this question requires special research. We can only assume the possibility of evaluating public policy by the criterion of promoting the approach to the "return point". It is clear that such an approach is justified only when the "return point" means the best combination of indicators of income differentiation and economic development.

What does social inclusion reflection in public policy mean? In our opinion, two standpoints can be regarded as follows.

First, the reflection of social inclusion in public policy occurs when social inclusion becomes a strategic target of public authority. This is the component of public policy which is identified as "social policy". We have already emphasized that in many countries social inclusion as a social value, as a direction of development, is targeted by governments. Moreover, not only the social sphere itself benefits from this, but also the economic one, as economic growth is accelerating.

Second, the reflection of social inclusion in public policy means the identification of specific targets. Such targets must be justified. The validity of inclusion indicators involves the identification of influential factors and assessment of the strength of their impact. The complexity of such isolation and evaluation increases with greater economic uncertainty.

We attempted to identify and evaluate exogenous effects on two inclusion indicators – Gini coefficient (%) and Quintile coefficient Income share ratio (times) – according to the Ukrainian data. At the first stage of the analysis the influence of 29 indicators of economic, financial, monetary, technological, demographic, educational spheres was investigated. The Neural Networks toolkit has been used to detect non-obvious (hidden) relationships inherent in economic uncertainty.

It is established that the model with seven exogenous variables is characterized by the best results (Table 2).

**Table 2.** Technical characteristics of the model of income differentiation indicators relationship with other variables.

<b>Regression statistics</b>								
Multiple R	0,98							
R <sup>2</sup>	0,97							
Adjusted R <sup>2</sup>	0,95							
Standard error	0,86							
Observations	19,00							
<b>Analysis of variance</b>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>F-significance</i>			
Regression	7,00	267,20	38,17	51,13	0,00			
Residual	11,00	8,21	0,75					
Total	18,00	275,42						
	<i>Coefficients</i>	<i>St.error</i>	<i>t-stat</i>	<i>P-Value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y -intersec	23,62	1,84	12,87	0,00	19,58	27,66	19,58	27,66
9. u Unemployment	-0,92	0,27	-3,41	0,01	-1,52	-0,33	-1,52	-0,33

10. $\pi_{CPI}$ Inflation	-0,01	0,00	-7,66	0,00	-0,01	0,00	-0,01	0,00
13. $q_{USD}$ Official exchange	0,11	0,05	2,09	0,06	-0,01	0,22	-0,01	0,22
15. $S_N/Y$ Gross savings	0,16	0,06	2,65	0,02	0,03	0,30	0,03	0,30
21. $i^r$ Real interest rate	0,06	0,03	1,95	0,08	-0,01	0,13	-0,01	0,13
22. $i_{dep}$ Deposit interest rate	0,24	0,03	7,17	0,00	0,17	0,32	0,17	0,32
29. $n$ Population	-6,89	1,44	-4,78	0,00	-10,06	-3,72	-10,06	-3,72

**Source:** Authors' own

The technical characteristics of the model indicate the following:

- income differentiation was influenced by the following seven variables: unemployment rate ( $u$ ), inflation rate ( $\pi_{CPI}$ ), the national currency exchange rate to USD ( $q_{USD}$ ), share of national savings in GDP ( $S_N/GDP$ ), real interest rate ( $i^r$ ), deposit interest rate ( $i_{dep}$ ), annual population growth rate ( $n$ );
- selected variables explain the differentiation of income by 97% ( $R^2=0,97$ ), the correctness of the selection of variables is proved by the fact that the F-criterion = 0, the coefficients for all seven variables of the model are significant because P-value < 0,1.

Not all the selected variables of the constructed model can be explained on the basis of traditional theoretical concepts. According to the logic of traditional theoretical constructions, the influence on the income differentiation of the following variables can be explained:

- inflation rate ( $\pi_{CPI}$ ), since the theoretical axiom is a statement that some segments of society benefit from inflation but others lose;
- unemployment rate ( $u$ ), as the growing share of the unemployed increases the stratum of the poor;
- population growth rate ( $n$ ), as declining population growth means an aging nation, ie, an increase in the share of people with lower economic activity and lower incomes.

