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Article

An unstoppable and navigating journey towards development reform in complex financial-economic systems: An interval analysis of government expenses (past, present, future)

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AN UNSTOPPABLE AND NAVIGATING JOURNEY TOWARDS DEVELOPMENT REFORM IN COMPLEX FINANCIAL-ECONOMIC SYSTEMS: AN INTERVAL ANALYSIS OF GOVERNMENT EXPENSES (PAST, PRESENT, FUTURE)

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Abstract. *Purpose* – The world is facing unprecedented opportunities to improve welfare and reduce poverty, so every day more and more public spending is becoming important in every country. The purpose of the research was prompted by the questions of whether there were development reforms and what is the complexity that has evolved in each variable (WS, GS, EU, ST, CE, and TE) for the time interval 2007–2020. How and are governing bodies able to continuously drive growth for decades by being more efficient users of government spending planning in complex financial and economic systems? Therefore, this paper aims to understand and advance by bringing a new approach to unstoppable and navigating reforms to government spending in complex financial and economic systems.

Research methodology – The research was conducted through secondary data from annual financial reports and statements for both central and local levels. The time interval for 14 years was analyzed through two analyses and one matrix such as descriptive analysis (9 tests), correlation analysis (3 tests), and Proximity Matrix (Euclidean Distance between years and variables, Z stress test) as in the Tables (1–12), in the Figures (1–11) using SPSS version 23.0 for Windows.

Findings – The findings showed that: a) the data had a normal distribution, b) there was an increase in expenditures for each year, especially in times of pandemic COVID-19, c) the data were obtained from financial reports and statements as well as different institutions over different years, d) there is a strong and positive relationship between the variables for government spending in complex systems, e) Public expenses have increased due to COVID-19 and the damage caused is continuing, affecting the decline in the well-being of the residents.

Research limitations – The limitations of this paper are that only a considerable number of variables are studied and only in the state of Kosovo for 14 years (2007–2020). In this case, for other analyses by other researchers' other variables can be analyzed, more extended periods or comparability with other states.

Practical implications – based on the above questions, it was confirmed that there were reforms in the complex financial and economic systems for government expenditures each year.

Originality/Value – Such research has not been analyzed before and the findings of this research can help budget experts to accurately plan expenses based on the three periods studied (past, present

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or the period of the Covid-19 pandemic and the future or the post-COVID-19 pandemic period). It is strongly recommended that governing bodies develop and improve the category of public investment expenditures.

Keywords: complex systems, interval analysis, public spending, financial reports and statements, financial and economic reform, past-present-future PPF.

JEL Classification: M48, B41, C01, H50, H61, H76, G00.

Introduction

Every day, the world is increasingly faced with unprecedented opportunities to improve human well-being and reduce poverty (López et al., 2008). Many studies emphasize that public spending is important and necessary for economic growth, but empirical results are still mixed. In this case, some empirical analyzes emphasize that macroeconomic stability, openness, investment in the private sector, and use of funds for productive purposes are quite important (Bayraktar & Moreno-Dodson, 2010). Many previous studies of public spending in complex financial and economic systems have helped policymakers and other researchers draw interesting lessons, but at the same time open up new avenues for further research on methodological improvements that support in-depth analysis, especially in complex systems for developing countries (Moreno-Dodson, 2009). In terms of complex financial and economic systems, they have contributed (Lulaj et al., 2022), it is emphasized that the risk management of budgetary challenges is greater than ever influenced by new technologies in e-government according to research findings such as lack of cooperation, lack of information, lack of budget experts, lack of resources and reduced focus, lack of resources (staff, funds, infrastructure, tools, etc.), selection of programs based on priorities and not based on wishes and policies, etc. Regarding the unstoppable journey of development in complex financial-economic systems (Dai, 2021) it is emphasized that the rapid development of the market economy is increasingly in demand for projects in industry and financial complexity through the development of computer technology and the promotion of robotic consultants to manage and supervise financial industry projects. According to Tang (2022), the main purpose of current policy in complex systems is a financial constraint and not financial constraint by recommending that the evaluation of the effectiveness of financial policies for the financial structure and scale to support quality investments be achieved through economic transformation and improvement as well as a sustainable and healthy development. To have performance in government spending on complex financial systems according to Zheng and Du (2015), it is recommended to use the laws of design synchronization control of hyperchaotic financial systems. Complex systems based on economics and finance according to Tabak et al. (2020) are showing interest in the micro-level analysis, but empirical methodologies are limited to mainly linear methods brought by traditional econometric methods. According to Huang et al. (2014), although much research has been done, there are still challenging open-ended questions about complex financial and economic systems where it is recommended to develop new theories and methods as well as to refine techniques known for analyzing financial problem classes and public spending time intervals. To look at the journey and navigating complex financial systems (Ding & Xu, 2016), it is emphasized that

the control method and synchronization criteria are applied to study the mixed synchronization of a chaotic class of modified financial systems. According to Squartini et al. (2018), the question arises when a financial system is considered complex. This question still does not have a definite answer for complex financial and economic systems. Regarding the capital expenditure variable (Ahuja & Pandit, 2020), it is emphasized that population growth and unemployment affect the increase of public expenditures, so the investments have a great impact on complex financial and economic systems. According to Ampah and Kotosz (2016), using Wagner's hypothesis for Bukrina Faso data between 1960–2015, it is emphasized that currencies have an impact on complex financial and economic systems. Relating to the transparency of the budget in expenditures in complex financial systems, it is emphasized that the state should provide citizens with access to financial statements and reports, fair distribution of resources, and efficient management at both levels of government and all institutions in complex economic and financial systems (Lulaj, 2019). To analyze the relationship between complex economic and financial systems through expenditures (Al-Faris, 2002) he used the data of the Gulf Cooperation Council (GCC) countries in his research, which states that the hypothesis of public spending that causes national income is not supported. Based on the variables of services and goods (GS) and transfers and subsidies (ST) according to Li and Li (2018), it is emphasized that the main obstacle to the economic advancement of the country is the low quality of service in the service sector (electricity, water, natural gas, etc.), so the main findings of this research are: government transfers fail to cover this deficit, institutions of reducing the quality of services and goods for subsidized consumers by suggesting future research to see the impact of cross-subsidies on the well-being of citizens and better design of subsidy financing in complex financial and economic systems. Based on the variables of utility expenses (EU) and total expenses (TE) (Marica & Piras, 2018) it is emphasized that the relationship between governments and economic growth has the opposite direction to theory and practice, so it is suggested to improve public spending on economic growth through the provision of municipal services for all citizens at both levels of government, also according to Kutasi and Marton (2020), regarding the variables of this research as WS (Wages and Salaries), GS (Goods and Services), UE (Utility Expenses), ST (Subsidies and Transfers), CE (Capital Expenses), TE (Total Expenses) have a significant and strong coefficient for public order expenditure in complex systems. Based on the analysis of the expenditure interval towards economic and financial development reforms and the variables taken in this study (WS, GS, UE, ST, CE, TE) (Schick, 2007) it is emphasized that extra-budgetary spending weakens government financial control in many aspects of budgeting that are still relevant today: public sector transformation, private sector interconnection, government scope and size, regulatory role, the emergence of new organizational forms and use of performance objectives and long-term planning. For all variables of this study, according to Kay and Llewellyn Smith (1985), there should be allocation criteria and incentives for sectors and countries that are most in need of public spending's such as subsidies and transfers, capital investments, goods and services, salaries and wages, and utilities. Regarding navigating and unstoppable expenses, it was emphasized that the latest global trends prove the great impact of public finances on the economies of world countries based on the fiscal management environment, which is unstoppable and moving fast. Therefore, the economic and social structures that

are floating and changing due to the demands of the citizens, which are becoming more and more diverse, must be encouraged (World Bank and Korea Development Institute, 2004).

