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## **THE IMPACT OF CORRUPTION ON THE EFFICIENCY OF PUBLIC SPENDING ACROSS COUNTRIES WITH DIFFERENT LEVELS OF DEMOCRACY**

**Abstract.** Corruption, being linked to institutions of power, affects the efficiency of using public funds in a country. This happens, in particular, due to distortions in the structure of public expenditure, worsening quality and decreasing accessibility of public services, and overpricing of public services. The consequences of corruption that arise in different areas of human activity often become subject of scientific investigations performed by reputable scientists. However, the issue of the impact of corruption on public spending efficiency in the countries with different levels of democratic development has not been researched. The aim of this study is to determine the impact of corruption on the efficiency of public spending across the world (in 166 countries for the period from 2004 until 2017). The research is carried out by applying regression analysis to indicators characterizing the level of corruption and the efficiency of public spending obtained from large-scale survey data collected by major international organizations and aggregated in the World Bank's "World Development Indicators" database. The analysis is also performed by using k-means clustering method to group countries into 4 clusters by the level of democracy and to build refined one-factor econometric models for each of them.

The study revealed strong correlation relationship between corruption and public spending efficiency. It has been determined that a unit increase in corruption perceptions (a decrease in corruption) leads to a marginal increase in the efficiency of public spending by 0.931 units in the simple linear regression model and by 0.807 units in the multiple regression model. The study also showed that the impact of corruption on public spending varies depending on the level of democracy in a country. In the countries with low democracy levels, a unit decrease in corruption increases the efficiency of public spending by 0.923 units, whereas a similar decrease in corruption in the countries with high democracy levels will increase public spending efficiency only by 0.701 units. The findings of this study allow us to determine with higher accuracy the effects of corruption reduction measures on the efficiency of public spending.

**Keywords:** public sector, budget, corruption, public services, public procurement.

**JEL Classification** C13; D73, H50

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## **ВПЛИВ КОРУПЦІЇ НА ЕФЕКТИВНІСТЬ ВИДАТКІВ БЮДЖЕТІВ ДЕРЖАВ ІЗ РІЗНИМ РІВНЕМ ДЕМОКРАТІЇ**

**Анотація.** Корупція, будучи пов'язаною з владними інституціями, позначається на ефективності використання коштів бюджету держави. Це відбувається, зокрема, через викривлення структури видатків бюджету, погіршення якості та доступності суспільних послуг, зростання вартості суспільних благ тощо. Наслідки корупції для різних сфер життєдіяльності часто є предметом дослідження авторитетних учених. Однак питання впливу корупції на ефективність використання бюджетних ресурсів у країнах із різними рівнями розвитку демократії не вивчене. Метою дослідження є з'ясування впливу корупції на ефективність бюджетних видатків у різних країнах світу (у 166-ти країнах світу впродовж 2004–2017 рр.) Дослідження передбачало застосування регресійного аналізу індикаторів, що характеризують рівень корупції та ефективність видатків бюджету. Аналіз передбачав також групування країн за допомогою методу *k*-середніх на чотири кластери за рівнем демократії та побудову для них якісних однофакторних економетричних моделей. Виявлено тісну кореляційну залежність корупції та ефективності видатків бюджету; встановлено, що зростанням оцінки корупції (її зменшення) на одиницю в однофакторній моделі призводить до граничного збільшення ефективності видатків бюджету на 0,931 одиниці, а в моделі множинної регресії приріст становив 0,807 одиниці. Встановлено, що вплив корупції на бюджетні видатки видозмінюється залежно від рівня демократії у країнах. У країнах із найнижчим рівнем демократії скорочення рівня корупції на одиницю призводить до зростання ефективності видатків бюджету на 0,923 одиниці, у той час, коли у країнах із найвищим рівнем демократії аналогічне зменшення корупції призведе до зростання ефективності видатків лише на 0,701. Одержані результати дають змогу точніше визначати наслідки для ефективності видатків бюджету від заходів, спрямованих на скорочення корупції.