Given the peculiarities of the Ukrainian economy, the influence on the income differentiation from the exchange rate of the national currency ( $q_{USD}$ ) is "exposed" to a certain logical explanation. After all, the dynamics of the exchange rate significantly influences the income of the richest owners of the shadow, "oligarchized" part of the Ukrainian economy.

The most difficult thing is to explain the impact of three other variables of the model on income differentiation, and namely: the real interest rate of the financial market ( $i^r$ ), deposit interest rates ( $i_{dep}$ ), the share of national savings in GDP ( $S_N/GDP$ ).

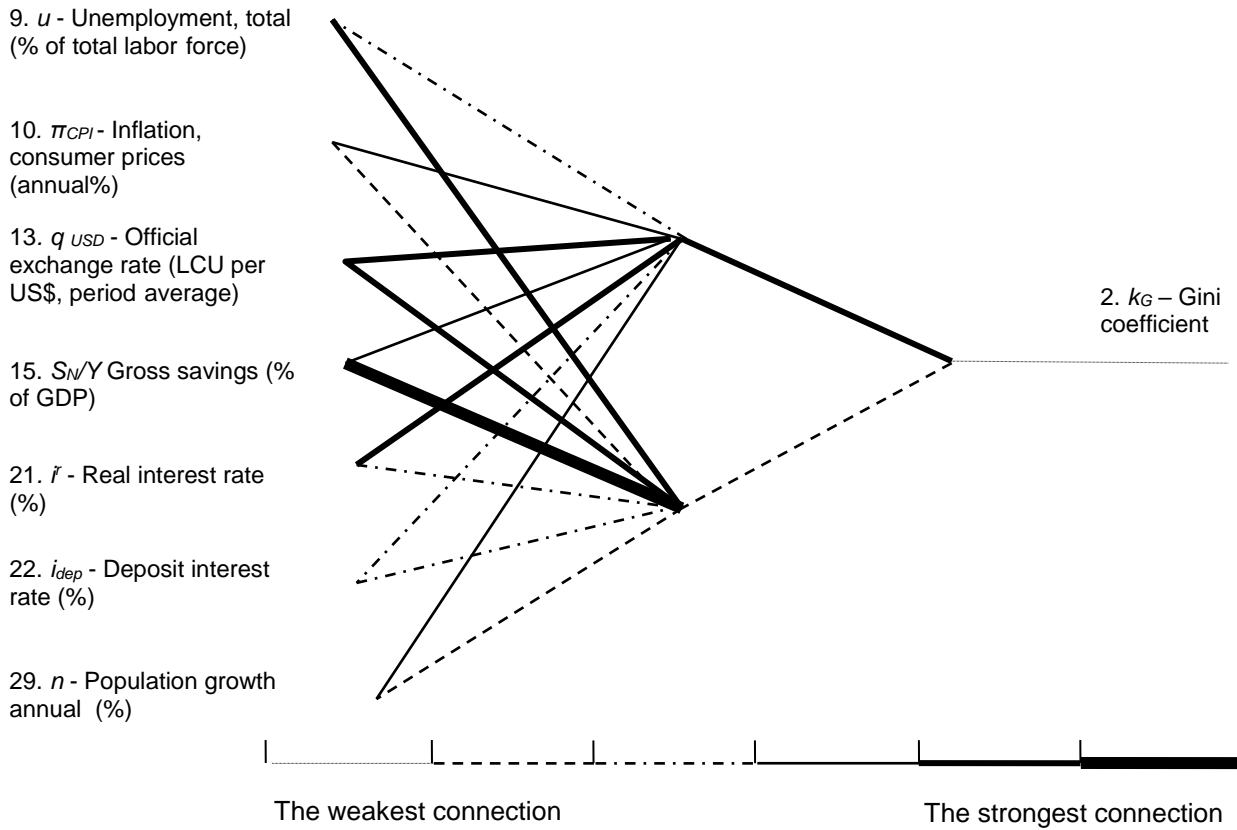
The signs ("+" or "-") of the coefficients for the model variables also look contradictory from the standpoint of traditional "linear logic". In particular, the coefficients for the two variables of the model – the unemployment rate ( $u$ ) and the inflation rate ( $\pi_{CPI}$ ) – have "-" signs. This means that the relationship is reversed: with the growth of both unemployment and inflation, income differentiation decreased.

