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DEPENDENCE OF THE STATE OF PUBLIC FINANCES ON THEIR TRANSPARENCY AND THE LEVEL OF CORRUPTION IN A COUNTRY

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ABSTRACT. Creating conditions for the effective formation, distribution and use of public finances, both at the macroeconomic and regional levels, is a key task for public administration. Achievement of high efficiency in this area is determined by many factors. For Ukraine, the most important here are the level of transparency and the level of corruption. Given that the level of transparency is not high enough, and the level of corruption, on the contrary, is high, the existing dependence between the state of public and local finances in Ukraine on the levels of corruption and transparency in the public sector is assessed. Based on the data characterizing the state of public finances at the national level through the indicators of Ukraine's consolidated budget, and at the regional level – through the indicators of local budgets of 22 regions (2010 to 2019) as well as a wide set of other selected factors, the relationship is determined between the corruption level, finance security, the transparency of public sector and the state of public finances at the macroeconomic and local levels. The use of Multiple Indicator – Multiple Cause and Dynamic Multiple Indicator – Multiple Cause models, based on the concept of soft modeling, revealed a significant impact of corruption on changes in Ukraine's consolidated budget expenditures. Besides, the importance of other factors such as economic freedom and conditions created by the state for doing business is established. At the regional level, the dependence of local finances on the level of corruption and transparency was much lower. However, the models used indicated the presence of latent variables with significant influence, which would be the subject of our further research.

Keywords: state budget, municipal budget, state debt, shadow economy, finance security, public finance, transparency, corruption.

Introduction

Public finance is the main segment of the financial system of Ukraine, since both the state and the local budgets accumulate a significant part of financial resources and the economy as a whole. At the beginning of 2020, Ukraine's consolidated budget expenditures amounted to about 35% of GDP. The volume of public finances could be much higher if Ukrainian economy has been unshadowed and the corruption decreased. The latter is usually associated with the budgeting process. Regarding the level of corruption, according to the Transparency International data, in 2019 Ukraine was recognized as a country with a high level of corruption – 126th out of 180 countries studied. Meanwhile, neighboring Poland ranks 41st and has much higher indicators of financial and economic development.

Transparency is one of the main instruments to ensure effective formation and use of financial resources in the public sector and to combat corruption. Transparency should cover all stages of the public financial resources movement – from taxes and revenue generation to the distribution of budget funds and their final use through most transparent public procurement. According to the Open Budget Survey of the International Budget Partnership, in recent years in Ukraine the level of transparency in the field of public finance has slightly improved and in 2019, for the first time in the past 10 years, has demonstrated the minimum sufficient level of transparency. The dynamic pattern of indicators characterizing the level of transparency in the public sector (according to the Open Budget Survey) and the dynamics of the Corruption Perceptions Index (according to the Transparency International) shows the consistency of their behavior, namely, the higher the transparency, the lower the level of corruption. The need for research in this area is confirmed by the calculated correlation coefficient between the freedom from corruption index and the fiscal freedom index, which has a high degree of dependence for Ukraine – 0.88. In this situation, it is important to assess the dependence of public finances on the level of corruption and transparency in public administration.

1. Literature review

Researchers from all over the world have paid considerable attention to studying the relationship between the state of public finances, their transparency and the level of corruption. The studies are carried out both for countries with a high level of economic development and a high level of democratic maturity of society, and for developing countries that are in the process of forming the democracy values. It is also worth noting that studies of this kind are not new, they have been actively carried out since the early 2000s and do not lose their relevance. Heald and McLeod (2005) investigated the issue of transparency of the financing systems in Scotland, Wales and Northern Ireland in the process of delegating authority and influence over the UK public expenditure planning system. The authors gave a number of tips to make the financing system in the process of decentralization in the UK as transparent as possible. In 2020, the same Heald co-authored with Hodges explored the role of public finance in the fight against the pandemic in the UK. Along with an analysis of budget expenditures and the forecast of the size of public debt and interest rates, the authors emphasize that in such a situation high-quality reporting and the timeliness of its publication are important, perhaps even more often than usual. Such steps can help maintain confidence in government.

Savage (2012) notes that transparency, in compliance with the macro-budgetary agreement, contributes to the integration of EU countries and affects the level of trust in supranational bodies. The author substantiates the need to strengthen measures to ensure transparency in public finances, the reliability of public budget information, as well as strengthen the role of Eurostat in budget supervision. Bozio et al. (2015), using six European

countries as an example (France, Germany, Ireland, Great Britain, Italy, and Spain) and studying the consequences of the financial crisis and fiscal policy reforms, proved that one of the factors that positively influenced the state of public finances in these countries was the provision of greater transparency when formulating economic and fiscal forecasts.