Research of this format on the unstoppable journey and navigation towards the development reform in complex financial-economic systems through the analysis of the government expenditure interval has not been conducted before, therefore the main purpose of this scientific research is whether there have been development reforms in complex systems financial-economic for the period 2007–2020 (14 years) based on the variables raised for government expenditures: WS (Wages and Salaries), GS (Goods and Services), EU (Utility Expenses), ST (Subsidies and Transfers), CE (Capital expenditures), TE (Total expenses), as well as what is the complexity that has evolved in each variable and has development reform been achieved in complex financial-economic systems? Regarding the problems caused by public government expenditures for all expenditure variables (WS, GS, EU, ST, CE, TE) many other researchers, have also contributed (Staats, 1950; Hulse, 1950; Harrell, 1950; Briggs, 1950). Therefore, based on the purpose of the research, his problem to look at the unstoppable and floating journey towards the reform of development in complex financial and economic systems for the interval of government expenditures for the period 2007–2020 in the state of Kosovo starts from questions such as: are governments able to sustain economic growth for decades? How can the state (government) be a more efficient use of public expenditure planning to improve its structure in complex financial and economic systems for certain time intervals? Therefore, this research (a) will bring a new approach to governance for the public spending interval for 14 years (2007–2020) on how governments can be more efficient, (b) will analyze which variables are needed to pay more attention to government public spending on economic growth, and (c) learn something special about unstoppable navigation to bring about reforms to complex financial and economic systems by increasing the well-being of its inhabitants through continuous encouragement.

1. Literature review

Seeing the great importance every day of an unstoppable and floating journey of reforms in complex financial and economic systems through the analysis of government spending from the past, present, and future, the measurements of each variable were explored individually. So, based on the variables taken for study in this research we emphasize the contribution of other researchers related to each variable: Wages and Salaries (WS), Goods and Services (GS), Utility Expenses (EU), Subsidies and transfers (ST), Capital expenditures (CE) and total expenses (TE). Regarding the variable of general government expenditures, he has contributed (Gómez, 2010), which emphasizes that the well-being and long-term growth of economic and financial development in the complex systems of the country are done in the case of imposing income tax to equalize the elasticity of public services. Regarding the capital expenditure variable (CE), according to Eicher and Turnovsky (1999), based on recent empirical research, it is emphasized that technology and capital are very important inputs for complex financial and economic systems but it is suggested that there be further improvements and that countries know how to plan for capital expenditures. General expenditures that are realized without proper planning can increase the state debt, therefore according Marle (2020), it is em-

phasized to forecast fiscal revenues, calculate the probability of non-payment of expenditures, increase the degree of security in complex financial systems through signaling guidelines to cope with the risks of general government expenditures during the unstoppable and floating development journey. reforms in complex financial-economic systems. In terms of the complexity of government spending (Bruce, 1995), it is emphasized that complex financial and economic systems are constructively used to achieve certain spending languages within the complex systems of the country. To elaborate reforms towards economic development in complex financial systems have contributed Ouyang and Lu (2021) which emphasizes that e-government of complex financial and economic systems has become one of the key points of the government building, but that the degree of success of e-government projects in variables (WS, GS, EU, ST, CE, and TE) both in developed countries and in developing countries it is not high. To look at general government spending on variables (WS, GS, EU, ST, CE, and TE) contributed Sun (2021), where it is emphasized that the Gaussian probability-based semantic analysis model can provide robust, extraordinary detection of anomalies in a fully automated data-driven solution in complex financial systems for government spending. To see the role of signaling systems in complex financial and economic systems for all variables taken in the study for the government expenditure interval (2007–2020) has contributed Chen (2021), which states that governments should use signaling systems to optimize the structure of the country's fiscal revenues and expenditures. Regarding the variable of capital expenditures and the variable of subsidies and transfers (Park, 2012), it is noted that the choice of government projects varies according to the methods of government intervention and according to the subsidy rate. While Roy (2012) states that government investment diverts private investment, therefore the overall effect of total government spending on economic growth is unclear. Regarding the subsidy and transfers (ST) variable, another contribution was given by Schaffitzel et al. (2020), who emphasized that the governments of the countries should attach great importance to projects for the allocation of government expenditures on subsidies and transfers were some unnecessary subsidies should be removed and replaced with subsidies that are useful and necessary for the country. Regarding the variable of goods and services in the category of municipal government expenditures for subsidies and transfers, according to Li et al. (2018), it is noted that governments when faced with financial deficits provide low-quality services to subsidized residents compared to those who pay additional tariffs. Therefore, the difference in the quality of services between groups of residents is reduced by an increase in the number of external transfers of governments in this case to boost electricity consumption by the poor, the Colombian government should finance subsidies, strengthen quality regulation and increase the transparency and reliability of government transfers. Again, they contributed regarding the utility variable (Clarke & Wallsten, 2002) who point out that until recently utility services (telecommunications, energy, water, and gas) around the world were provided by large monopolies usually state-owned but encouraged by technological change and innovation in complex financial systems as well as pressure from international organizations many developing countries are privatizing state-owned companies to increase competition in providing the highest quality services. But at the interval of government spending on the unstoppable journey of reforming the development of these complex systems, some governments worry that even if reforms improve the efficiency of goods and utilities, they may

undermine an important public policy goal of securing “access” universal for low-income and rural households, but the results have suggested that these reforms of complex financial and economic systems have not harmed the poor and rural residents but in most cases have improved their utility in the communal services (Clarke & Wallsten, 2002). Regarding the variable of wages and salaries (WS), according to Dabre (2014), the administration deals with the creation and implementation of sound employee compensation policies and practices through employee performance appraisal, payroll and payroll surveys, institutional problem analysis, the development and maintenance of the payroll structure, and the establishment of rules for the administration of salaries and wages, profit sharing, changes and adjustments of wages and salaries, additional wages, the cost of compensation, etc. Regarding the investment variable of government expenditures, similar analyzes were also emphasized for the unstoppable and floating travel, emphasizing that investment financing in any sector is vital and profitable towards the progress of the well-being of the country's population, also evaluating the future scenarios of government spending until 2040 (Global Burden of Disease Health Financing Collaborator Network, 2018).

2. Methodology

2.1. Methods

For this study, data were collected from institutions in the state of Kosovo, specifically at the central level (Ministry of Finance) and the local level (38 Kosovo Municipalities). Therefore, the research was conducted through secondary data for the variables studied (WS, GS, EU, ST, CE, TE) from reports published on the website of the Ministry of Finance after their audit by internal and external auditors and signature by the Minister of Finance and analyzing in detail the reports and financial statements of all municipalities for the variables also mentioned after the audit by the auditor and the signature by the director of the finance department (reports and financial statements for the period 2007–2020) by looking at the unstoppable and floating journey towards development reforms in complex financial and economic systems (Ministry of Finance, 2007–2020). All variables were analyzed through descriptive analysis and correlation analysis as well as tests that fit these two analyzes using SPSS version 23.0 for Windows. The analysis involved several processes where some of the factors were deleted to make the model acceptable, in which case, as stated in the conceptual model, the purpose of these analyzes and models is to obtain reliable data (r above value 0.50). In this case, 6 factors were analyzed as stated above with their sub-variables.

2.2. Instruments and research methodology

As stated in the introduction, the main purpose and objective of this research are to see if there have been development reforms in complex financial and economic systems during the time interval 2007–2020 and what the complexity of evolution is in the variables studied. Based on these issues, the findings from econometric models will provide recommendations for Kosovo institutions and beyond complex financial and economic systems.



Figure 1. Instruments and research methodology

Figure 1 shows: the research methodology for each phase for all variables taken into the study through the analysis of annual financial reports for the period of 14 years.

2.3. Data collection process

Data collection was performed by the results of Descriptive analysis, Correlation analysis, Tests of Normality (TN), Data Patterns (all cases) (DP), Summary of Estimated Means (SEM), Wald-Wolfowitz test (WWT), Mann-Whitney test (MWT), Friedman test (FT), Run test (RT), Kruskal-Wallis test (KWT), Pearson (P), Kendall’s Tau_b (KT), Spearman’s rho (SR), Proximity Matrix (Euclidean Distance between years 2007–2020 and variables: WS, GS, UE, ST, CE, TE), Z statistics (stress test).

