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Determinants of the financial liquidity of local governments: Empirical evidence from Poland

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The aim of this paper was to examine the financial, economic and social factors as well as spatial relations influencing the level of the financial liquidity of local governments. In the study research, logistic regression models were applied as well as Moran's *I* statistic concerning the spatial autocorrelation on the counties in Poland. According to the data for the period 2018-2020, there were estimated regressions for each year and the longitudinal models. The results of the models' calculation and validation indicated that they might be used to define the level of liquidity in the local public units, since this liquidity influences the local economic condition and the range of public service delivery. The findings show that the predictors of the cash position have both an internal and an external character. Some of these factors appear constantly and result from the situation of the operating part of the local budget. Hence, the fiscal capacity is crucial in this field and the share of own revenues. A debt burden might also determine the analysed liquidity, as well as the size of the unit, which is in line with the presented findings of other scholars, therefore it is important to constrain the growth of the fixed costs and make the local budget more flexible. On the other hand, the share of students in the population is significant due to the fact this influences the scope of public tasks in the field of education. Thus, the local units have real instruments to manage their financial liquidity, which is mainly affected by the transactions-motive and the precautionary-motive. Analysing the spatial structure on the financial liquidity, there is a weak, negative spatial correlation in this field. The study also revealed the phenomenon of 'outliers'. To sum up, there are specific fiscal and socio-economic characteristics of the local public units affecting their cash positions, which is also influenced by the spatial structure.

Keywords: financial liquidity, local government, ordered logistic regression, spatial autocorrelation

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1. Introduction

The financial liquidity of various business units operating in the economy is the subject of numerous studies and analyses. This liquidity is related, according to the findings of J. M. Keynes, to the amount of money demand, which is the result of three motives, namely the transactions, precautionary, and speculative ones. The

transactions motive results from the need for cash for the current transaction of personal and business exchanges. The precautionary motive, in turn, means the desire for security as to the future cash equivalent of a certain proportion of total resources. The speculative motive is determined by the possibility to make a profit based on having better knowledge about the future than the information available on the market for the other participants (Keynes, 2018, p. 149). Keynes (2018, p. 173) indicated that in normal circumstances the amount of money required to satisfy the transactions motive and the precautionary motive is mainly an effect of the general activity (economic situation) of the economic system and of the level of money income. Moreover, the strength of these motives partly depends on the cheapness and the reliability of methods of obtaining cash as well as the relative cost of its holding (Starleaf and Reimer, 1967, p. 71). Thus, it is crucial to identify both endogenous and exogenous issues affecting the financial liquidity, especially in the units of the public sector. This concerns especially local governments (LGs) which have an influence on the condition of the local economy and the range of public service delivery. In addition, these units are required by law to meet fiscal rules in order to control their spending and reduce intertemporal burden shifting (Haughwout et al., 2021, p. 2). As a result, the liquidity features of the unit are impacted on by the context of the system or of internal organization (endogenous liquidity), or the liquidity has a broader range, affecting many institutions in a sector (exogenous liquidity). In the second context it is out of the direct control of any single institution, although in certain instances the actions of individual units can contribute to the exogenous pressures (Banks, 2005, p. 5). Furthermore, local governments should lead a prudent policy in the field of the financial liquidity to minimise the negative outcomes in the public service quality resulting from required budgetary cutbacks (Vignieri, 2022, p. 67). This liquidity also determines the fiscal distress at local level. In the phase of high exposure to this distress LGs cannot provide public services and meet its own operating needs to the extent that they did previously (Gorina, 2018, pp. 78-89). Thus, it is crucial to study the relationships between the financial liquidity and fiscal or socio-economic circumstances.

In the subject literature, there is a dearth of surveys identifying factors influencing LGs' financial liquidity. In most cases the financial health of these units is presented, while the liquidity is only a part of the overall studies (Iacuzzi, 2021, pp. 76-81). Moreover, there is a lack of models which show both the internal and external factors determining the cash position. However, it could be important for the public authorities and policymakers to have knowledge in this sphere in order to improve the stability of the local public finances and to predict cash flows. The novelty of this article is to examine the factors affecting the financial liquidity of LGs, defined using balance sheet data, which is not a common practice in surveys on the local public sector, and the liquidity's relationships with fiscal and economic categories against the background of the spatial structure in the country.