Bergman et al. (2016), using the example of 27 EU countries based on the use of dynamic panel econometric model for the period 1990–2012, analyzed the indices of fiscal rule strength and proved that supranational fiscal rules are more effective in shaping public finances than supranational ones. As a result, they noted that the effectiveness of fiscal rules significantly increases the transparency of public finances, including the application of fiscal rules when forming national budget revenues.

Santiso (2006) argues that improving the efficiency of public regulation of the economy, as well as strengthening fiscal responsibility in developing countries, such as Latin America, is impossible without increasing transparency and accountability in public financial management.

Howell-Moroney and Hall (2011), examining the local debt crisis in Alabama, USA, in 2008, showed that it was caused by serious problems with local government accountability and transparency in public finance. Shkolnyk et al. (2019) analyzed the transparency of public finances at the local level in Ukraine and concluded that it differed significantly across regions and was much lower than at the state level. This is one of the conditions for the low efficiency of the formation and use of finances of local budgets. In the process of improving the transparency and accountability of public finances, information disclosure technologies and the e-Government system are becoming increasingly important. Chen et al. (2008) proposed to apply a methodology for disclosing the state of public finances in the e-Government system, using the idea of DRM (Digital Rights Management). Oktaviani et al. (2019), examining the results of the introduction of e-government and e-budgeting in Indonesia, show a significant increase in government's transparency and accountability in the use of public finances. Shkolnyk et al. (2018) studied the effectiveness of e-procurement in Ukraine and concluded that they increase their efficiency as a result of improving the transparency of operations using the PROZORO electronic platform. Smirnova (2020) notes that one of the most important tasks of e-government is to ensure transparency and access to public information. At the same time, adequate legislation is the weakness of the use of Internet technologies in this area. Adequate legislation allows creating an appropriate balance between security, efficiency in the use of public financial resources and the quality of public services. Popoła et al. (2018) argue that when formulating the requirements for transparency of public finances, optimal balance and rationality, as well as the security of information disclosure, are important. They also emphasize the need for intensive oversight of public financial accounts to ensure transparency and accountability. Currently, more and more research is being done on the possibilities of modern technologies in ensuring transparency in the public sector. One of the most feasible options is the use of Blockchain technologies, the potential application of which in public finance has been studied by Khan and Syed (2019) who identified technical problems and limitations of their application.

Issatayeva and Adambekova (2016) study the state of the art of the budget system of the Republic of Kazakhstan and compare the level of transparency of public finances with other countries. They note that greater transparency of public finances plays a key role in achieving the goals of the country's socio-economic development.

Transparency of public finances in the field of public debt formation is gaining in importance. Thus, Astudillo et al. (2017) proved that after the 2008 crisis in countries where it was not obligatory to disclose public debt levels, its size was almost 30% higher than others. At the same time, in countries where clear debt limits and a high level of information transparency were set, debt was on average 43% lower. This, in turn, has significantly improved

the efficiency of public finance management. Bova et al. (2019) conducted a similar study, but with regard to the formation of contingent liabilities, which were part of public debt and were especially active after the 2008 crisis. Using an analysis of developed and developing countries, they showed that countries with greater transparency and better oversight of the formation and use of public finances had significantly lower contingent liabilities, which typically ranged from 6% to 40% of GDP.

Bach (2020), analyzing data on the activities of fiscal councils as public oversight bodies in the field of public finance in 18 EU countries, found that their activities significantly affected transparency and accountability in public finance management and could influence the ratings of politicians and thus help improve governance.

A high level of transparency and accountability in public administration, including in the field of public finance, significantly reduces the opportunities for corruption. Sironi and Tornari (2013) analyzed the relationship between the level of public spending, corruption and political stability in 28 European countries. They found that countries with higher political instability experienced higher levels of corruption as well as higher government spending. Gupta et al. (2001) obtained reliable cross-regression results among 120 countries over the period 1985–1998, which confirmed the relationship between the growing share of government spending on the defense sector and the level of corruption.

Pushkarev (2007), based on modeling the impact of corruption on economic development in a regional context, determined that corruption is one of the determining factors of regional development. At the same time, factors such as the level of budgetary independence of the region, education, population, investment, etc. were taken into account. Research on the dependence of the amount of funding from public finance, the social component and the level of corruption was conducted by Mauro (1998), who found a trend towards a decrease in public spending on the education sector, as a consequence of an increase in the level of corruption. The results obtained are explained by the fact that other areas of public spending provide for the possibility of civil servants receiving a larger volume of illegal benefits. In addition, a significant correlation was found between indicators of the quality of education (academic performance, school enrollment rate), i.e. a low level of educational indicators is a concomitant indicator of higher levels of corruption.