If we limit ourselves to the use of regression analysis tools, then "illogical" results and "incomprehensible" effects could hardly be interpreted in any way. However, the construction of Neural Networks opens up the possibility of such an interpretation. After all, analysis based on Neural Networks reveals the internal relationships of variables in the "nodes" of multilevel dependencies. These dependencies are difficult or impossible to present in simple single-level chains. Instead, they can be represented as graphs.

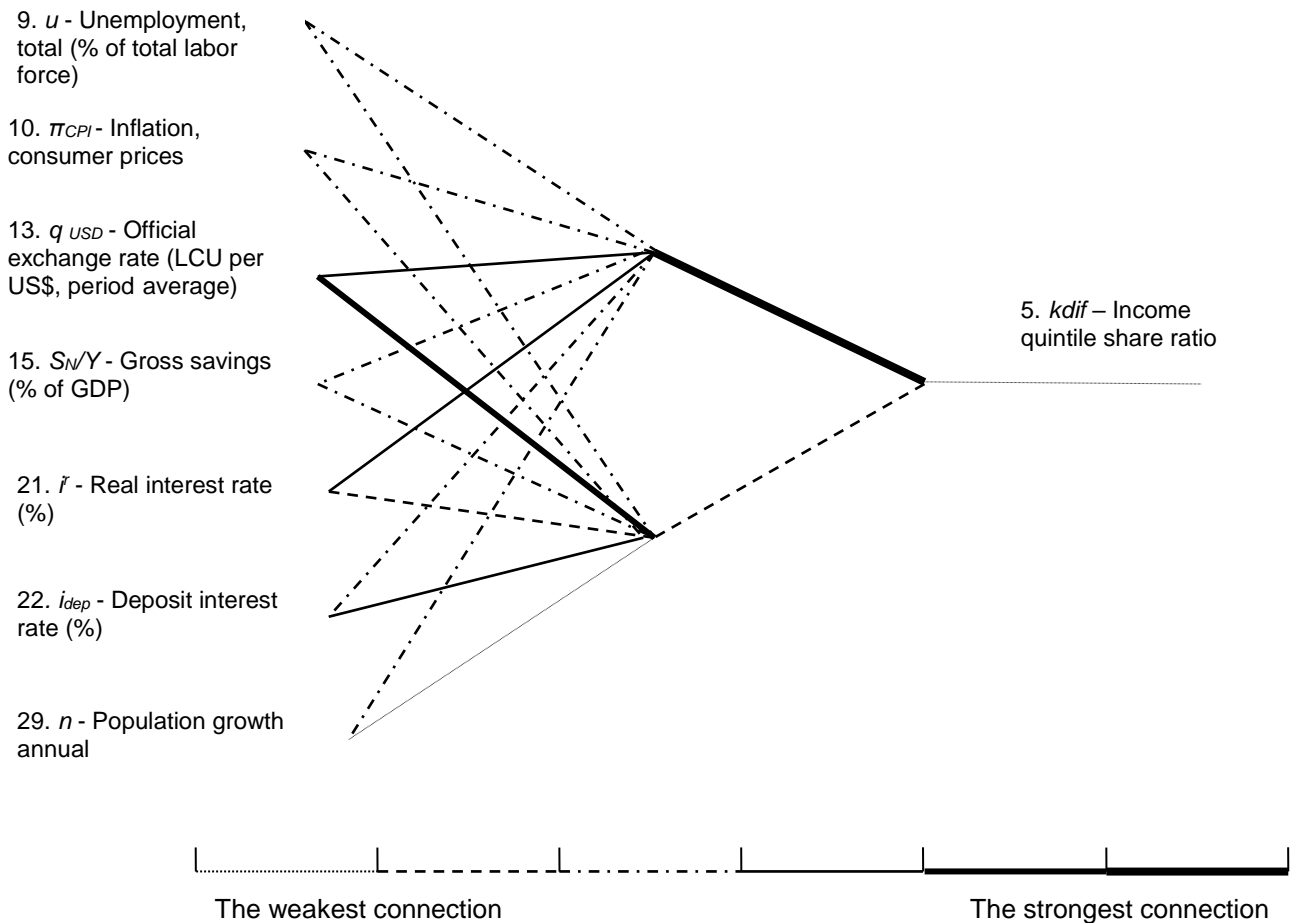
The results of constructing a neural network that reflects the relationship between the Gini coefficient (%) and the seven previously selected variables are presented in Fig. 2. The Neural Networks model was built in the Deductor environment.