**Ключові слова:** суспільний сектор, бюджет, корупція, суспільні послуги, публічні закупівлі.

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## ВЛИЯНИЕ КОРРУПЦИИ НА ЭФФЕКТИВНОСТЬ РАСХОДОВ БЮДЖЕТОВ ГОСУДАРСТВ С РАЗЛИЧНЫМ УРОВНЕМ ДЕМОКРАТИИ

**Аннотация.** Исследованы теоретические основы и практические аспекты влияния коррупции на эффективность расходов бюджета. Установлено, что уменьшение коррупции на единицу в однофакторной модели приводит к предельному увеличению эффективности расходов бюджета на 0,931 единиц, а в модели множественной регрессии прирост составил 0,807 единиц. Доказано, что воздействие коррупции на бюджетные расходы видоизменяется в зависимости от уровня демократии в государствах. В странах с низким уровнем демократии сокращение уровня коррупции на единицу приводит к росту эффективности расходов бюджета на 0,923 единицы, в то время, когда в странах с высоким уровнем демократии аналогичное уменьшение коррупции приведет к росту эффективности расходов только на 0,701.

**Ключевые слова:** общественный сектор, бюджет, коррупция, общественные услуги, государственные закупки.

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**Introduction.** Corruption is one of the most negative phenomena accompanying states over the entire period of their existence. It distorts the process of management, establishes a variety of false goals and enhances motivations for their achievement, as well as vitiates the set priorities. The mentioned consequences are directly related to public spending that represents an important element of the country's financial system and frequently becomes subject to corrupt wrongdoings. Thus, the propagation of corruption in the system of public spending management shifts the priorities in public spending from those that generate positive consequences for the society in general to those that generate personal advantages for public officials. Thus, given a fixed amount of resources, the volume of produced public goods tends to decrease, leading to falling efficiency of public spending. Increasing the efficiency of public spending is among top priorities in the modern world. The instability of political systems shows itself increasingly on the quality of fiscal policy. Often the enhancement of public spending efficiency becomes a precondition to exit from a crisis. In addition, it might not be an infrequent occurrence when the countries exhibiting significant problems in the budgetary system are also suffering from escalating corruption. Therefore, it is important to understand the nature of the dependence between the progress in solving the problem of corruption and the positive outcomes for the efficiency of public spending.

**Review of recent literature.** Economic studies have investigated various impacts of growing corruption on public expenditures. Thus, Tanzi and Davoodi (2000) proved that the negative impact of corruption on economic growth is driven by inefficient allocation of resources. They assert that corruption in particular leads to increasing volumes of public investment and its decreasing efficiency [1]. D'Agostino, Dunne and Pieroni (2016) found that the dependency between corruption and investment, as well as between corruption and defense expenditures, has a strong negative impact on economic growth [2]. The IMF team led by Gupta and Ogada (2016) revealed that corruption negatively affects economic growth by creating distortions in the functions of the state [3]. In deforming state functions in many areas, it damages the macro-financial stability, public and private investment, human capital accumulation, and total factor productivity. The negative impact of corruption on the structure of public expenditures is corroborated by the study of Wu, Li, Nie and Chen (2017) as well [4]. Liu and Mikesell (2014) found that because of corruption, the share of expenditures carrying higher corruption risks increases [5]. Hessami (2014) reports that under the influence of corruption, the structure of expenditures changes, in particular that an increase in corruption results in increasing shares of healthcare expenditures and environmental protection expenditures, whereas the shares of expenditure on social security, recreation, culture, and religion decrease [6].

Rajkumar and Swaroop (2008) have empirically proved that public expenditures on healthcare produce a strong negative influence on child mortality in countries with good governance [7]. They acknowledge that a combination of decreasing corruption and increasing quality of bureaucracy results in increased efficiency of public expenditures on healthcare in what concerns the reduction of child mortality. Olken (2006) suggested that corruption in developing countries, such as Indonesia, can significantly impede the government's ability to carry out redistribution programs, especially in rural areas [8]. In such conditions, the costs of corruption can actually exceed potential social benefits from redistribution. In the process of laboratory experiments, Rema and Shing-Yi (2017) revealed that students that are more apt to lie tend to choose employment in the public sector. In the authors' opinion, this is predetermined by the peculiarities of employee selection procedures in public service [9]. The study of Lewis (2016) on the impact of local government expenditures on public service providing in Indonesia points to the fact that corruption is one of the factors that affect the accessibility and efficiency of public spending [10]. The initiative to investigate social consequences of corruption was further developed by Banerjee (2016). In his research, the author revealed the negative impact of corruption on the social capital (measured as the level of trust) [11]. Thus, the negative impact of corruption manifests itself in the government's decreased ability to satisfy the need in public services due to reduced accessibility and increasing inadequacy of the latter with respect to adopted standards.