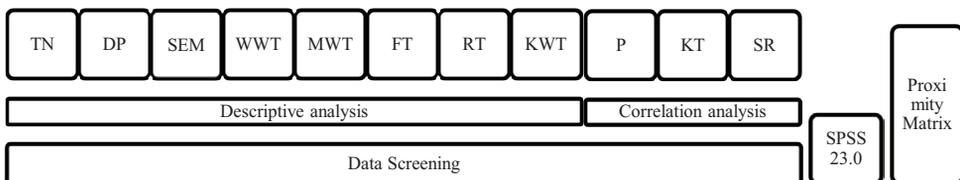


Figure 2. Data collection process

Figure 2 shows the process of data analysis through descriptive analysis using tests (NT, DP, SEM, WWT, MWT, FT, RT, and KWT) and correlation analysis using tests (P, KT, SR). Descriptive statistics have been used to elaborate the time interval of expenditures in complex financial and economic systems, whereas according to Mc Cue (2007), descriptive analysis is the process of categorizing and describing information by analyzing sample data for all variables. To look at the distribution of data in complex financial systems, the normality test was analyzed where according to Shaik and Gulhane (2021), the application of normality tests in different periods to the Indian stock exchange is abnormal. Regarding Data Patterns (all cases) he contributed (Clain & Leppel, 2018) where the characteristics related to the variables were analyzed, which variable has had changes at different time intervals. To see where the financial reports are obtained and whether the navigation and development are the same in

complex financial systems, the Wald-Wolfowitz Test was used, therefore about this test they contributed (Khan et al., 2006) from their analysis emphasized that the results provided by variables re-emphasize the close connection between statistical decision theory and variables. To analyze if there is a difference between the time interval (2007–2020) the Mann-Whitney test was used in all variables, therefore concerning this test in their research they contributed (Ayadi & Ghorbel, 2018) analyzed the characteristics for each variable studied. To see the differences between the variables and if they are random, Friedman and Runs tests were used, which he contributed to this research his research (Melitz, 1965), while in terms of the Run test he contributed (Watts, 2020). To see the differences between the variables and their navigation over the years, Kruskal-Wallis's test was used, and he contributed to this test in his research (Salkind, 2010). Regarding the importance of the correlation of variables, Pearson, Kendall's Tau_b, and Spearman's rho tests were used, where (Shekhovtsov, 2021; De Winter et al., 2016; Kirch, 2008).

2.4. Data analysis process

The research data related to the unstoppable journey and navigation towards the development reform in complex financial-economic systems through the analysis of the government expenditure interval have been analyzed through the previously mentioned analyzes for the testing of hypotheses through SPSS 23.0 software.

2.5. The conceptual framework for government spending in complex financial and economic systems

Figure 3 shows: the conceptual framework for government spending in complex financial and economic systems by analyzing each variable (WS, GS, EU, ST, CE, and TE) through the quality of arguments and useful information from the annual financial reports for unstoppable navigation 14-year period in complex financial and economic systems.

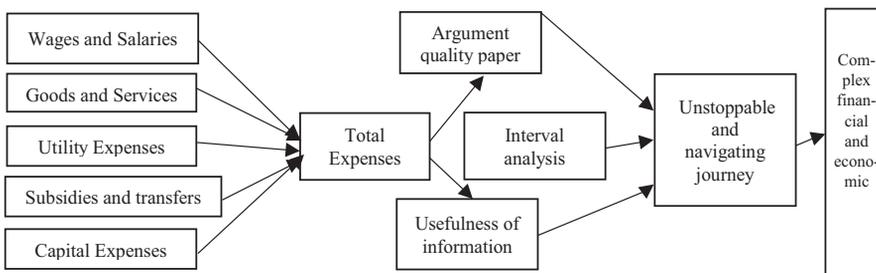


Figure 3. Conceptual framework (source by the author)

2.6. Research hypotheses

Regarding the raised hypothesis, many opinions were given by different researchers, where according to Cordes et al. (2015), it is emphasized that to have a normal distribution of

expenses in complex financial systems (H1), there must be effectiveness of the rules of expenses. Regarding the importance of reforms for public spending in the economic development of complex financial systems (H2, H3), (Constantine, 2017), it is emphasized that economic structures are the fundamental cause of economic performance based on a case study in the USA where the structural origin of the financial crisis was exposed. Developing countries are hit hard by financial crises, including the crisis caused by COVID-19, and the recovery in each variable of government spending may be limited due to the lack of resources to stimulate the economy (Gurtner, 2010; Ocampo et al., 2000; Roaf et al., 2014; Peng et al., 2014; Hawtrey, 1996).

The hypotheses of this research are presented below:

H1: Distribution of data on public expenditures in financial reports to complex financial-economic systems follows the normal distribution.

H2: Economic development reforms are significant in complex financial-economic systems for public spending.

H3: Data is not obtained from the same year in the reports of complex financial-economic systems.

H4: Is there a difference between the years of transition for financial reforms in complex financial-economic systems.

H5: There is a link between the variables in the three tests for public spending towards the development of reforms in complex financial-economic systems.

2.7. Materials

Kolmogorov and Smirnov proposed the KS test in 1993 (Kolmogorov, 1933) as:

$$\begin{aligned}
 x^2 &= D^+ = \left\{ \left(\frac{1}{n} \right) - z_i \right\}, 1 \leq i \leq n \\
 D^- &= \left\{ z_i - \frac{i-1}{n} \right\}, 1 \leq i \leq n \\
 D &= \max(D^+, D^-), \tag{1}
 \end{aligned}$$

where z_i where black is the cumulative probability of the normal distribution for the expenditure interval (2007–2020) and D is the difference between the observed and expected values for complex financial and economic systems. Shapiro and Wilk formed the original test in 1965 (Shapiro & Wilk, 1965). Test statistics for complex financial and economic systems at the cost interval are defined as:

$$W = \frac{\sum_{i=1}^n a_i x_{(i)}^2}{\sum_{i=1}^n x_i - \bar{x}}^2, \tag{2}$$

where, $x_{(i)}$ is the government expenditure interval i th statistics, i^{th} , \bar{x} is the sample mean for complex financial and economic system it is the constant obtained:

$$a_i = (a_1 \dots a_n) = \frac{m^T V^{-1}}{(m^T V^{-1} V^{-1} m)^{1/2}},$$

where $m = (m_1 \dots m_n)^T$ are the expected values of the ranking statistics of the independent variables expected for complex financial and economic systems and V is the covariance matrix of these statistics for government spending. According to Fraser (1956), Wald and Wolfowitz have a general theorem of specifics for complex financial and economic systems as follows (Amstatnews, 2010):

$$\frac{1}{2\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right] + \frac{1}{2\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}(x-\mu)^2\right]. \tag{3}$$

Regarding the Mann-Whitney test, he has contributed (Mann & Whitney, 1947) so the equation in complex financial-economic systems is as follows:

$$U = \sum_{i=1}^n \sum_{j=1}^m \phi(x_i, y_j), \tag{4}$$

where, Y_j per $j = 1, n$ in the sample size sample for government expenditure $N = m + n$, and,

$$\phi(x_i, y_j) = \begin{cases} 1, & \text{if } x_i > y_j \\ 0, & \text{if } x_i \leq y_j \end{cases}.$$

Regarding complex financial and economic systems, Friedman mitigated normative conflicts by defining issues related to government spending to achieve a common goal, he said, making a major contribution to the “Positive Economy Methodology” (Hetzl, 2007). The Friedman test determines whether the ranking totals for each condition/treatment differ significantly from the values that would be randomly expected for government spending. The test statistics suggested by Friedman (Siegel & Castellan, 1988) are as follows:

$$T_1 = \frac{12}{mK(K+1)} \sum_{k=1}^K R_k^2 - 3n(K+1), \tag{5}$$

where, $R_k = \sum_{i=1}^n R_{ik}$, is the sum of degrees for handling k over n blocks for government spending on complex systems. The Kruskal-Wallis test statistic measures the extent to which the ratings of the current \bar{R}_i observed averages differ from their expected value $(N + 1)/2$ (Ostertagová et al., 2014). The calculation for government expenditures is as follows:

$$H = \frac{12}{N(N+1)} \sum_{i=1}^k n_i (\bar{R}_i - \bar{R})^2 = \frac{12}{N(N+1)} \sum_{i=1}^k n_i \left(\frac{R_i}{n_i} - \frac{N+1}{2} \right)^2. \tag{6}$$