The Neural Network graph presented in Fig. 2 shows the existence of two nodes of interaction between the seven selected model variables. The following variables had the strongest relationship with the Gini coefficient through the first node: 1)  $q_{USD}$  - Official exchange rate, 2)  $i^r$  - Real interest rate 3)  $\pi_{CPI}$  - Inflation rate, 4)  $S_N/Y$  - Gross savings (% of GDP); 5)  $n$  - Population growth annual. In the second node, the variables with the strongest relationship were: 1)  $S_N/Y$  - Gross savings (% of GDP), 2)  $u$  - Unemployment, total (% of total labor force), 3)  $q_{USD}$  - Official exchange rate.

The results of Neural Network construction that reflects the relationship between the second indicator of income differentiation – Quintile coefficient (Income share ratio (times) – and the other seven previously selected variables are presented in Fig. 3. The Neural Networks model was built in the Deductor environment.



**Fig.2.** Neural network graph for Gini coefficient  
**Source:** Authors' own

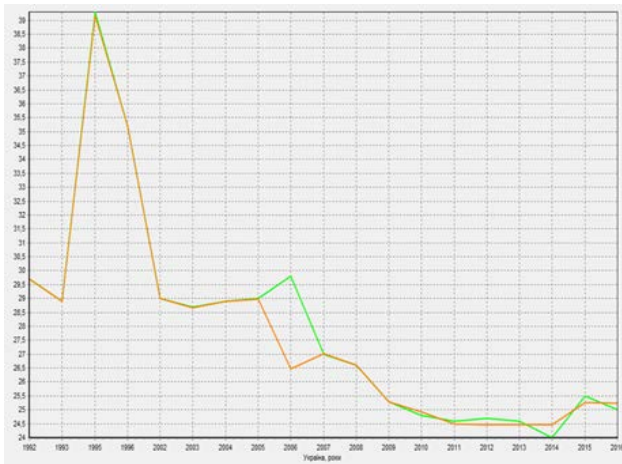




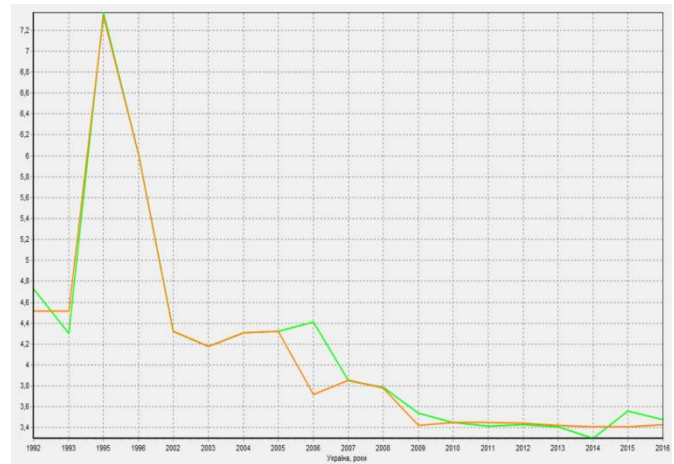
**Fig.3.** Neural network graph for Income quintile share ratio  
**Source:** Authors' own

The Neural Network graph in Fig. 3 shows two nodes of interaction among the seven variables of the model. The following variables had the strongest relationship with the Income quintile share ratio through the first node: 1)  $q_{USD}$  - Official exchange rate, 2)  $i^r$  - Real interest rate. In the second node, the strongest relationship was noticed with such variables: 1)  $q_{USD}$  - Official exchange rate 2)  $i_{dep}$  - Deposit interest rate.

The quality control of the Neural Network in the test sample is given in Fig. 4.