Therefore, scientists pay attention to the negative influence of corruption on public finance, and in their studies they emphasize the feasibility of paying consideration to social aspects related to causes and consequences of corruption. The growing awareness of the importance of information about social perceptions of economic processes has become a powerful stimulus for the development of various forms and methods used to monitor social processes. The decades of full-fledged studies allowed accumulating a rich set of important data. Nevertheless, these data are only marginally used to investigate the impact of different factors on budgeting. In particular, there is a lack of modern research on the impact of corruption on public spending.

The aim of this article is to systematize the theoretical provisions and to elaborate a theoretical framework on the relationship between public spending and the level of corruption, as well as to determine the impact of the latter on the efficiency of public expenditure in different countries.

**Main findings.** The financial literature corroborates the influence of corrupt wrongdoings on the management of public spending. The wrongdoings of public officials lead to changes in the qualitative and quantitative characteristics of public expenditures. The corrupt wrongdoings of the officials having decision-making authority in the sphere of public finance generate additional improper advantages for the latter. Thus, the primary consequences of corruption consist in the concentration of benefits from public expenditure in the hands of a limited group of individuals compared to a situation with no corruption. The secondary consequences of corruption consist in its negative impact on the national economy as manifested in the loss of competitiveness and increasing transaction costs. Taken together, all this leads to a decrease in the volume of public goods received by the society as a result of public expenditure.

Corruption deforms the structure of public expenditure, leading to its diversion from social priorities. This relationship is explained by the fact that the more the budget authorities are penetrated by corruption, the more the public spending is directed towards expenditures that can generate higher corruption rents. Thus, smaller funds are directed towards expenditures, which are less important for the decision-making individuals personally, even though they might be valuable for the community as a whole. Mauro (1998) describes a phenomenon when, under the influence of corruption, education and healthcare expenditures are losing their priority, whereas the share of expenditures that can generate higher corruption rents is increasing [12]. In addition, the deformation of priorities occurs within certain directions. The research performed by Tanzi and Davoodi (2002) proves that the selection of public investment projects is being twisted under the influence of bribery and rent-seeking behavior [13].

Another important negative implication of the impact of corruption on the process of public

spending is the worsening quality and accessibility of public goods caused by the negative impact of corruption on the intensity and efficiency of control over the use of funds. Increasing corruption in the management system brings forth a decreasing responsibility for legal performance, but a growing disposition towards generating corruption rents. As a result, the incentives to provide high-quality public goods become much weaker for public officials. Hall (2012) also took notice of the problem with public goods accessibility caused by petty bribery of public officials [14]. Therefore, another consequence of corruption is that it negatively affects the government's ability to meet the need in public goods due to their decreasing accessibility and growing inadequacy with respect to accepted standards.

An increase in the price of public goods under the influence of corruption is caused primarily by distortions in public procurement. The consequence of corrupt wrongdoings usually includes purchases of goods and services at unreasonably high prices. This creates an opportunity for public officials to extract corruption rents, whereas the competitiveness of national economy decreases giving rise to oligarchic formations and other negative consequences. Monte and Papagni (2001) proved that corruption in public procurement produces a negative influence on long-term economic growth opportunities. In their opinion, this is explained by the fact that since some portion of public funds is used in vain, the share of public expenditure that could have been used to provide public goods decreases [15]. The study performed by Burguet (2017) revealed that the availability of rules on public procurement can decrease corruption in this sphere [16]. Thus, an obvious negative consequence of corruption in the sphere of public procurement is the decrease in the volume of public goods that are provided to population and financed by the state budget.