Therefore, the aim of this paper was to examine the financial, economic and social factors as well as spatial relationships influencing the level of the financial liquidity of local governments (LGs) based on the example of counties in Poland. To attain the aim, the following hypotheses were formulated, i.e.:

- Hypothesis 1 (H1): There is a direct relationship between the level of financial liquidity of local government and its financial autonomy;
- Hypothesis 2 (H2): There is a direct relationship between the level of financial liquidity of local government and the budget balance in its operational side;
- Hypothesis 3 (H3): There is an inverse relationship between the level of financial liquidity and the share of students in the population due to an impact of this share on the rigidity of the spending;
- Hypothesis 4 (H4): Spatial relationships between local governments influence their financial liquidity.

This paper is structured as follows: Section 2 surveys the findings related to issues determining financial liquidity in local government, while Section 3 describes the data and methodology, especially applied logistic regression and the spatial autocorrelation statistics. In turn, Section 4 presents the empirical results, both the regressions for each year and panel data models, as well as the measures of the spatial autocorrelation of the liquidity position of LGs, and the validation of the empirical models is also examined. Finally, the author summarises the findings and indicates the factors which determine the improvement of the level of financial liquidity at the local level of public finances.

2. Financial liquidity of local governments, its determinants and measures – literature review

The financial liquidity of LGs is one of the factors that significantly determines, as was mentioned, the economic condition of these units and the local community. This characterises the ability to fulfil the short-term obligations (Rivenbark and Roenigk, 2011, p. 249) and pay current liabilities (Iacuzzi, 2011, p. 81). Thus, it demonstrates the entity's capability to achieve cash flows to cover its typical and unexpected cash expenses in the process of an implementation of public tasks. This liquidity also represents the ability to meet the cash demands in the context of LGs' policy. In the subject literature some more detailed definitions of liquidity risk are developed – with funding (or liability) liquidity, asset liquidity, and joint liquidity distinguished. Funding liquidity focuses on the availability of unsecured liabilities that can be drawn on to create cash, including short-term and long-term debt facilities. Asset liquidity focuses, in contrast, on the availability of assets, such as securities, inventories, receivables, and equipment, which can be sold or pledged to generate the required cash. In certain cases, joint liquidity is indicated, which represents the possibility of acquiring money or converting other assets into cash in order to meet

obligations (Banks, 2005, p. 4). In addition, in LGs there are two other principal types of financial liquidity:

1) short-term, measured as the ability to meet current liabilities;

2) long-term, in which tasks and obligations (current and capital expenditures) are covered by budget inflows.

Hence, short-term liquidity is an important focus in the public sector. LGs failing to maintain necessary balances might be considered inefficient (Andrews and Shah, 2005, pp. 193-194). In turn, the lack of long-term liquidity leads to fiscal distress, which inevitably burdens the local community by means of higher taxation or a lower scope and quality of services.

As a result, the financial liquidity of LGs is affected by two main issues:

1) internal factors, which result from the activities of the unit in its financial and organizational areas, including the processes as well as the methods, techniques and instruments used in the sphere of finance and asset management. This was determined by (Filipiak, 2010, p. 159):

- asset level and structure;
- level and structure of liabilities;
- revenue policy, which includes the planning of budget revenues and methods to increase the efficiency in this field;
- expenditure policy, understood as deliberate public funds allocation in order to comply with the rules and satisfy public needs;
- the size of the budget deficit and public debt;

2) external factors, defined as a set of components not included in the organization/unit, but whose direct impact or change may affect the financial condition of the analysed LGs. These determinants result from (Ghuman and Aswatappa, 2010, pp. 37-38):

- the microenvironment, which consists of diverse types of stakeholders outside the organization, such as: inhabitants, as both service recipients and taxpayers, suppliers, creditors, distributors, etc. Therefore, these constituents can influence the local policy and strategies;
- the macroenvironment of economic, business, social, cultural, political, demographic, legal and spatial spheres.