Sandholtz and Gray (2003) found a positive relationship between the volume of lending to countries and the level of corruption, one of the reasons for this is a deficit in the balance of payments in the studied countries.

Liebert et al. (2017) conducted a comprehensive survey and analysis of public administration and public finance in the post-Soviet countries, some states of the former socialist camp – Bulgaria, Hungary, Romania and Poland, as well as Mongolia, which was under the political influence of the Soviet Union. The features of the government accountability and the formation of corruption in public finances and other areas were revealed.

The role of public finances in the spread of corruption is also explored through fiscal policy transparency. Johnson et al. (1998) indicated that countries with higher levels of corruption have lower levels of tax revenue relative to GDP or per capita. Tanzi and Davoodi (1997) have argued that increased public funding for new investment is a possible manifestation of increased corruption, since the cost of financing existing capital projects is less of a source of benefit for officials. Further work by Tanzi and Davoodi (2001) was to identify structural changes in the share of individual tax sources of budgeting. It was revealed that an increase in the level of corruption by 1 point leads to a decrease in the share of income in GDP by 1.5 points, while the share of tax revenues in GDP decreases by 2.7 percentage points. That is, tax sources of budget revenues are more negatively affected by the growth of corruption. It was also found that direct tax collection is more negatively impacted than indirect tax revenue.

Hwang (2002) concluded that corruption leads to a decrease in total tax revenues, but the share of tax revenues from customs duties, export/import duties and taxes on international trade is increasing. This result may be attributed to the reasons for protecting import/export policy of individual entities.

Bastida et al. (2017) analyzed the role of corruption in terms of its impact, as well as the transparency of public finances, the level of public trust in politicians, and credit ratings of countries, on public debt. This is also true for Ukraine, where the level of public debt is quite high. There is a relationship between the level of transparency and the cost of public debt; the higher the transparency, the lower the cost, because transparency reduces information asymmetry between governments and financial markets. For this study, data from 103 countries were used through a non-linear transformation of the International Budget Partnership's Open Budget Index.

Recently, research in Ukraine to determine the relationship between transparency of public finances and corruption has become more and more relevant. Bukhtiarova et al. (2019) proposed a scientific and methodological approach to assessing the institutional and political transparency of the Ministry of Finance of Ukraine and the State Fiscal Service, determined the level of their openness and offered practical recommendations to improve the reliability and timeliness of published information. Kutsenko (2019) considered modern methods for assessing the transparency of local budgets in Ukraine. Iholkin (2016) examined theoretical aspects of transparency in the context of public financial management. Shkolnyk et al. (2020) analyzed the impact of corruption and the state of public finances on the level of financial security of the state using the examples of Ukraine and Poland and determined the presence of a significant impact in Ukraine and much less in Poland. Liuta and Mershchii (2019) studied the problems of transparency of local finances in Ukraine, namely, they proposed a scientific and methodological approach to determining the transparency of regional policy and socio-economic development. Glushchenko and Kozhalina (2019) identified the growing role of local finances in shaping the foundations of a democratic state in Ukraine. Kuzheliev et al. (2018) investigated the main problems that reduce the effectiveness of budgetary discretionary costs in modern conditions, and proposed the main ways to improve their financing.

Some research is theoretical due to the lack of empirical evidence to rely on. However, this trend is declining due to the emergence of rating research in the field of transparency of public administration and assessment of the level of corruption. In particular, Höffner et al. (2016) analyzed the role of open public finance data platforms (OpenSpending.org) and proposed an RDF conversion Linked Spending approach.

2. Data and methodology

The study used data for the period from 2010 to 2019, which characterize the state of public finances in Ukraine, as well as indicators of macroeconomic development and indicators characterizing the state of public finances in the regional context. To determine the existing relationship between the state of public finances, transparency and the level of corruption at the macro level, the consolidated budget indicators and indicators that potentially affect the state of public finances, namely unemployment in Ukraine, GDP per capita, personal income, and monetary aggregate M3, were taken as a basis. In addition, the values of indices calculated for Ukraine by international organizations, in particular Ease of Doing Business Index, Corruption Perceptions Index, and Index of Economic Freedom, were used for calculations at the macro level.

To assess the situation at the level of local budgets, the volume of local budget expenditures, the volume of GDP per capita, the unemployment rate in the region, the income

of the population in the regions, as well as the transparency index of the Ukrainian regions were taken as a basis.