To sum up the aforementioned, we have to acknowledge that promulgation of corruption leads to decreasing satisfaction of the society with public services and increasing costs of their providing. A decrease in the estimated value of supplied public goods combined with an increase in the costs of public goods provision will directly show in the falling efficiency of public spending. In general, such a viewpoint fits into the modern approach to efficiency assessment as described by Mandl, Dier and Ilzkovitz (2008). They define "efficiency" as a ratio of outputs obtained to the resources deployed. The outputs of public spending, in the authors' opinion, are frequently linked to social well-being or growth targets. Moreover, it may be complicated to measure public sector outputs, since public goods are often not sold on the market, which implies that the price data might not be available [17].

In view of the objective complexity of measuring public spending outputs, the financial science has been extensively using public opinion surveys in order to evaluate its efficiency. Assessments provided by economic entities, which are both the taxpayers and the consumers of public goods, are a logical and objective indicator of the efficiency of using state budget funds. The application of this approach in this study allows us to avoid the problem of identifying the numerous determinants of the influence of corruption on the efficiency of spending, tracing the mechanisms of this impact, and studying the interrelationships among the determinants themselves.

Public perceptions and assessments lay the basis for studying not only the phenomenon of corruption, but also the efficiency of public funds usage. Thus, this process is affected by the level of interaction between the civil society and the public authorities which is determined by the level of democracy. A number of scientists, in particular Bazzi and Clemens (2013), highlighted the positive influence of democracy on the spreading of corruption [18]. The study performed by Boffa, Piolatto and Ponzetto (2016) revealed that the participation of politicians in the election process is an important stimulus for preventing corruption [19]. Having compared corruption across different countries, Treisman (2000) identified democracy as one of the six factors that affect the phenomenon of corruption [20].

In our study, we develop two hypotheses. First, since scientific studies have already found proof that corruption negatively impacts upon separate dimensions of public spending management, and the latter, in their turn, are affecting the efficiency of spending, this means that corruption produces a negative impact on the overall estimate of public spending efficiency. We also have to take into account

that it is the society that is the main assessor of both the level of corruption and the level of public spending efficiency, however, the citizens in different countries have different capabilities of exerting influence upon public management, which leads us to suggest that for equal corruption levels, the respondents will differ in their perceptions of public spending efficiency. Thus, our second hypothesis is that the impact of corruption on public spending efficiency depends on the level of democratic development in the country.

The indicators for empirical research were obtained from the World Bank's *Worldwide Governance Indicators* (WGI) database. In this database, we have chosen two groups of indicators: "Control of Corruption" and "Government Effectiveness". The data in the first group capture perceptions of the extent to which public power is exercised for private gain. The Government Effectiveness indicators, on the other hand, offer the most comprehensive sets of data on the efficiency of public spending, since they capture perceptions of the quality of public services, civil service, as well as policy formulation and implementation. It is worth to underscore that the above mentioned activities are financed from the state budget, thus its assessments reflect the efficiency of public spending. The datasets were sourced from a large number of corporate respondents, individuals, as well as experts in economics and economic development. The assessment of the corruption level and government effectiveness varies in the range from -2.5 (weak position) to 2.5 (strong position) [21]. For this study, we use panel data for 166 countries over the period from 2004 to 2017. The sample includes all countries for which the data was available with respect to each indicator for each year of the entire period under study.

The task of this analysis is to study the dependency between the level of public spending efficiency and the estimated level of corruption. At first, we will carry out a cross-sectional analysis by using the *ordinary least squares* (OLS) method based on average indicators for the entire period from 2004 to 2017. In order to determine the influence of corruption, we build a simple regression model and a multiple regression model with exogenous corruption and democracy variables; after that, we will identify the influence of each of the factors on the endogenous variable – the efficiency of public spending.

Suppose, we consider the following simple one-factor linear regression model:

$$y_t = \alpha_0 + \alpha_1 x_t + \varepsilon_t, \quad (1)$$

so that  $y_t$  is the dependent variable (estimated public spending efficiency in year  $t$ ),  $x_t$  — the independent variable (corruption level in year  $t$ ),  $\alpha_0$  and  $\alpha_1$  — unknown parameters that need to be estimated,  $\varepsilon_t$  — normal random disturbance (error).

The coefficient  $\alpha_1$  is the slope parameter, which measures the change in efficiency given a unit change in corruption perceptions, the coefficient  $\alpha_0$  is the intercept parameter, which measures the efficiency given the average level of corruption equals 0 (note that according to assessment of the expert group, the levels of corruption and efficiency ranged from -2.5 to 2.5).