On the one hand, these micro and macro issues determine the fiscal efficiency of the local taxes (own revenues) as budget inflows and finally the cash holdings of LGs. They also affect the current and capital expenditures and the budget balance on its operational side. Nevertheless, some determinants of cash holdings in LGs are underlined (see Gore, 2009, pp. 186-187):

- the uncertainty of cash flows, defined by the fact that when LGs have volatile revenue sources, managers are likely to increase cash holdings in order to maintain a constant level of services;
- access to credit markets determined by the rare possibility of bankruptcy, moral hazard or level of decentralisation of the public sector;

- size and its consequences that larger units can hold relatively less cash;
- growth, meaning that growing municipalities have incentives to save cash in anticipation of future spending on capital projects such as infrastructure expansion and the further increase of maintenance spending;
- regulations concerning the accumulation of revenues.

In the context of these conditions, Gore found that municipalities with a higher variation in revenues, more limited revenue sources and higher growth hold higher levels of cash, whilst larger units and those with more state funding tend to hold less cash. It should be mentioned that many findings in the field of corporate finance indicate the size of an entity as a significant factor of its cash position. Similarly in the private sector, cf. Magerakis et al. (2020, pp. 1-26), small firms tend to hold more cash than their larger counterparts due to precautionary motives. Furthermore, the size of the LG determines the methods and instruments of cash management and finally the cash level (Coe, 1988, p. 82). Moreover, according to Gore (2009, p. 204), there is no consistent relation between access to credit markets and cash holdings. Hence, LGs with high cash levels, or excess cash, spend significantly more on administrative expenses, managers' salaries, and bonuses. Other studies also revealed an association between the level of cash and fiscal capacity (certain own revenues, transfers and the others reduced by personnel expenditures in relation to the level of the poor population; Fahlevia and Nariski, 2018, pp. 1233-1243). It should be mentioned that fiscal potential in economics can be defined as the tax capacity, i.e. the ability of LGs to gain revenues from their own sources in order to finance a certain combination of public goods and services (Gałecka et al., 2022, pp. 52). Taxes (especially local ones) are key elements of this financial category (Malinowska-Misiąg, 2020, p. 52). Zéman (2017, p. 305) found that the ability of the population to pay taxes, such as Personal Income Tax (PIT), may have a positive correlation with the liquidity of companies run by the local government.

As far as the assessment of the financial liquidity in LGs is concerned, it can be measured by some indicators. Similar to corporate finance, the current ratio (current assets to current liabilities) or quick ratio (cash and marketable securities to current liabilities) can be applied (Damodaran, 2012, p. 49; Turner, 2005, p. 146). Hence, the higher the current and cash ratios, the greater the margin of safety the unit possesses to cover short-term debts (Brand, 2016, p. 100). Some scholars claim that the quick ratio is a stringent test of liquidity and its value below one implies that an entity is dependent on the collection of receivables to meet its current obligations (Crawford and Loyd, 2019, p. 4.22; Otrusinova and Kulleova, 2019, p. 86). Consequently, the assessment of this indicator is one of the elements of assessing the financial condition of LGs (Kooij and Groot, 2021, pp. 234-235). Moreover, some other types of relations might be estimated to analyse the liquidity, which is determined by the estimation approach as well as legal aspects of the national public finance system. The Office of the New York State Comptroller (2015, pp. 1-2), within the fiscal stress monitoring system, uses two measures of liquidity: cash and short-term investments

as a percentage of current liabilities (cash ratio), and as a percentage of the expenditures in certain periods. This latter indicator is also perceived as a cash position or as cash holdings (Hoque et al., 2022, pp. 606–612). Low levels of these ratios indicate 'low liquidity', a 'poor cash position' or 'weak cash flow'. Therefore, the basis of the liquidity is the capability to acquire cash (Modlin, 2010, pp. 583-586). Furthermore, the liquidity might be measured by means of the relations of budget inflows to budget outflows (Filipiak, 2011, p. 304).

Summarising, in the literature there are three types of approaches to construct measures of financial liquidity, based on the applied financial categories:

1) only the balance sheet data, i.e. cash to liabilities.
2) only the budgetary data, i.e. budget inflows to budget outflows.
3) a combination of the balance sheet and budgetary data, i.e. cash to budget expenditures.