**Fig.4a.** Neural network quality control for the model with Gini coefficient



**Fig.4b.** Neural network quality control for the model with Income quintile share ratio

**Fig.4.** Neural network quality control  
**Source:** Authors' own

Fig. 4a illustrates the degree of approximation of actual and simulated Gini coefficient values using Neural Networks. In the test sample of the last two (of the above) years, the forecast error was, on average, less than 1%. This indicates a very high Neural Network quality.

Fig. 4b illustrates the extent to which the actual and simulated by means of using Neural Networks values of the Income quintile share ratio are approximated. In the test sample of the last two years, the forecast error was, on average, less than 2%. This indicates the Neural Network high quality.

The high quality of the two Neural Networks is the basis for using the model in forecasting and making management decisions in the field of social inclusion management.

The comparison of the two Neural Networks gives grounds for interesting generalizations regarding the strength of the influence of the selected variables on the Gini coefficient and the Income quintile share ratio. Probably the peculiarities of the content of the two indicators of income differentiation determine the peculiarities of the impact. After all, the Income quintile share ratio differentiates from the point of view of the gap in the incomes of the richest and poorest groups of the population. Instead, the Gini coefficient takes into account differences in income for other groups as well. Analytical table 3, based on the results of the creation of two Neural Networks, illustrates these peculiarities of the effects.

**Table 3.** Hierarchy of influence of variables in the nodes constructed by Neural Networks.

Gini coefficient	Income quintile share ratio
<i>The most influential variables in the first node of interaction</i>	
$q_{USD}; i^r; \pi_{CPI}; S_N/Y; n$	$q_{USD}; i^r$
<i>The most influential variables in the second node of interaction</i>	
$S_N/Y; u'; q_{USD}$	$q_{USD}; i_{dep}$

**Source:** Authors' own

The information given in Table 3 offers to make rather obvious generalizations. According to the Gini coefficient, income differentiation in the Ukrainian economy largely depended on the indicators of the financial, monetary and real sectors of the economy. Indicators of the real sector – unemployment rate, consumer price inflation, the share of savings in GDP – had a strong impact on the Gini coefficient. Instead, the Income quintile share ratio

was strongly influenced only by the monetary and financial sectors, namely the exchange rate, the real interest rate and the deposit interest rate.

## Conclusion

Having conducted this research, we have made the following conclusions:

1. The idea of the appropriateness of reflecting in public policy the relationship between social inclusion and economic uncertainty has sufficient theoretical and applied justification. The state of inclusion, which depends significantly on the state of the economy, can be reflected in public policy in at least two ways. First, when social inclusion becomes a public value and target of public authority. Second, when policies use sound indicators to assess and predict the level of inclusion. The justification of predictions depends on the understanding of factors influencing social inclusion.
2. The relationship between social inclusion and the condition of the economy is ambiguous. It requires special analysis in each country to ensure the relevance of management decisions. There are grounds to believe that social inclusion can be associated only with a differentiation level reduction in income of different segments of society, which occurs against the background of economic indicators improvement. There are reasons to believe that when studying the level of social inclusion it is not advisable to be limited to only one indicator, such as the level of income differentiation. It is also not advisable to limit the analysis to only one economic indicator as such, which is associated with differentiation. The range of studied indicators should expand. However, at the initial stage of the social inclusion study, the relation between income differentiation and GDP per capita should be considered.
3. Under the conditions of growing economic uncertainty, a tool for building Neural Network models can be effective for analyzing social inclusion. The effectiveness of this toolkit is due to its ability to detect hidden, multilevel dependencies of variables. In particular, the study of income differentiation indicators, according to the Ukrainian data, made it possible to identify unclear but significant relationships between income differentiation, respectively, social inclusion, on the one hand, and a set of economic, financial, etc. variables, on the other. It has been found that such variables were: unemployment rate, inflation rate, the national currency to the USA dollar, the share of national savings in GDP, real interest rate, deposit interest rate and population growth rate.
4. Probably, further research on the issue regarding social inclusion reflection in public policy, taking into account the achieved level of economic certainty, will be carried out in the following areas. First, in the process of developing basic theoretical constructions similar to the Kuznets hypothesis. Second, in constructing relevant indicators for assessing social inclusion. Third, when using various tools of econometric analysis and when forecasting indicators of social inclusion. Fourth, when designing changes in public institutions and public policy to implement an effective response to changes in the social sphere.

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