Obviously, the error term  $\varepsilon_t$  should satisfy the conditions:

$$M(\varepsilon_t) = 0, \text{Var}(\varepsilon_t) = \sigma^2 \text{ for all } t, \text{cov}(x_t, \varepsilon_t) = 0 \text{ and } \text{cov}(\varepsilon_i, \varepsilon_j) = 0 \text{ for } i \neq j.$$

In spite of the simplicity of the linear model, the obtained estimates will allow us to determine the degree of dependency between the level of public spending efficiency and the perceived corruption level. It should be noted that other types of functional dependencies did not help us to considerably improve the quality of the model. That is why we believe that it is sufficient to base the first step of our analysis on using the linear models.

Drawing on the statistical data on corruption and efficiency estimates for 166 countries, as well as using equation (1), we construct linear one-factor econometric equations for each year within the period from 2004 to 2017. Table 1 consolidates the data on the respective coefficients of correlation, coefficients of determination and values of Fisher statistics. As for the last two rows of the table, we suggest that the respective models are adequate and reliable at 5% level.

Table 1

Main parameters of the econometric linear equation (1) for the period from 2004 to 2017

Year	$a_1$	$a_0$	$R^2$	$F$
2004	0.940	0.038	0.91	1697.6
2005	0.945	-0.003	0.91	1760.6
2006	0.928	0.008	0.89	1270.7
2007	0.930	0.019	0.89	1279
2008	0.917	0.021	0.88	1211.6
2009	0.920	0.033	0.86	1248.1
2010	0.919	0.039	0.88	1145.3
2011	0.920	0.041	0.88	1184.9
2012	0.918	0.039	0.88	1201.9
2013	0.921	0.039	0.88	1194
2014	0.906	0.06	0.85	931.2
2015	0.918	0.058	0.86	102.6
2016	0.912	0.051	0.87	1089
2017	0.911	0.055	0.85	940.9

Source: Calculated by the authors based on [21]

In the constructed linear econometric models, the coefficients  $a_1$  and  $a_0$  are estimates of the coefficients  $\alpha_1$  and  $\alpha_0$  in model (1). For the estimated values of coefficient  $a_1$  (see Table 1) we can observe a persistent general tendency ( $a_1 \approx 0.9$ ), and thence, we can draw a conclusion that an improvement in corruption by one unit leads to a 0.9-unit increase in the efficiency of public spending. At the same time, taking into account the coefficient of determination, we can assert that there is a strong correlation between the public spending efficiency and corruption.

After having derived the average values for corruption and public spending efficiency estimates, we can perform the cross-sectional analysis. Based on the OLS method, we obtain the following generalized equation of relationship:  $y = 0.931x + 0.037$ , which fits the above-mentioned tendency. The quantitative estimate of parameter  $a_1$  shows that an increase in corruption perceptions by one unit leads to a marginal increase of 0.931 units in the efficiency of public spending. The coefficient of corruption is significant at  $<0.0001$ . Taking into account the values of standard errors for estimated parameters  $a_0$  and  $a_1$  (0.025 and 0.024 respectively), we can see that the estimates are not skewed. The coefficient of determination  $R^2 = 0.9$  indicates that 90% of the variation in the efficiency levels of the studied countries is driven by the variation in the corruption perceptions. The coefficient of residual determination ( $1 - 0.9$ ) indicates that 10% of the variation in the efficiency level is explained by other factors, which allows us to suggest that the model is adequate.

Although cross-sectional analysis is useful in studying the dependency relationship, it nevertheless does not allow to control for the specific effects caused by independent variables used in the model. Let us now analyze trends in average corruption estimates and the respective efficiency for all countries in the sample. The world tends to exhibit minor growth in both the corruption estimate (which means corruption is decreasing) and the efficiency estimate, as described by equation  $y = 0.931x + 0.037$ , where  $y$  represents the average value of the efficiency estimate and  $x$  – the average value of the corruption estimate ( $0.931 > 0$ ).