The dependence of public finances on the level of corruption and transparency at the macro level was studied using the MIMIC model (Multiple Indicator – Multiple Cause); this is a multidimensional regression model that consists of measurement equations and structural equations and is represented by the following equations:

$$y = \lambda\eta + \varepsilon \quad (1)$$

$$\eta = \gamma x + \zeta \quad (2)$$

$$\gamma = \Pi x + z \quad (3)$$

where η is a scalar latent variable (as the size of the corruption component);

y is a vector of indicators for η ;

x is a reason vector for η ;

λ and γ – $(p \times 1)$ and $(q \times 1)$;

ε and ζ are scalar random errors;

$\Pi = \lambda\gamma$,

$z = \lambda\zeta + \varepsilon$,

$Cov(z) = \lambda\lambda'\psi + \theta_\varepsilon$.

The first equation is a measurement equation, and the second equation is structural. The model assumes that ε and ζ are normally distributed and mutually uncorrelated, i.e. $Var(\zeta) = \psi$, a $Cov(\varepsilon) = \theta_\varepsilon$.

A schematic use of the Multiple Indicator – Multiple Cause model is shown in Figure 1.

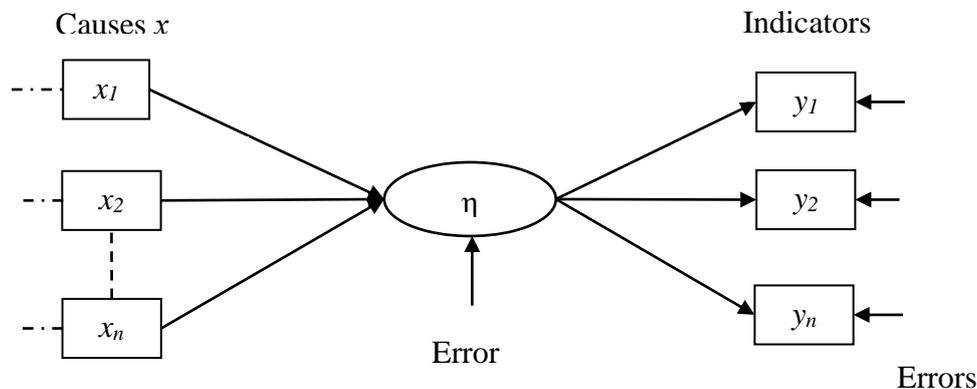


Figure 1. The Multiple Indicator and Multiple Cause model

Source: own compilation

The study of the dependence of public finances at the regional level was carried out using the DYIMIC model (Dynamic Multiple Indicator – Multiple Cause). This method allows independently reviewing a set of the most significant factors in the context of regions.

The sequence of the study was as follows: first, effective variables and factor characteristics were identified to determine the existing dependence at the macroeconomic level for the Multiple Indicator – Multiple Cause model; second, the most significant model of the influence of a group of actual indicators on the resulting feature is determined; third, the

fulfillment of the analysis assumptions and the adequacy of the MIMIC model at the macroeconomic level were verified. Fourth, the list of factor characteristics for building the DYMIMIC model (Dynamic Multiple Indicator – Multiple Cause) at the regional level was revised, indicators for 22 Ukrainian regions were included in the model and factors were selected. Then, an adequate temporal dynamics model was built using panel data; the regression “Within” model was built taking into account the panel data structure. As a result, models with fixed and random individual effects were constructed, and their adequacy was assessed using the Hausman test.

3. Results

To assess the dependence of public finances on the level of corruption and transparency in the macroeconomic aspect, a list of factors was selected in accordance with available statistical information publicly available on the official websites of the Ministry of Finance of Ukraine, National Bank of Ukraine and State Statistics Service of Ukraine. The total volume of expenditures of Ukraine's consolidated budget was chosen as an effective variable that undergoes changes due to corrupt practices caused by insufficient transparency. To build the model, the following factor characteristics were selected: X_1 is the share of the public sector in GDP (bud_spend), %; X_2 is the share of the public sector in Ukraine's GDP (bud/GDP), %; X_3 is the share of tax revenues in the consolidated budget of Ukraine (tax/inc), %; X_4 is the unemployment rate, %; X_5 is GDP per capita (GDP per capita), UAH; X_6 is the share of the monetary aggregate M3 in GDP (M3/GDP), %; X_7 is the population income (pop_inc), UAH million; X_8 is the volume of products sold by economic entities (sold_prod), UAH million; X_9 is the Ease of Doing Business Index (Do_Bus); X_{10} is the Corruption Perceptions Index (CPI); and X_{11} is the Index of Economic Freedom (IEF).