The coefficient $12/N(N+1)$ is a normalization factor suitable for complex economic-financial systems in the time interval of government expenditures, then the statistic can be rewritten in another equivalent form as:

$$H = \frac{12}{N(N+1)} \sum_{i=1}^k R_i^2 - 3(N+1). \tag{7}$$

Pearson’s test for complex systems is a proper statistic (Obilor & Amadi, 2018) to measure the correlation between variables (WS, GS, EU, ST, CE, and TE). Bivariate union $(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)$, then the correlation of the Pearson coefficient (r) for government expenditure variables in complex systems are defined as:

$$r = \frac{S_{xy}}{S_x S_y}. \tag{8}$$

Given the above relationship, the Pearson (r) correlation coefficient in complex financial systems for the cost interval can be written as:

$$r = \frac{\frac{1}{N} \sum xy - \bar{x} \bar{y}}{\sqrt{\left(\frac{1}{N} \sum x^2 - \bar{x}^2\right) \left(\frac{1}{N} \sum y^2 - \bar{y}^2\right)}} \tag{9}$$

when r – Pearson Correlation Coefficient in complex systems, N – number of values in variables, $\sum xy$ – the sum of government expenditure variables x and y , \bar{x} – mean of values, \bar{y} – mean of values y , $\bar{x} \bar{y}$ – calculation of average values of the expenditure interval, $\sum x^2$ – the sum of squares of values x , $\sum y^2$ – the sum of squares of values y . Kendall test (Kendall, 1955), is a measure of consistency between the two variables observed for government spending during the time interval 2007–2020. The statistic τ is defined as the difference between the probabilities of matching and the mismatch between the two variables (Kendall & George, 1948). The equation for calculating the government expenditure interval in complex systems according to Kendall Tau_b is as follows:

$$\tau = P\left(y_i < y_j \mid x_i < x_j\right) - P\left(y_i > y_j \mid x_i < x_j\right) = 2P\left(y_i > y_j \mid x_i < x_j\right) - 1 = 2\pi_1 - 1 \tag{10}$$

According to the definition in equation (10), τ is a population property for complex financial and economic systems. When X and Y are double normal with correlation coefficient ρ , it is straight forward to government spending:

$$\tau = \frac{2}{\pi} \sin^{-1} \rho \tag{11}$$

The formula for the Spearman correlation coefficient rho to the time interval of government spending on complex financial and economic systems is as follows (Clef, 2013):

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} \tag{12}$$

$$\rho = \frac{S_{xy}}{S_x S_y} = \frac{\frac{1}{n} \sum_{i=1}^n R(x_i) - \overline{R(x)} * \left(R(y_1) - \overline{R(y)}\right)}{\sqrt{\frac{1}{n} \sum_{i=1}^n R(x_i) - \overline{R(x)}^2} * \sqrt{\frac{1}{n} \sum_{i=1}^n R(y_i) - \overline{R(y)}^2}} \tag{13}$$

when $R(x)$ and $R(y)$ are the ranks for financial complex systems, $\overline{R(x)}$ and $\overline{R(y)}$ are the mean ranks for public spending.

3. Results and discussion of results obtained

This research, as discussed in the methodology are included two analyzes and one matrix: Descriptive analysis, Correlation analysis, Tests of Normality, Data Patterns (all cases), Summary of Estimated Means, Wald-Wolfowitz test, Mann-Whitney test, Friedman test, Run test, Kruskal-Wallis test, Pearson, Kendall’s Tau_b, Spearman’s rho, Proximity Matrix (Euclidean

Distance between years 2007–2020 and variables: WS, GS, UE, ST, CE, and TE), Z statistics (stress test).

Factors analyzed for all variables WS, GS, EU, ST, CE, TE:

I. Presentation of data on the time interval of public expenditures in complex financial-economic systems to their distribution in public institutions at both levels (local and central).

II. Analysis of data related to the interval of public expenditures in complex financial-economic systems at both levels in all institutions.

III. Analysis of data on unstoppable and floating travel towards development reform in complex financial and economic systems of government spending through Wald-Wolfowitz, Mann-Whitney, Friedman, Run, Kruskal Wallis tests.

IV. Analysis of data through correlation according to tests Pearson, Kendall Tau, and Spearman related to public spending in complex financial-economic systems at both levels in all institutions.

3.1. Results from the presentation of data on the time interval of public expenditures in complex financial-economic systems to their distribution in public institutions at both levels (local and central)

Regarding the presentation of time interval data on public spending (Goemans, 2022), the multipliers of government spending in America were analyzed to why they are high during periods of uncertainty and whether the distribution is normal compared to safe periods through the use of data from 1990 onwards in local governments, where it was pointed out that unemployment is rising in uncertain times compared to normal times. Regarding the shocks to the distribution of government expenditures, according to Ricco et al. (2016), it is emphasized that when there are low disputes, the production response to innovation in fiscal expenditures is large and positive due to the reaction to private investment and vice versa.

Table 1 shows: The data during the unstoppable and floating journey towards the development reform in the complex financial-economic systems for public expenditures are fully used, which means that there is no lack of data in the reports and financial statements on the financial items for public expenditures for period 2007–2020 at both central and local levels in all institutions of the state of Kosovo.

Table 1. Case processing summary

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Years	14	100.0%	0	0.0%	14	100.0%

Table 2 shows: The arithmetic mean for 14 years is (2013.5) and the standard deviation for 4.1830, while 95% reliability values are given at the lowest and highest limits (2011.09 and 2015.91). The maximum number of years calculated for public spending is 2007 while the maximum is 2020. According to Skewness, the distribution is normal, while according to the Kurtosis test (-1.200) the distribution is not fair.

Table 2. Descriptive statistics

Descriptive Statistics			
		Statistic Wages and Salaries	
Years	Mean	2013.5000	
	95% Confidence Interval for Mean	Lower Bound	2011.0846
		Upper Bound	2015.9154
	5% Trimmed Mean	2013.5000	
	Median	2013.5000	
	Variance	17.500	
	Std. Deviation	4.18330	
	Minimum	2007.00	
	Maximum	2020.00	
	Range	13.00	
	Interquartile Range	7.50	
	Skewness	.000	
	Kurtosis	-1.200	

Table 3 shows: According to the level of importance 5% in the variables (Wages and Salaries, Goods and Services, Utility Expenses, Subsidies and Transfers, Capital Expenses, and Total Expenses) the value of both tests Kolmogorov-Smimov and Shapiro-Wilk (0.200 & 0.196) values are greater than 5% in this case the H1 hypothesis is accepted because the data are distributed normally.

Table 3. Tests of normality

Tests of Normality						
Years/Variables Independent	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Years/ Ind. Var.	.084	14	.200 [*]	.965	14	.196

3.2. Results for the analysis of data related to the interval of public expenditures in complex financial-economic systems at both levels in all institutions

Regarding complex financial and economic systems have contributed (Tsviliuka et al., 2010), it is emphasized that complex systems are provided by applications in the fields of finance and economics. Regarding capital investments made by the government, according to Titman et al. (2004), the institutions that increase capital investments tend to have higher returns. Regarding the variable of goods and services, they contributed (Isaac et al., 1985) analyzed that the problem of providing public services has been major in many areas of the economy. According to traditional economic models which are based on the assumption that behavior

and non-compliance during a period of public good sent governments into decision-making processes relying on voluntary individual payments to provide public services and goods (... see Feldman's example 1980), the results, therefore, stressed that governments need to solve problems of public services and goods.

Table 4. Data patterns (all cases)

Data Patterns (all cases)															
Case	# M	% M	Missing and Extreme Value Patterns						Variable Values						
			WS	GS	UE	ST	CE	TE	Years	WS	GS	UE	ST	CE	TE
1	0	.0					-		2007	208923.00	132877.00	17903.00	154552.00	159208.00	673463.00
2	0	.0							2008	228059.00	144583.00	18489.00	210006.00	351651.00	952788.00
3	0	.0							2009	268925.00	154739.00	19234.00	257767.00	406382.00	1107047.00
4	0	.0							2010	316200.00	167156.00	19527.00	253484.00	459272.00	1215639.00
5	0	.0							2011	388303.00	161591.00	20388.00	256476.00	531290.00	1358048.00
6	0	.0							2012	409245.00	172482.00	21560.00	280317.00	554813.00	1438417.00
7	0	.0							2013	418546.00	195365.00	21664.00	315619.00	534690.00	1485884.00
8	0	.0							2014	486691.00	188033.00	22100.00	364526.00	412920.00	1474270.00
9	0	.0							2015	526311.00	184828.00	24166.00	422099.00	407926.00	1565330.00
10	0	.0							2016	544831.00	183050.00	23362.00	475103.00	449147.00	1675493.00
11	0	.0							2017	550749.00	204151.00	24158.00	508316.00	471098.00	1758472.00
12	0	.0							2018	592588.00	229057.00	23440.00	558778.00	533064.00	1936927.00
13	0	.0		+					2019	616921.00	273312.00	24866.00	627959.00	533773.00	2076831.00
14	0	.0		+					2020	661343.00	280007.00	22168.00	868480.00	384471.00	2216469.00

Note: - indicates an extremely low value, while + indicates an extremely high value. The range used is (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Table 4 shows: Based on the table it is noted that in 2007 (Case 1 = 159208.00) in the capital investment variable (Q6) unlike other years there is a small number of investments in complex financial and economic systems while in 2019–2020 (Cases 13 & 14) in the variable of goods and services there is an increase in expenditures for this category due to the management of the COVID-19 pandemic in 2020 (280007.00).