The construction of mathematical models based on the data for each country in the sample showed that the models built for developed countries with high levels of democracy are adequate. For example, Austria –  $y = 0.502x + 0.824$ ,  $R^2 = 0.61$ ; Denmark –  $y = 1.682x - 1.88$ ,  $R^2 = 0.74$ , etc. For the countries with lower democracy levels, we failed to construct relationships with sufficient coefficients of determination, for example: Afghanistan –  $y = 0.884x - 0.027$ ,  $R^2 = 0.343$ ; United Arab Emirates –  $y = 1.303x - 0.309$ ,  $R^2 = 0.327$ ; Ukraine –  $y = 0.326x - 0.323$ ,  $R^2 = 0.114$ . This brings up the question why we cannot build a refined econometric equation for a separate country,

but, based on average estimates, we obtained an adequate mathematical model  $y = 0.931x + 0.037$  ( $R^2 = 0.9$ ) for the entire sample? Based on the central limit theory of Lyapunov and the Law of Large Numbers, we can say that the probability distribution for respective estimates is close to normal distribution.

The analysis of obtained equations allowed us to observe certain regularities in the groups of countries that are close in terms of their democratic development. That is why the next step of our study is to analyze the influence of corruption on the level of efficiency, given the democracy level. The data on democracy levels were taken from the Democracy Index compiled by The Economist Intelligence Unit (The EIU), a structural unit at The Economist.

The Democracy Index is calculated based on 60 indicators grouped into five categories, with the scores ranging from 0 to 10. The sub-indices are the sums of indicators assigned to the category and converted according to a scale ranging from 0 to 10 (The Economist, 2017) [22].

In order to process the data on 166 countries in the sample with the help of *Statistica* package, we grouped the countries according to their similarity in the level of democratic development. For that we used the hierarchical clustering and the *k*-means clustering methods. The construction of a dendrogram enabled us to determine four clusters, which we believe is the optimal number. By applying *k*-means clustering method, we used dispersion analysis and divided objects into clusters by applying Fisher-statistics, so that the within-cluster variation was small, but the between-cluster variation was large.

When constructing mathematical models for each of the clusters of countries grouped by democracy level, we obtained the models (1) with considerably high coefficients of determination (Table 2), which indicates the possibility of obtaining predicted estimates for the countries in each of the clusters.

The analysis revealed that the countries in Cluster 3 (with lowest democracy levels) exhibited a consistent pattern: Each additional unit of improvement in the level of corruption generated a faster increase in public spending efficiency in these countries compared to countries with higher democracy levels, since  $0.923 = \max(a_{11}=0.76, a_{12}=0.912, a_{13}=0.923, a_{14}=0.682)$ . Obviously, the countries with higher democracy levels take increasing corruption estimates for granted, whereas in the countries with lowest democracy levels this is a less frequent occurrence. For the countries in Cluster 3, this phenomenon can be explained by the availability of the largest potential for both the increase in public spending efficiency and the decrease in corruption, on the one hand, as well as high social approval for minor progress in solving the corruption problem, which manifests itself at the level of public spending efficiency, on the other hand.

Table 2

Results of cross-sectional regression analysis for Clusters 1 to 4

Parameters of the model	Cluster 1 (lower-middle democracy level)	Cluster 2 (higher-middle democracy level)	Cluster 3 (lowest democracy level)	Cluster 4 (highest democracy level)
Y-intercept	-0.116*	0.129***	-0.097*	0.409***
Coefficient of corruption	0.76***	0.912***	0.923***	0.682***
$R^2$	0.64	0.78	0.78	0.83
$p$	< 0.001	< 0.001	< 0.001	< 0.001
$F$	53.83	169.34	151.67	178.43
Observations	32	51	44	39
*significant at 10%, **significant at 5%, ***significant at 1%				

Source: Calculated by the authors based on data in [21].

As for Cluster 4, the value of the intercept estimate (0.409) indicates that given the medium



level of corruption (close to 0), the perceptions of public spending efficiency are higher in these countries than in the less democratically developed countries. This phenomenon can be explained by the fact that by exerting influence on state authorities (which is an indicator of higher democratic development of the country), citizens generate positive impacts on public spending efficiency estimates. At the same time, in the countries of Cluster 4, a unit increase in corruption perceptions gives a smaller increase in public spending efficiency (0.682) than in less democratic countries. The value of the coefficient of determination (0.83) in the model applied to countries in Cluster 4 indicates that the dependency of public spending efficiency in these countries is to a larger extent explained by the level of corruption than in the less democratic countries.