Among the indicators included in the construction of the model, several directions were chosen to assess the degree of openness of public authorities to the population. One of the indicators that assesses the state of corruption in the country is the Corruption Perceptions Index, which is a consolidated indicator calculated by the international organization Transparency International. The index is a generalized indicator of research by international institutions and research organizations operating in the selected country and having comparable qualifications. The score for this indicator ranges from 0 (maximum possible level of corruption) to 100 points (there is practically no corruption). This indicator is the most relevant for the topic of this study, since it assesses the state of corruption only in the public sector.

The second factor chosen in the model is the state of favorable conditions for doing business in a country, which is assessed using the Ease of Doing Business Index. This indicator was chosen to evaluate the dynamics of changes in the level of corruption in business. The indicator is measured on a scale from 0 to 100, where 0 is the worst result, and 100 is the best result and recommendations. The aggregate index is calculated based on an assessment of important areas such as the conditions for starting a business, obtaining permits, legalizing property rights, tax pressure, etc. That is, in the process of its activities, business is in direct contact with government and local authorities, which may have certain manifestations of corruption. The task of the state in the direction of improving the conditions for doing business should be to create comfortable legal conditions, create rules and procedures that deprive an official of influence necessary to obtain illegal benefits.

One of the factors of the analyzed model is the state of development of various types of economic freedom faced by the population in the process of interaction with the authorities, labor activity, consumption of goods and services, etc. This factor is assessed using the Index of Economic Freedom, published by The Heritage Foundation. Corruption in the state

mechanism leads to a decrease in the well-being of the population from the implementation of economic freedoms. This index characterizes the role of the state in the process of legislative activity (observance of citizens' rights, the possibility of protection in courts), the effectiveness of regulatory policy, the role of the state (the volume of government spending, the level of tax burden). That is, the level of economic freedom largely depends on the role of the state, and, accordingly, this indicator is potentially significant in the research process.

The next step is to determine the most significant model of the influence of the selected group of factor indicators on the effective feature. The calculation results were carried out in the STATISTICA software-statistical complex. Figure 2 shows the results of descriptive statistics.

Regression Summary for Dependent Variable: bud_spend (Spreadsheet1.sta)						
R= ,99998330 R ² = ,99996659 Adjusted R ² = ,99989978						
F(6,3)=14967, p<,00000 Std.Error of estimate: 3,6109						
N=10	Beta	Std.Err. of Beta	B	Std.Err. of B	t(3)	p-level
Intercept			178,4488	72,62704	2,4571	0,091106
tax/inc	-0,007684	0,003970	-0,9575	0,49465	-1,9357	0,148330
GDP per capita	1,044909	0,021042	0,0150	0,00030	49,6582	0,000018
M3/GDP	0,019626	0,010885	0,7490	0,41545	1,8030	0,169174
Do_Bus	-0,095233	0,008489	-3,2415	0,28893	-11,2189	0,001518
CPI	0,107324	0,009445	13,4912	1,18727	11,3633	0,001462
IEF	-0,045385	0,007830	-6,8138	1,17556	-5,7962	0,010218

Figure 2. The regression model descriptive statistics of the impact of lack of transparency and the corruption level on Ukraine's consolidated budget

Source: own compilation

The obtained value of the multiple coefficient of determination (R^2) 0.99 indicates a high level of significance of the model. Residuals should be considered to test the assumptions of the regression analysis and the adequacy of the model. For this, the Durbin-Watson statistics were used; there is no autocorrelation of residuals for all the studied indicators, so the model is adequate. The level of significance of indicators was taken to be 0.1, so it was decided to leave all the selected variables in the model.

$$Y_x = -0.95X_3 + 0.015X_5 + 0.74X_6 - 3.24X_9 + 13.49X_{10} - 6.81X_{11} + 178.4 \quad (4)$$

The analytically obtained coefficients for the selected variables are explained as follows. The insignificant negative effect of the share of tax revenues in the Consolidated Budget of Ukraine (-0.95) can be explained by the fact that in case of its growth, a complex effect arises: an increase in the efficiency of economic entities, an increase in the efficiency of local budgets due to tax revenues, which will lead to a decrease in the total amount of transfer revenues from the state budget. That is, the principle of increasing budget independence is the basis for increasing the share of tax payments to the budget compared to expenditures.

The growth of GDP per capita has a positive effect on the increase in expenditures due to the appearance of new resources in the budget and the opportunity to improve the level of financing of expenditure items.

A positive index for the monetary indicator (the share of the monetary aggregate M3 in GDP) indicates that the money supply in Ukraine's economy is sufficient. This means that there

are opportunities for increasing budget spending, which is reflected in the growth of budget spending.