Nevertheless, the balance sheet data approach is the universal one and can be applied and examined in different countries. It provides knowledge about the real cash needs in the period, which might result from disparities between revenues and expenditures as well as other financial, managerial, and socio-economic factors. Furthermore, it is a measure of the actual cash position.

3. Data and methodology

The author studied the population of 314 counties ('powiat') in Poland in the process of econometric modelling. Thus, cities with county rights were not included in the models due to their different structures of revenues (e.g. access to local taxes) and expenditures, the scope of their public tasks as well as the different level of their analysed liquidity, which is presented in the article. In Poland, counties make up the second-level unit of local government and administration. Since in other countries this tier is referred to as a county, district or prefecture (Korzeniewski and Kozłowski, 2020, p. 1592), the term 'county' was applied. The data from the consolidated balance sheets of LGs (taken from the Ministry of Finance database, Poland) as well as from the Local Data Bank of Statistics Poland were employed for the period 2018-2020, i.e. from the beginning of the term of office of the new local authorities. It is worth mentioning that the analysed counties are responsible for secondary education, local roads, a wide variety of inspection and permitting services, some land use planning, some cultural functions, local labour market policy, some social welfare functions, and the ownership and management of primary health care institutions (Kopańska and Levitas, 2005, p. 31).

In the process of identifying the factors determining the level of the financial liquidity of LGs, ordinal regression models (logit models) were applied. They can be developed in different ways, each of which leads to the same form of the model. The

ordinal regression model is commonly presented as a latent-variable (Y^*) model (Long, J. Freese, 1997, p. 310; Long, 1997, pp. 115-117) (1):

$$Y_i^* = X_i\beta + \varepsilon_i, \tag{1}$$

where X_i is a row vector with a 1 in the first element for the intercept and i-th (i = 1, 2, …, n) observation for X_{ik} (k = 1, 2, …, p); β is a column vector of structural coefficients with the first element being the intercept β_0, and ε_i is a random error. Thus, this model describes the relationship between an ordered categorical response variable, with J categories, and the collection of p explanatory variables, (X_1, X_2..., X_p) (Fagerland and Hosmer, 2017, pp. 668-679), which can be both quantitative and qualitative.

In practice, numerous ordered variables can be modelled using this approach, i.e. (Gruszczyński, 2020, p. 36):

- unit bond rating: junk bond (Y = 1), low-grade bond (Y = 2), investment grade bond (Y = 3);
- credit risk of a client: very low (Y = 1), low (Y = 1), medium (Y = 1), high (Y = 1), very high (Y = 1);
- unit's financial distress: low (Y = 1), medium (Y = 1), high (Y = 1).

At the same time, the proportional odds model (parallel-lines model, ordered logistic regression) is distinguished here. It assumes that each predictor has the same effect across the categories of the ordinal outcome variable (coefficients are the same across the ordinal categories) (Liu, 2016, pp. 194-199). However, this assumption might be violated (the parallel-lines in ordered logistic regression). This can be verified by the Brant test (both the univariate test for each predictor and the omnibus test for the overall model) (Liu, 2016, p. 199), as it was applied in this paper (using p-value 0.05). As a result, the estimation using the generalised ordered logit model, can be expressed as (2) (Liu, 2016, p. 238):

$$\begin{aligned}\operatorname{logit}\left(\pi\left(Y > j \mid x_1, x_2, \ldots, x_p\right)\right) &= \ln\left(\frac{\pi\left(Y > j \mid x_1, x_2, \ldots, x_p\right)}{\pi\left(Y \le j \mid x_1, x_2, \ldots, x_p\right)}\right) = \\ &= \alpha_j + \left(\beta_{1j}x_1 + \beta_{2j}x_1 + \ldots + \beta_{pj}x_p\right),\end{aligned} \tag{2}$$

where α_j are the intercepts (*cons*); $\beta_{1j}, \beta_{2j}, \ldots, \beta_{pj}$ are the logit coefficients and $\pi(Y > j \mid x_1, x_2, \ldots, x_p)$ is the probability of being beyond category j given a set of predictors, j = 1, 2, …, J-1. It is worth adding that the formulas for the parallel-lines model and the generalised ordered logit model are equivalent, except that in the parallel-lines model the β's (but not the α's) are the same for all values of j. Thus, partial-proportional odds models could be estimated (according to the results of the Brant test), in which some of the β coefficients can be the same for all values of j, while others can differ (Williams, 2006, pp. 58-60).