Table 5. Summary of estimated means

Summary of Estimated Means						
	WS	GS	UE	ST	CE	TE
Listwise	2013.5000	444116.7857	190802.2143	21644.6429	396677.2857	442121.7857
All Values	2013.5000	444116.7857	190802.2143	21644.6429	396677.2857	442121.7857

Table 5 shows: In Listwise the arithmetic averages are calculated only for complete observations in complex financial systems on public expenditures, while in (All values) the averages are calculated taking all the values of public expenditures for all years. In all variables the averages are the same in both tests with crust it is emphasized that the distribution is

normal there is no coincidence in the unstoppable and floating journey towards the reform of development in complex financial-economic systems for the interval of public expenditures during 2007–2020, therefore hypothesis 2 (H2) is accepted.

Figures 4–9: public expenditures in complex financial-economic systems (2007–2020).

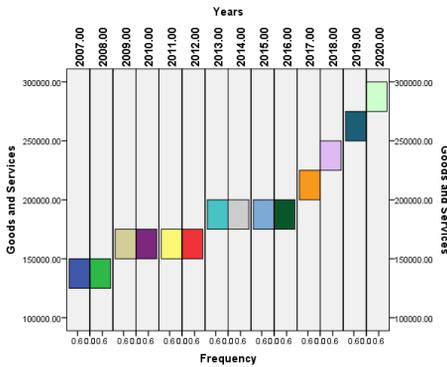


Figure 4. Goods and services

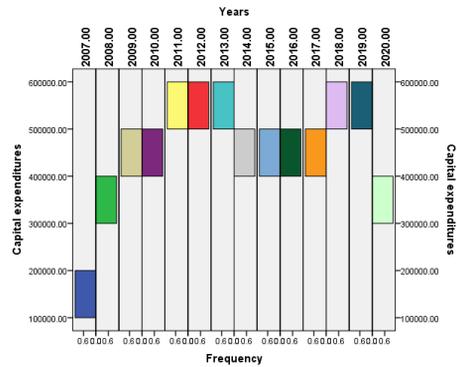


Figure 5. Capital expenditures

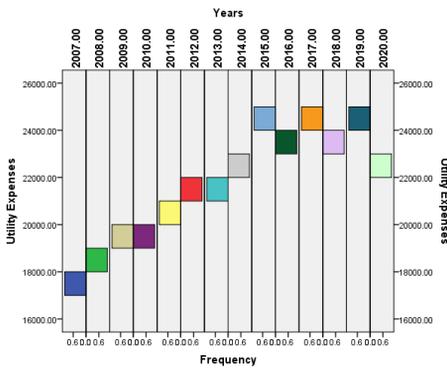


Figure 6. Utility expenses

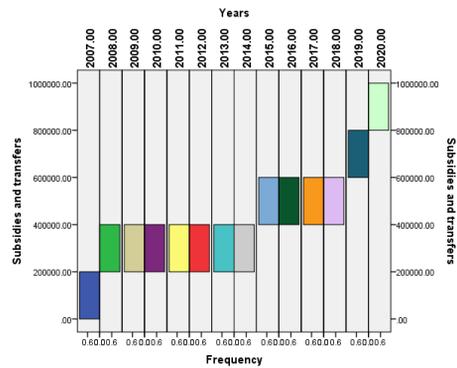


Figure 7. Subsidies and transfers

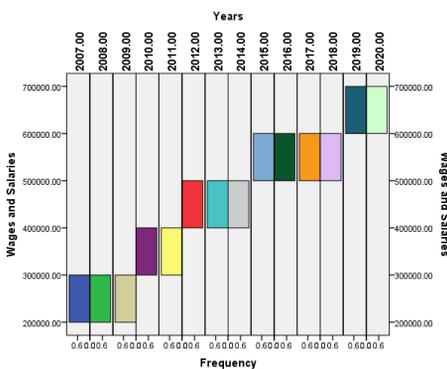


Figure 8. Wages and salaries

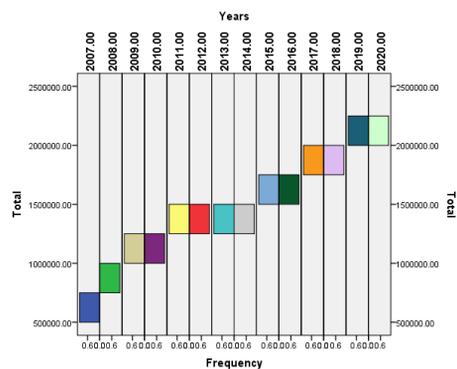


Figure 9. Total of public expenditures

Based on the Figures 4–9 for public expenditures in complex systems, it is emphasized that in the variable WS (Wages and Salaries) in the years 2007–2009 the expenditures were small, while during the unstoppable and navigable journey towards the development reform there is an increase of expenditures in each year and in particular there is an increase in expenditures in the years (2019–2020) as noted in the results in Table 5 due to the COVID-19 and other expenditures allocated by the state for both levels for salaries and wages of employees and other categories according to the financial statements. The variable GS (Goods and Services) states that in the years (2007–2008) there was a smaller number of goods and services category, then over the years' financial reforms in complex systems for this category went on increasing and in particular, there was an increase in 2020 due to COVID-19. The EU variable (utility expenses) states that in each year (2007–2020) there are reforms in complex systems in this category, in this case, 2007 had lower municipal expenditures and there was a reduction of these expenditures in 2020 due to the pandemic which had blocked everything at both levels and that the demand for municipal expenditures was quite small on the part of citizens and other actors. The variable ST (subsidies and transfers) states that in 2007 had very small expenditures, while in 2020 there were quite large expenditures due to COVID-19, the state had allocated subsidies and transfers for the recovery of the country's economy. In the category CE (Capital Expenditures) it is stated that the year with the lowest capital expenditures was 2007 as was pointed out in Table 5, where there were small expenditures in 2020 due to COVID-19. The TE variable (total expenditures) states that 2007 had small expenditures, while large expenditures were created during the years 2019–2020 as elaborated in each category. Therefore, the state had an unstoppable and floating journey towards development reform in complex financial-economic systems for the interval of government expenditures during the years 2007–2020.

3.3. Results for the unstoppable and navigating journey towards development reform in the complex financial and economic systems of government spending through the Wald-Wolfowitz, Mann-Whitney, Friedman, Run, and Kruskal-Wallis tests

To see if the financial data are taken from the same ratio and year in complex economic-financial systems are analyzed the results of tests Wald-Wolfowitz, Mann-Whitney, Friedman, Run, Kruskal-Wallis, in all variables for expenditures public navigation and development towards complex reforms. Regarding the impact of reports and financial reporting on whether data is taken for time intervals from one report, or several reports have contributed (Power, 2021) where it is emphasized that each model of financial reporting system should be as simple and dynamic as possible focused on relationships between financial items and not in static entities.

Table 6 shows: the data obtained from the Wald-Wolfowitz Test indicate that the value of p (sig. = 1.000) at the significance level 0.05 hypothesis 3 (H3) is accepted. The data for (WS, GS, EU, ST, and CE) were received from different institutions at both levels for the categories of public expenditures in the complex financial and economic systems for the period 2007–2020. Navigation and development in financial-economic reforms in complex systems are not the same.

Table 6. Wald-Wolfowitz test

Wald-Wolfowitz Test Test Statistics ^{a,b}					Frequencies	
		Number of Runs	Z	Exact Sig. (1-tailed)	Years	N
Wages and Salaries (WS)	Exact Number of Runs	2 ^c	.000	1.000	2007.00	1
					2020.00	1
					Total	2
Goods and Services (GS)	Exact Number of Runs	2 ^c	.000	1.000	2007.00	1
					2020.00	1
					Total	2
Utility Expenses (UE)	Exact Number of Runs	2 ^c	.000	1.000	2007.00	1
					2020.00	1
					Total	2
Subsidies and transfers (ST)	Exact Number of Runs	2 ^c	.000	1.000	2007.00	1
					2020.00	1
					Total	2
Capital expenditures (CE)	Exact Number of Runs	2 ^c	.000	1.000	2007.00	1
					2020.00	1
					Total	2

Note: a. Wald-Wolfowitz Test; b. Grouping Variable: Years; c. No inter-group was encountered.