The improvement in the business environment according to the Doing Business rating indicates the creation of convenient conditions, rules and procedures that deprive an official of influence necessary to obtain illegal benefits. In addition, an increase in the number of self-employed persons and extension of opportunities for expanding the work of entrepreneurs reduce the social burden on the budget by increasing the welfare of citizens and increasing the average income.

The rise in the Corruption Perceptions Index demonstrated the potential for growth in budget spending. This can be explained by an increase in budget revenues at various levels due to a decrease in corruption at the stages of tax collection, control over compliance with regulatory requirements, and the availability of an appropriate budget revenue base leads to an increase in funding for the needs of the population.

The growth of the Index of Economic Freedom indicates an improvement in the situation with economic freedom for the population in the process of interaction with government, labor, and consumption of goods and services. This means that liberalization and ease of receiving the necessary services by the population and business lead to an increase in their independence, an increase in the turnover of goods and services, and an increase in production volumes. This is the reason for growth of local budget revenues and their independence from transfers from the state budget.

The next stage of the study is to determine the dependence of the state of public finances on corrupt practices due to the lack of transparency at the regional level. An effective indicator that can potentially change as a result of corruption is the amount of local budget spending (*bud_spend*).

Regional development indicators were added to the list of factor characteristics at the regional level in the DYMIMIC model. Among the main groups of indicators of the DYMIMIC model, one can single out monetary indicators (the growth of the shadow sector and possible corruption are associated with an increase in money transactions and expenses); labor market indices indicating that a decrease in the level of official employment leads to a possible increase in the corruption component and the growth of the shadow economy (Mishchuk et al. 2020; Navickas et al. 2020).

The following factors were chosen as factor indicators for constructing the model: X_1 is the share of local budget spending in GRP (*Spending/GRP*), %; X_2 is the Gross Regional Product per capita (GRP per capita), UAH; X_3 is the number of unemployed in the region (*unempl*), thousand people; X_4 is the income of the population in the region (*pop_inc*), UAH million; X_5 is the volume of products sold by economic entities (*vol_sal*), UAH million; X_6 is a Region Transparency Index (*Transp*). The level of corruption is assessed by the degree of openness of local governments. The indicators of the Transparency, Financial Health and Competitiveness of Municipalities project, calculated by the International Center for Policy Studies, were chosen as a statistical basis for assessing the consolidated state of openness and transparency of regional budgets. They characterize the degree of openness of regional authorities in information policy, budgeting, public procurement, social services, citizen participation in the life of the region, etc.

To determine the level of losses in public finance from corruption associated with the lack of transparency of local budgets, panel data were used for all Ukrainian regions to build an adequate model of the temporal dynamics of dependence. The main advantages of panel data allow building more flexible and capacious models and get answers to questions that are not available in spatial data-based models. Panel data represent many observations, increasing the number of degrees of freedom and decreasing the relationship between explanatory variables,

so the standard errors of estimates decrease. Another significant advantage of panel data models is that they allow you to track the individual evolution of the characteristics of all objects in the sample over time.

To perform calculations, one must specify a temporary variable and a space variable using the `tsset` command. In this case, the command will be `tssetidyear`, then the variable is set and the sample is recognized a cross-section and consists of time series. Thus, the data is recognized as panel.

Based on the generated panel data, a regression model "Within" is built. This model, rewritten in terms of deviation from the time mean values of the variables, looks like this:

$$y_{it} - y_i = (X_{it} - X_i)' \beta + \varepsilon_{it} - \varepsilon_i. \quad (5)$$

The advantage of this model is that it makes it possible to eliminate from the model individual effects that are not observed.

In the process of building the model, several variants of sets of factor features were chosen. As a result, the most adequate and statistically significant was the model, the evaluation results of which were obtained by executing the following command:

`xtregbud_spendSpend_GRPGRP_pcunempl , fe.`

```
. xtreg bud_spend Spend_GRP GRP_pc unempl Transp , fe
```

Fixed-effects (within) regression	Number of obs	=	66
Group variable: id	Number of groups	=	22
R-sq:	Obs per group:		
within = 0.7462	min =		3
between = 0.7912	avg =		3.0
overall = 0.5761	max =		3
corr(u_i, Xb) = -0.8924	F(4, 40)	=	29.39
	Prob > F	=	0.0000

	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
bud_spend					
Spend_GRP	669.4638	91.11337	7.35	0.000	485.3168 853.6108
GRP_pc	.25379	.0789402	3.21	0.003	.0942459 .413334
unempl	626.1047	278.9614	2.24	0.030	62.30268 1189.907
Transp	-10.38907	70.73054	-0.15	0.884	-153.3408 132.5627
_cons	-51436.92	19542.76	-2.63	0.012	-90934.31 -11939.53
sigma_u	9273.7335				
sigma_e	4179.7964				
rho	.83115667	(fraction of variance due to u_i)			