It should be noted that the countries in Cluster 4 are characterized by the highest average values of indicators for each factor: the level of public spending efficiency -- 1.27, corruption perceptions -- 1.25 (low level), and democracy -- 8.31 (Figure 1). The majority of the countries in this cluster are European countries. The countries in Cluster 3 exhibit the lowest average values of both public spending efficiency  $-0.85$  and corruption perceptions (high level)  $-0.79$ , given the democracy level of 2.73. The majority of countries in this cluster are the countries of Africa and the Middle East. The countries in Cluster 1 are characterized by lower-middle average values of the factors ( $-0.58$ ,  $-0.61$  respectively) and by the democracy level of 4.51. The majority of countries in this cluster are located in Africa and Asia. The majority of countries in Cluster 2 are located in Central and Southern America, as well as island countries. The average values of the factors analyzed in this study are  $-0.09$ ,  $-0.24$  respectively, that is the levels of public spending efficiency and corruption are close to zero (i.e. close to average estimates provided by experts) and the level of democracy is 6.41, which suggests rather high democratic development. Although the geographic composition of Clusters 1 and 2 is non-homogenous, it features high levels of democracy, whereas countries in Clusters 1 and 3 are geographically proximate (Africa and Asia) and characterized by low levels of democracy.

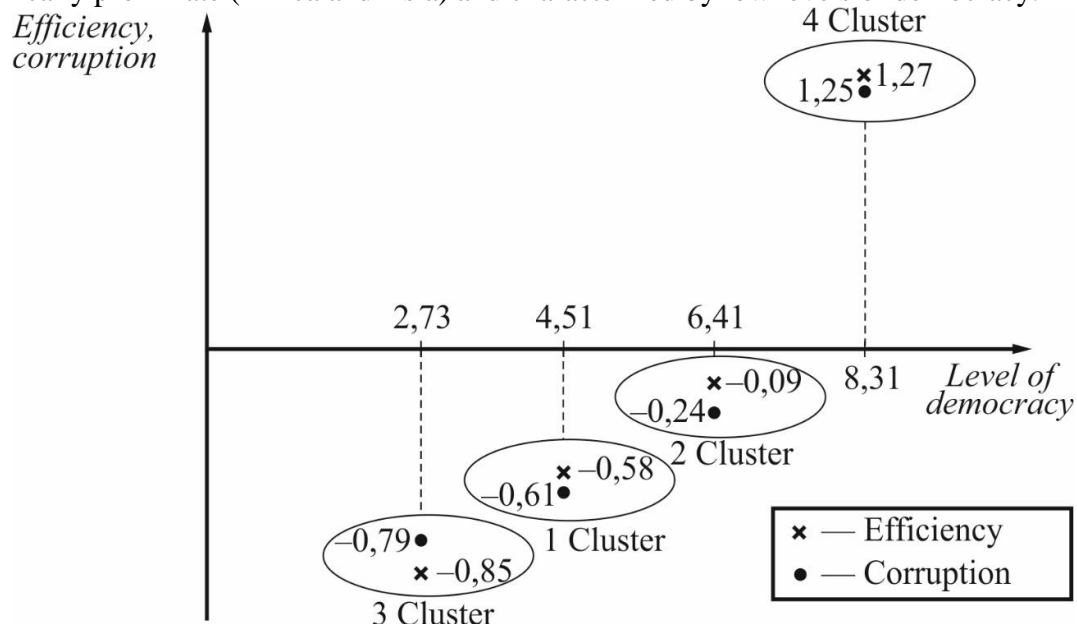


Figure 1. Average values for public spending efficiency and corruption estimates in relation to democracy level (Clusters 1 to 4)  
Source: Calculated by the authors based on [21].

Since average values for public spending efficiency in each of the clusters are distinctly different, it is necessary to test the hypothesis with respect to impact of one additional factor – the level of democratic development. Although the one-factor model of the relationship between public spending efficiency and corruption (1) is adequate, the analysis of clusters formed by countries grouped according to democracy level led us to develop the following hypothesis: the level of public spending efficiency is to a larger extent affected by the level of democracy than by the level

of corruption.