Table 7. Mann-Whitney test

Mann-Whitney Test Test Statistics ^a						Ranks			
	WS	GS	UE	ST	CE	Var	Years	N	Mean Rank
Mann-Whitney U	21.000	21.000	21.000	21.000	21.000	WS	2007.00	1	1.00
							2020.00	1	2.00
							Total	2	
Wilcoxon W	1.000	1.000	1.000	1.000	1.000	GS	2007.00	1	1.00
							2020.00	1	2.00
							Total	2	
Z	-1.000	-1.000	-1.000	-1.000	-1.000	UE	2007.00	1	1.00
							2020.00	1	2.00
							Total	2	
Asymp. Sig. (2-tailed)	.009	.009	.009	.009	.009	ST	2007.00	1	1.00
							2020.00	1	2.00
							Total	2	
Exact Sig. [2*(1-tailed Sig.)]	.005 ^b	CE	2007.00	1	1.00				
							2020.00	1	2.00
							Total	2	

Note: a. Grouping Variable: Years; b. Not corrected for ties.

Table 7 shows the value of Z -1000 for all variables and the value of the significance level $p = 0.009$, in this case, the results are statistically significant there is a difference between the interval of 2007 and 2020 for all variables which means that the state has developed complex financial and economic systems, hypothesis 3 (H3) is accepted.

Table 8. Runs and Friedman tests

	Runs Test					Friedman Test		Test Statistics ^a	
	WS	GS	UE	ST	CE	Ranks	Mean Rank	N	14
Test Value ^a	452618.50	183939.00	21882.00	340072.50	454209.50	Years	1.00	Chi-Square	79.102
Cases < Test Value	7	7	7	7	7	WS	5.43	df	6
Cases >= Test Value	7	7	7	7	7	GS	3.00	Asymp. Sig.	0.000
Total Cases	14	14	14	14	14	UE	2.00	N	14
Number of Runs	2	4	2	2	5	ST	4.57	a. Friedman Test	
Z	-3.060	-1.947	-3.060	-3.060	-1.391	CE	5.00		
Asymp. Sig. (2-tailed)	.002	.022	.002	.002	.004	Total	7.00		

Note: a. Median

Table 8 shows: according to the Runs test the data are not random, because the values of Z are (WS = -3.060; GS = -1.947; EU = -3.060; ST = -3.060; CE = -1.391) and Sig is (WS = 0.002; GS = 0.022; UE = 0.002; ST = 0.002, CE = 0.004), Hypothesis 4 (H4) is accepted. According to the Friedman test, there is a difference (asympt. Sig.0.000 <0.005) between categories (Y = 1.00; WS = 5.43; GS = 3.00; UE = 2.00; ST = 4.57; CE = 5.00; TE = 7.00). According to the variables, it is emphasized that there is an unstoppable journey and navigation towards the development reform in the complex financial-economic systems through the analysis of the government expenditure interval, especially in capital investments and salaries and wages, again hypothesis 4 (H4) is accepted.

Table 9 shows: there is a difference between the years in all variables. In the first variable (WS) in 2020 = 14, there was an increase in expenditures for salaries and meditation due to the pandemic, while lower expenditures were in 2007 = 1. In the second variable (GS) also in 2020 = 14, there was an increase in expenditures for goods and services, while lower expenditures were in 2007 = 1. In the third variable (EU) there was an increase in expenditures for municipal expenditures in 2019 = 14, while lower expenditures were in 2007 = 1. In the fourth variable (ST) there was an increase in expenditures for transfers and subsidies in 2019 = 14, while lower expenditures in 2007 = 1. In the fifth variable (CE) there was an increase in capital investments in 2012 = 14, while lower expenditures were in 2020 = 3 in 2007 = 1. In total, the increase in expenditures was in 2022 = 14 due to COVID-19, while the decrease in expenditures was in 2007, which means that there were not many reforms in the complex financial-economic systems. Hypothesis 4 (H4) is accepted.

Table 9. Kruskal-Wallis test

Kruskal-Wallis Test											
WS		GS		UE		ST		CE		Total	
2007.00	1.00	2007.00	1.00	2007.00	1.00	2007.00	1.00	2007.00	1.00	2007.00	1.00
2008.00	2.00	2008.00	2.00	2008.00	2.00	2008.00	2.00	2008.00	2.00	2008.00	2.00
2009.00	3.00	2009.00	3.00	2009.00	3.00	2009.00	3.00	2009.00	4.00	2009.00	3.00
2010.00	4.00	2010.00	5.00	2010.00	4.00	2010.00	4.00	2010.00	8.00	2010.00	4.00
2011.00	5.00	2011.00	4.00	2011.00	5.00	2011.00	5.00	2011.00	10.00	2011.00	5.00
2012.00	6.00	2012.00	6.00	2012.00	6.00	2012.00	6.00	2012.00	14.00	2012.00	6.00
2013.00	7.00	2013.00	10.00	2013.00	7.00	2013.00	7.00	2013.00	13.00	2013.00	8.00
2014.00	8.00	2014.00	9.00	2014.00	8.00	2014.00	8.00	2014.00	6.00	2014.00	7.00
2015.00	9.00	2015.00	8.00	2015.00	13.00	2015.00	13.00	2015.00	5.00	2015.00	9.00
2016.00	10.00	2016.00	7.00	2016.00	10.00	2016.00	10.00	2016.00	7.00	2016.00	10.00
2017.00	11.00	2017.00	11.00	2017.00	12.00	2017.00	12.00	2017.00	9.00	2017.00	11.00
2018.00	12.00	2018.00	12.00	2018.00	11.00	2018.00	11.00	2018.00	11.00	2018.00	12.00
2019.00	13.00	2019.00	13.00	2019.00	14.00	2019.00	14.00	2019.00	12.00	2019.00	13.00
2020.00	14.00	2020.00	14.00	2020.00	9.00	2020.00	9.00	2020.00	3.00	2020.00	14.00

3.4. Correlation results according to tests Pearson, Kendall_tau, Spearman’s rho for the analysis of data related to public spending in complex financial-economic systems at both levels in all institutions

To see the impact of the Pearson, Kendall_Tau, and Spearman’s rho tests on data and all variables on public spending during the unstoppable and floating journey towards reforms in complex financial and economic systems, the following results are presented based on the hypotheses raised.

$$H_0 : \mu_{Pearson}(WS,GS,UE,ST,CE,TE) = \mu_{Kendall_tau}(WS, GS,UE,ST,CE,TE) = \mu_{Spearman's\rho}(WS, GS,UE,ST,CE,TE) \text{ or } \mu_{Pearson}(WS, GS,UE,ST,CE,TE) - \mu_{Kendall_tau}(WS,GS UE,ST,CE,TE) - \mu_{Spearman's\rho}(WS, GS,UE,ST,CE,TE) = 0$$

Or

H₀: There is no link between the variables in the three tests for public spending toward the development of reforms in complex financial-economic systems

$$H_5 : \mu_{Pearson}(WS,GS,UE,ST,CE,TE) \neq \mu_{Kendall_tau}(WS,GS,UE,ST,CE,TE) \neq \mu_{Spearman's\rho}(WS, GS,UE,ST,CE,TE) \text{ or } \mu_{Pearson}(WS, GS,UE,ST,CE,TE) - \mu_{Kendall_tau}(WS,GS,UE,ST,CE,TE) - \mu_{Spearman's\rho}(WS,GS,UE,ST,CE,TE) \neq 0$$

H₅: There is a link between the variables in the three tests for public spending toward the development of reforms in complex financial-economic systems

3.4.1. Pearson Correlation (2-tailed) test results

Table 10. Pearson Correlation (WS, GS, UE, ST, CE, TE)

		Pearson Correlations					
		WS	GS	UE	ST	CE	TE
Wages and Salaries	Pearson Correlation	1	.866**	.852**	.905**	.298**	.968**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	6217635	6217635	6217635	6217635	6217635	6217635
Goods and Services	Pearson Correlation	.866**	1	.618**	.935**	.241**	.939**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	6217635	6217635	6217635	6217635	6217635	6217635
Utility Expenses	Pearson Correlation	.852**	.618**	1	.603**	.443**	.768**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	6217635	6217635	6217635	6217635	6217635	6217635
Subsidies and Transfers	Pearson Correlation	.905**	.935**	.603**	1	.060**	.939**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	6217635	6217635	6217635	6217635	6217635	6217635
Capital Expenditures	Pearson Correlation	.298**	.241**	.443**	.060**	1	.379**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	6217635	6217635	6217635	6217635	6217635	6217635
Total Expenses	Pearson Correlation	.968**	.939**	.768**	.939**	.379**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	6217635	6217635	6217635	6217635	6217635	6217635