F test that all u_i=0: F(21, 40) = 1.17 Prob > F = 0.3224

Figure 3. Model for assessing the impact of lack of transparency and corruption on the level of local budget development (fixed effects)

Source: own compilation

According to the calculations, the correlation of individual effects is $\text{corr}(u_i, Xb) = -0.8924$, which indicates a significant flexibility of the fixed effects model. The fit quality of this model is characterized by the coefficient "R-sqwithin" 0.7462. The "R-sqbetween" indicator is slightly higher than that analyzed earlier and amounts to 0.7912. It can be concluded that in this model, interpersonal differences manifest themselves at approximately the same level as dynamic ones. That is, it is necessary to further investigate the need to take into account individual effects in the model. This hypothesis needs further statistical testing.

A random effects model can be seen as a trade-off between pooled regression, which imposes strict homogeneity constraints on all regression equations for any i and t , and fixed-effects regression, which allows each sample object to enter its own constant and thus account for the existing heterogeneity, which cannot be observed. The use of a random effects model is due to the following: first, the estimates of the fixed effects regression model are significant for statistical models in the absence of endogeneity, but it may happen that the coefficients for the most important variables in the study are erroneous; secondly, this model does not allow one to estimate the coefficients for time invariant regressors, as they are excluded from the model after the "Within" transformation.

In the model with random effects (u_i are random), individual heterogeneity is taken into account not in the equation itself, but in the covariance matrix, which has a block-diagonal form, since within each group the random effects correlate with each other. This model is based on an important hypothesis: $\text{corr}(u_i, X) = 0$ (assumed), namely, regressors should not correlate with random effects that are not observed. The generalized least squares method (GLS) was used to estimate this regression. Figure 4 shows the obtained results of the random effects regression model.

```
. xtreg bud_spend Spend_GRP GRP_pc unempl Transp , re
```

Random-effects GLS regression	Number of obs	=	66
Group variable: id	Number of groups	=	22
R-sq:	Obs per group:		
within = 0.7315	min =		3
between = 0.7497	avg =		3.0
overall = 0.7343	max =		3
corr(u_i, X) = 0 (assumed)	Wald chi2(4)	=	168.58
	Prob > chi2	=	0.0000

bud_spend	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
Spend_GRP	696.0607	74.63147	9.33	0.000	549.7857 842.3357	
GRP_pc	.155229	.0318714	4.87	0.000	.0927622 .2176958	
unempl	232.663	34.02487	6.84	0.000	165.9755 299.3505	
Transp	37.01707	40.80289	0.91	0.364	-42.95512 116.9893	
_cons	-24022.75	3249.025	-7.39	0.000	-30390.72 -17654.78	
sigma_u	0					
sigma_e	4179.7964					
rho	0	(fraction of variance due to u_i)				

Figure 4. Model for assessing the impact of lack of transparency and corruption on the local budget development levels (random effects)

Source: own compilation

It should be noted that the level of transparency in the studied model was insignificant in comparison with the factors of the labor market and the state of regional development. This indicates that the model may have a certain endogeneity, therefore, the selected transparency coefficient may be incompatible with the selected set of factor indicators.

To determine a more adequate model between fixed individual effects regression and random individual effects regression, the Hausman test was used and the following results were obtained (Figure 5).

	— Coefficients —			
	(b) fe	(B) re	(b-B) Difference	sqrt (diag (V_b-V_B)) S.E.
Spend_GRP	669.4638	696.0607	-26.59691	52.26653
GRP_pc	.25379	.155229	.098561	.0722203
unempl	626.1047	232.663	393.4417	276.8786
Transp	-10.38907	37.01707	-47.40614	57.77485

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$$\text{chi2}(3) = (b-B)' [(V_b-V_B)^{-1}] (b-B)$$

$$= 7.69$$

Prob>chi2 = 0.0529
(V_b-V_B is not positive definite)

Figure 5. Hausman test results

Source: own compilation

Hausman test (the null hypothesis of the adequacy of the random effects versus fixed effects model) shows a p-level of 0.0529, which is slightly above the 0.05 confidence interval. This means that both models are equivalent, but the random effects model is somewhat more statistically significant. This can be explained by the fact that the constructed model does not include certain random variables that affect the level of local budget development. In addition, the model has a transparency index, which is irrelevant. The share of expenditures in the gross regional product has the greatest impact on the expenditure side of regional budgets. This is due to the significant share of the public sector in the overall structure of its formation. The share of local expenditures in final regional consumption is also significant. If the share of local budget expenditures in GRP increases by 1%, the volume of local budget expenditures should theoretically increase by UAH 698.0 million.