In order to test the proposed hypothesis, we construct a linear multiple regression equation and add one more independent variable  $z$  for the level of democracy to model (1):

$$y = \beta_0 + \beta_1x + \beta_2z + u, \quad (2)$$

where  $u$  is random disturbance, which satisfies the analogous conditions in model (1).

The coefficient  $\beta_2$  in equation (2) describes the marginal impact of democracy level on the public spending efficiency, which allows us to prove our hypothesis, if  $\beta_2 > \beta_1$  (in the case when the corruption estimate and democracy estimate are adequate), or dismiss it, if  $\beta_2 < \beta_1$ .

By using the OLS method for average values of the exogenous and endogenous variables over the entire observation period for 166 countries, we find estimates of the parameters in model (2), which are significant at the level of  $< 0.0001$  (Table 3).

We can conclude that the estimated parameters in the multiple regression equation are stable to random changes in the series. The approximate values of standard errors for estimated parameters  $\beta_0, \beta_1, \beta_2$  (0.094, 0.034, 0.016 respectively) are small, which leads us to assert that parameter estimates are unbiased. The coefficient of determination is 0.91, which shows high quality of the model.

Table 3

Comparison of regression results

Parameters of the Model	Model (1)	<i>t</i> -Statistics	Model (2)	<i>t</i> -Statistics
Y-intercept	0.037*	1.49	-0.402***	-4.25
Corruption coefficient	0.931***	38.22	0.807***	25.53
Democracy coefficient			0.077***	4.79
$R^2$	0.9		0.91	
$p$	0.001		0.001	
$F$	1460.09		839.63	
$DW$	2.01		2.05	
Observations	166		166	

\*significant at level 10%, \*\*significant at 5%, \*\*\*significant at 1%.

Source: Calculated by the authors based on [21]

The values of coefficients  $\beta_1$  and  $\beta_2$  suggest that a marginal increase in the efficiency of public spending in response to unit increase in democracy will be only 0.077 units. Whereas when the level of democracy is held constant, an increase in the level of corruption perceptions by one unit will lead to an increase in efficiency by 0.807 units. When analyzing the values of the coefficients of correlation, we can once again assert that the level of efficiency significantly depends on the level of corruption (0.95) and to a lesser extent on the level of democracy (0.78). Therefore, the level of democracy does not have such a significant impact on the efficiency of expenditure as does the level of corruption. Thus, we shall stick to our conclusion that the level of efficiency significantly depends on the level of corruption.

When analyzing the coefficients of exogenous variables in each of the models, we can find that it is corruption that produces the largest impact on the level of public spending efficiency, and notably, these estimators are non-skewed, efficient and consistent.

### Conclusions

Thus, the hypothesis that corruption produces an impact on public spending efficiency has been proved empirically by applying regression models to data for 166 countries over the period from 2004 to 2017. The analysis of the regression models showed that there is a strong correlation between corruption and the efficiency of public spending. Moreover, improvement of the situation with corruption in the country leads to higher estimates of the level of public spending efficiency. The quantitative assessment of the parameter which indicates the impact of the corruption factor shows that a unit increase in corruption estimate in a simple linear model leads to a marginal increase in the efficiency of public spending by 0.931 units, whereas in the multiple regression models this marginal increase equals 0.807 units.

With the help of k-means method, the countries in the sample were divided into 4 clusters according to their levels of democracy development. For each of them, we constructed refined econometric models. In the model built for the cluster of most democratic countries, the coefficient of determination is the largest one (0.83), which means that the impact of corruption on the efficiency of public spending is the largest one. The analysis of the models constructed for other clusters revealed that the largest increase in the value of public spending efficiency estimate (0.923) was observed in the countries with lowest democracy levels, whereas the lowest increase in the value of efficiency estimates (0.682) was observed in the countries with highest democracy levels.

The prospects for further research in this area, in our opinion, consist in extending the range of factors that should be studied in conjunction with corruption in the process of analyzing the impacts on public spending efficiency. Moreover, the prospects for future research consist in selecting additional criteria for country clustering that will allow to perform an in-depth and thorough assessment of the influence of corruption on public spending.

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