Table 10 shows: According to the Pearson test (2-tailed) there is a strong, positive significant relationship between WS and (GS = 86%, EU = 85%, ST = 91%, TE= 97%), while a link is positive but small with CE = 30%, which means that wages and salaries on the part of capital investments are small because there was not a large number of capital investments as noted in the above tables and graphs of especially in 2020 the damage caused by the COVID-19. The GS variable has a strong and important position correlation with (WS = 87%, EU = 62%, ST = 94%, TE = 94%), while a positive but small correlation with CE = 24% due to COVID-19. The EU variable has a strong and important positive relationship with (WS = 86%, GS = 62%, ST = 60%, and TE = 77%), while there is a positive but smaller relationship with CE = 44%, which will mean that municipal expenditures were for goods and services, transfers and subsidies, while lower municipal expenditures were on the part of capital investments due to COVID-19. The ST variable has a strong and significant positive correlation with (WS = 91%, GS = 94%, EU = 60%, and TE = 94%), while a positive but small correlation with CE = 6%. The CE variable has positive and significant correlations but not

in high values (WS = 30%, GS = 24%, EU = 44%, ST = 6%, TE = 38%). The TE variable has a positive and important relationship with (WS = 97%, GS = 94%, EU = 7%, ST = 94%, and CE = 38%). Based on this table, it is strongly recommended to develop reforms in complex financial-economic systems in the category of capital investments, because for 14 years there is no unstoppable journey and navigation towards the reform of the development of complex systems, but that this category has been quite affected by the COVID-19 pandemic. Hypothesis 5 (H5) is accepted.

3.4.2. Kendall's Tau_b & Spearman's rho test results

Table 11. Kendall_tau b & Spearman's rho Correlation (WS, GS, UE, ST, CE, and TE)

Correlations Kendall Tau_b & Spearman's rho									
			WS	GS	UE	ST	CE	TE	
Kendall's Tau_b	WS	Correlation Coefficient	1.000	.846**	.802**	.956**	.297	.978**	
		Sig. (2-tailed)	.	.000	.000	.000	.139	.000	
		N	14	14	14	14	14	14	
	GS	Correlation Coefficient	.846**	1.000	.692**	.802**	.319	.868**	
		Sig. (2-tailed)	.000	.	.001	.000	.112	.000	
		N	14	14	14	14	14	14	
	UE	Correlation Coefficient	.802**	.692**	1.000	.758**	.319	.780**	
		Sig. (2-tailed)	.000	.001	.	.000	.112	.000	
		N	14	14	14	14	14	14	
	ST	Correlation Coefficient	.956**	.802**	.758**	1.000	.253	.934**	
		Sig. (2-tailed)	.000	.000	.000	.	.208	.000	
		N	14	14	14	14	14	14	
	CE	Correlation Coefficient	.297	.319	.319	.253	1.000	.319	
		Sig. (2-tailed)	.139	.112	.112	.208	.	.112	
		N	14	14	14	14	14	14	
	TE	Correlation Coefficient	.978**	.868**	.780**	.934**	.319	1.000	
		Sig. (2-tailed)	.000	.000	.000	.000	.112	.	
		N	14	14	14	14	14	14	
	Spearman's rho	WS	Correlation Coefficient	1.000	.952**	.903**	.987**	.345	.996**
			Sig. (2-tailed)	.	.000	.000	.000	.227	.000
			N	14	14	14	14	14	14
		GS	Correlation Coefficient	.952**	1.000	.837**	.938**	.420	.956**
			Sig. (2-tailed)	.000	.	.000	.000	.135	.000
			N	14	14	14	14	14	14
UE		Correlation Coefficient	.903**	.837**	1.000	.890**	.411	.899**	
		Sig. (2-tailed)	.000	.000	.	.000	.144	.000	
		N	14	14	14	14	14	14	
ST		Correlation Coefficient	.987**	.938**	.890**	1.000	.301	.982**	
		Sig. (2-tailed)	.000	.000	.000	.	.296	.000	
		N	14	14	14	14	14	14	
CE		Correlation Coefficient	.345	.420	.411	.301	1.000	.376	
		Sig. (2-tailed)	.227	.135	.144	.296	.	.185	
		N	14	14	14	14	14	14	
TE		Correlation Coefficient	.996**	.956**	.899**	.982**	.376	1.000	
		Sig. (2-tailed)	.000	.000	.000	.000	.185	.	
		N	14	14	14	14	14	14	

Table 11 shows: according to the correlation coefficients (rho and tau_b, 2-tailed) the values are very important and positive between the variables in all categories for the period 2007-2020. In the variable WS, there is a strong and important positional relationship in both Tau_b tests (GS = 85%, UE = 80%, ST = 96%, TE = 98%) and Rho (GS = 95%, UE = 90%, ST = 99%, TE = 100%) while a positive but small correlation with (Tau_b: CE = 30%, Rho: CE = 35%). In the variable GS there is a strong and important positional relationship in both Tau_b tests (WS = 85%, UE = 69%, ST = 80%, TE = 87%) and Rho (WS = 95%, UE = 84%, ST = 94%, TE = 96%), while a positive but small correlation with (Tau_b: CE = 32%, Rho: CE = 42%). In the EU variable there is a strong and important positional relationship in both Tau_b tests (WS = 80%, GS = 69% ST = 76%, TE = 78%) and Rho (WS = 90%, GS = 84% ST = 89%, TE = 90%), while a positive but small correlation with (Tau_b: CE = 32%, Rho: CE = 41%). The CE variable in both Tau_b and Rho tests for all categories and variables for the period 2007-2020 has a positive relationship but with small values and in particular, the impact of the pandemic during 2020 is emphasized as a blow to capital investment by not functioning properly. In the TE variable there is a strong and important positional relationship in both Tau_b tests (WS = 98%, GS = 87%, EU = 78%, ST = 93%) and Rho (WS = 100%, GS = 96%, EU = 90%, ST = 98%), while a positive but small correlation with (Tau_b: CE = 31%, Rho: CE = 38%). According to both the Taub_b and Rho tests, it is emphasized that there is a strong and positive relationship between the variables, but it is strongly recommended to develop and improve the category of public investment expenditures to have reforms in complex financial and economic systems as stressed and to the Pearson test.

Figure 10 shows: the distance between years with the years goes by increasing, in this case, 2007 compared to other years has this distance as ten distances between two years with the

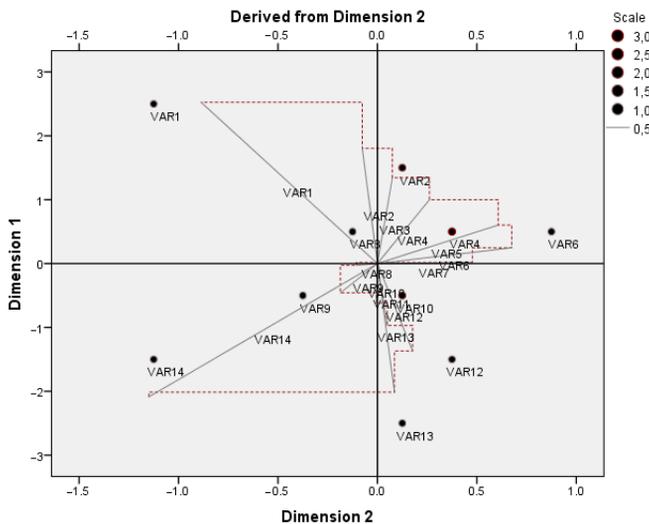


Figure 10. Proximity matrix (Euclidean distance between years)

value of 2007 (2007 = 2008 =, 458; 2008 = 2009 =, 459; 2009 = 2010 =, 471; 2010 = 2011 =, 516; 2011 = 2012 =, 499; 2012 = 2013 =, 417; 2013 = 2014 =, 252; 2014 = 2015 =, 277; 2015 = 2016 =, 316; 2016 = 2017 =, 307; 2017 = 2018 =, 309; 2018 = 2019 =, 296; 2019 = 2020 =, 540), which means that the closer the years to each other the distance is small in complex financial and economic systems and conversely the existence of long distances of dependent variables reduces the levels of explanation of the dependent variable. **Matrix** (Stress test =, 03359 & **RSQ** =, **99613**) à The value of stress according to Kruskals is 100% emphasizes the suitability of the data for the years 2007–2020 in complex financial and economic systems.