The second most important indicator in the constructed model is the number of unemployed, which belongs to the group of labor market indicators. The obtained coefficients of the model show that in the case of an increase in the number of unemployed by 1%, the volume of local budget expenditures will increase by UAH 232.6 million. The logical explanation for this pattern is an increase in social spending from budgets aimed at helping the unemployed.

GRP per capita is the third significant indicator of the model; it has a direct positive effect on the studied budget expenditures. Given the 1% growth of GRP per capita, the change in local budget expenditures will amount to UAH 0.16 million.

Conclusion

Thus, the model for determining the dependence of public finances on the current level of corruption and transparency at the macroeconomic level unambiguously indicated the importance of indices of economic freedom, the quality of doing business and the corruption perception index. That is, the level of changes in these indicators clearly correlates with the trend of changes in Ukraine's consolidated budget. Therefore, a detailed study and confirmation of the significance of the identified patterns in practice are an important area of further analytical work. The importance of key indicators of economic development such as the share of the public sector in GDP, GDP per capita, and the ratio of the monetary aggregate M3 to GDP was also confirmed.

At the regional level, the obtained values of the constructed regression models did not confirm the dependence of the state of public finances on the level of budget transparency. However, it should be noted that there are other implicit factors not included in the model. Therefore, further research is needed on the role of budget openness at the micro level, simplification of regulations, and increased cooperation between the public and government. At the micro level, the indicators of the share of expenditures in GRP, the volume of GRP per capita, and the unemployment rate turned out to be significant.

Further research should focus on confirming the identified trends to reduce the identified budget losses from corruption caused by lack of openness. Empirical research has shown that government accountability and openness to the public are among the factors in reducing corruption.

Openness of government activities, public participation in control over the spending of budget funds and decentralization of governance are important conditions for the effective formation and use of public finances at both the national and regional levels.

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Appendix A

Initial data for determining the dependence of the state of public finances at the regional level on the levels of transparency and corruption

Region	Budget expenditures, UAH mln	Share of expenditures in GRP, %	GRP per capita, UAH	Number of unemployed, thousand	Openness indicator, %	Personal income by regions of	Volume of products sold by business entities UAH	Transparency rating	Average transparency level
Vinnitsia	10877,0	9,8	71104	71,6	89	114480	200213,5	74,2	81,6
Volyn	7764,3	12,8	58297	47,9	78	63810	190544,7	51,4	64,7
Dnipropetrovsk	22290,4	6,0	114784	121,5	55	307844	1115583	69,2	62,1
Zhytomyr	8812,0	11,4	62911	59,8	43	84830	129626,8	66,1	54,55
Zakarpattia	7436,9	14,2	41706	56,1	57	69194	81015	56,6	56,8
Zaporizhzhia	11278,2	7,7	85784	80,4	75	147627	350826,6	55,9	65,45
Ivano-									
Frankivsk	9372,2	11,9	57033	47,9	70	87479	117315	61,6	65,8
Kyiv	12770,9	6,4	112521	51,1	71	150606	535372	64	67,5
Kirovohrad	6491,4	10,1	67763	49,9	51	63999	111072,7	55,4	53,2
Lviv	16237,2	9,2	70173	78,7	58	189077	405218,8	73,7	65,85
Mykolaiv	6437,4	8,1	70336	52,8	47	81581	167677,8	56,3	51,65
Odesa	12391,6	7,2	72738	68,7	74	193923	429223,7	57,6	65,8
Poltava	10600,5	6,1	123763	73,3	45	114656	320193	47,8	46,4
Rivne	8695,6	15,3	49044	50,6	93	73661	84202,6	54,5	73,75
Sume	7892,2	11,5	62955	46,4	67	79848	120749,1	57,2	62,1
Ternopil	7223,0	14,7	46833	47,8	65	61731	85717	76	70,5
Kharkiv	15352,6	6,6	86904	70,7	55	216227	448258,2	42,8	48,9
Kherson	6211,5	11,3	52922	51,3	44	68064	87338,3	43,1	43,55
Khmelnyskyi	8705,9	11,5	59583	48	90	86821	126668,6	64,7	77,35
Cherkasy	8399,2	9,0	76904	55,8	53	82600	198145,3	58,6	55,8
Chernivtsi	5692,2	16,8	37441	33	34	52108	46194	55,8	44,9
Chernihiv	7222,4	10,2	69725	51	65	69247	117908,5	56,2	60,6