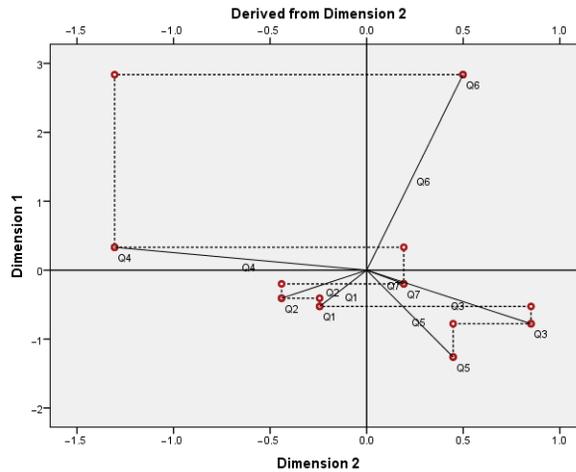


Figure 11. Proximity matrix (Euclidean distance between variables)

Figure 11 shows: Variable Wages and Salaries has the closest distance to Utility Expenses (WS = UE = 1.507). The variable Goods and Services have the closest distance to Subsidies and Transfers (GS = ST = 1.220). The Utility Expenses variable has the closest distance to Wages and Salaries (UE = WS = 1.507). The Subsidies and Transfers variable has the closest distance to Goods and Services (ST = GS = 1.220). The Capital Expenditures variable has the closest distance to Utility Expenses (CE = EU = 3.408). All the farthest distance variables have the variable of capital investments, again the development of complex financial and economic systems to the variable of capital investments is strongly recommended. Matrix (Stress test =, 04053 & **RSQ** =, **99462**) à The stress value according to Kruskal’s is 100% emphasizes the suitability of the data for all variables in complex financial and economic systems.

3.5. Elaboration validation of the hypotheses

Table 12 shows: The validation of the hypotheses (H1, H2, H3, H4, and H5) for all variables (WS, GS, EU, ST, CE, and TE) through 7 tests on the 5 hypotheses raised, with their most extensive verification and elaboration is done in the above tables.

Table 12. Elaboration validation of the hypotheses (H1, H2, H3, H4, H5)

No.	Tests	Hypotheses (H1, H2, H3, H4, H5)	Approved/ rejected
1	Tests of Normality Kolmogorov-Smirnova Shapiro-Wilk	H1: Distribution of data on public expenditures in financial reports to complex financial-economic systems follows the normal distribution	Approved H ₁
2	Data Patterns (all cases) Listwise	H2: Economic development reforms are significant in complex financial-economic systems for public spending	Approved H ₂
3	Wald-Wolfowitz test	H3: Data is not obtained from the same year in the reports of complex financial-economic systems	Approved H ₃
4	Mann-Whitney Test	H3: Data is not obtained from the same year in the reports of complex financial-economic systems	Approved H ₃
5	Runs Test Friedman Test	H4: Is there a difference between the years of transition for financial reforms in complex financial-economic systems	Approved H ₄
6	Kruskal-Wallis Test	H4: Is there a difference between the years of transition for financial reforms in complex financial-economic systems	Approved H ₄
7	Pearson	$H_0: \mu \text{ Pearson } (WS, GS, UE, ST, CE, TE) = \mu \text{ Kendall_tau } (WS, GS, UE, ST, CE, TE) \mu \text{ Spearman's rho } (WS, GS, UE, ST, CE, TE)$ or $\mu \text{ Pearson } (WS, GS, UE, ST, CE, TE) - \mu \text{ Kendall_tau } (WS, GS, UE, ST, CE, TE) - \mu \text{ Spearman's rho } (WS, GS, UE, ST, CE, TE) = 0$ Or $H_0: \text{There is no link between the variables in the three tests for public spending towards the development of reforms in complex financial-economic systems}$ $H_5: \mu \text{ Pearson } (WS, GS, UE, ST, CE, TE) \neq \mu \text{ Kendall_tau } (WS, GS, UE, ST, CE, TE) \neq \mu \text{ Spearman's rho } (WS, GS, UE, ST, CE, TE)$ or $\mu \text{ Pearson } (WS, GS, UE, ST, CE, TE) - \mu \text{ Kendall_tau } (WS, GS, UE, ST, CE, TE) - \mu \text{ Spearman's rho } (WS, GS, UE, ST, CE, TE) \neq 0$ $H_5: \text{There is a link between the variables in the three tests for public spending towards the development of reforms in complex financial-economic systems}$	Approved H ₅ Rejected H ₀
	Kendall Tau_b		Approved H ₅ Rejected H ₀
	Spearman Rho		Approved H ₅ Rejected H ₀

Conclusions

Public spending is becoming more and more important in every country. In modern times there has been a tremendous increase in government spending in all countries of the world, especially in times of the COVID-19 pandemic. Modern states are social states which are aiming to prove the well-being of their citizens by taking many functions upon themselves, so to complete these activities there is more and more public spending. Therefore, the purpose of public spending is to meet common needs that people in their capacity are not able to meet effectively. Expenditures should be planned, analyzed, and controlled using the rules of coordination and focusing on their time interval in complex financial systems, in such a way that the governing bodies do not endanger the well-being of a municipality or a ministry. So, the results of this research were easy to understand and apply, as well as the originality of

this research was the combination of conceptual and managerial methodology for the years 2007–2020 for future years to benefit governing institutions at both levels from the advantages and recommendations of this research. More specifically, an unstoppable and navigating journey towards the reform of development in complex financial-economic systems through the time interval of public expenditures for the period 2007–2020 analyzed through: Descriptive analysis, Correlation analysis, Tests of Normality, Data Patterns (all cases), Summary of Estimated Means, Wald-Wolfowitz, Mann-Whitney, Friedman, Run, Kruskal-Wallis, Pearson, Kendall's Tau_b, Spearman's rho, Proximity Matrix as in Tables (1–12), in Figures (1–11). Therefore, 6 variables were analyzed (WS, GS, EU, ST, CE, and TE) where it is stated that the data had normal distribution, there was an increase in expenditures for each year, and especially during the COVID-19, the data were taken from reports and different institutions for different years, as well as there is a strong and positive correlation between all variables, but a positive but lower correlation was with capital investment expenditures in 2007 and 2020. WS = Tau_b (GS = 85%, UE = 80%, ST = 96%, TE = 98%) and Rho (GS = 95%, UE = 90%, ST = 99%, TE = 100%), GS = Tau_b (WS = 85%, UE = 69%, ST = 80%, TE = 87%) and Rho (WS = 95%, UE = 84%, ST = 94%, TE = 96%), UE = Tau_b (WS = 80%, GS = 69% ST = 76%, TE = 78%) and Rho (WS = 90%, GS = 84% ST = 89%, TE = 90%), CE in both Tau_b and Rho tests for all categories and variables for the period 2007–2020 there are positive correlations, but with small values and in particular, the impact of the pandemic during 2020 is emphasized as a blow to capital investments by not functioning properly. The variable TE = Tau_b (WS = 98%, GS = 87%, UE = 78%, ST = 93%) and Rho (WS = 100%, GS = 96%, UE = 90%, ST = 98%). Pearson(r): GS (WS = 87%, UE = 62%, ST = 94%, TE = 94%), UE = (WS = 86%, GS = 62%, ST = 60%, TE = 77%), ST = (WS = 91%, GS = 94%, UE = 60%, TE = 94%), CE = (WS = 30%, GS = 24%, UE = 44%, ST = 6%, TE = 38%), TE = (WS = 97%, GS = 94%, UE = 77%, ST = 94%, CE = 38%). But other techniques, methodologies, and philosophies exist from other research to implement reforms in complex financial and economic systems for government spending. Given the main goals mentioned in the methodology, whether there have been development reforms in complex financial-economic systems for the period 2007–2020 (14 years), what is the complexity that has evolved in each variable, and whether development reforms have been achieved in the complex financial-economic systems? it was confirmed that there were reforms in the complex financial and economic systems for government spending each year, but it is strongly recommended that the category of public investment spending be developed and improved.

The limitations of this paper are that only a considerable number of variables are taken into the study and only in the state of Kosovo for a period of 14 years (2007–2020). In this case, for other analyzes by other researchers' other variables can be analyzed, longer periods or comparability with other countries. Because there are still challenging questions for complex financial and economic systems by studying financial items at the micro level.

Data availability

The data used to support and prove the findings of this study are available from the corresponding author upon request.

Conflict of interest

The author declares that there are no conflicts of interest regarding the publication of this paper.

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