In the interpretation of this model the term 'odds' is used. Thus, the odds of being beyond a category are the probability of being above a category relative to the probability of being at or below that category (Liu, 2016, p. 238) (3):

$$\text{odds}\left(Y_i > j\right) = \frac{P\left(Y_i > j\right)}{P\left(Y_i \leq j\right)} \cdot \tag{3}$$

The implementation of this estimation required to define the dependent variable (Y) with ordered categories, which could indicate the levels of financial liquidity of the LGs. Thus, for each year the quick ratio was estimated, taking into account the specificity of the LG balance sheet, according to formula (4):

$$Quick\ Ratio\left(QR\right) = \frac{cash}{short-term\ liabilities\ and\ special\ funds} \cdot \tag{4}$$

Next, the counties were grouped into one of four categories using the value of quartiles (Q_k) of the quick ratio:

- $Y = 1$ – low level of financial liquidity: $Quick\ Ratio < Q_1$;
- $Y = 2$ – medium level of financial liquidity: $Q_1 \leq Quick\ Ratio < Q_2$;
- $Y = 3$ – high level of financial liquidity: $Q_2 \leq Quick\ Ratio < Q_3$,
- $Y = 4$ – very high level of financial liquidity: $Quick\ Ratio \geq Q_3$.

This approach enabled ordering the analysed units in terms of the level of the financial liquidity and determining the probability of a change of a certain category due to a change in the predictor. Therefore, it allows to rank the units, monitor their liquidity and implement effective remedies due to warning signals. In practice, in some reports or studies, LGs are categorised according to the level of their liquidity in order to measure their financial condition or fiscal distress, thus these findings could be developed using ordinal logistic regression.

The author proposed two main types of independent variables: financial as well as socio-economic predictors (Table 1). In turn, in the process of selecting explanatory variables for the estimated econometric models, a certain set of rules was followed (cf. Gruszczyński, 2012, pp. 97-98):

1) the author considered variables on the basis of the literature review and expert knowledge, namely predictors that, from the point of view of the LG's functioning (its financial policy), may affect the level of its financial liquidity;

2) statistically significant variables were included in the final econometric models using the backward selection (p-value 0.1);

3) the author included variables for which the signs of coefficients are consistent with the theoretical and expert knowledge;

4) avoiding multicollinearity between variables; using the variance inflation factor (VIF) (Harrell, 2015, p. 79);

5) the models were controlled using the AIC, BIC information criteria and certain pseudo-R^2 (McFadden R^2 and Cragg-Uhler (Nagelkerke) R^2 as well as count R^2).

Table 1

Independent variables applied in the process of the logistic regression model estimation

Sphere	Variable	Calculation / label/	Description and the idea of the application
1	2	3	4
Financial	Operating balance	Current revenues to current expenditures in % /current balance/	Arnett (2014, p. 18) found that cash solvency is positively correlated with budget solvency – units with greater liquidity are also more likely to have balanced revenues and expenses. Thus, this predictor expresses the balance in the current (operating) part of the budget. A ratio above 100 indicates that the LG generates an operating surplus (positive difference between current revenues and current expenditure).
Financial	Financial autonomy	Own-revenues to total revenues in % /own revenues/	This is a principle measure of the financial autonomy of the LG, which affects the opportunity to fulfil its obligations without a financial contribution from the central government (Dimitropoulos et al., 2018, p. 368). According to Gore (2009, p. 204), LGs with more state funding tend to hold less cash.
Financial	Debt burden	Total debt to current revenues in % /debt burden/	Debt determines the leverage which is included in models explaining cash holdings (Hoque et al., 2022, pp. 612–613). Debt burden affects problems with financial liquidity (Gałecka and Cyburt, 2019, p. 140). Excessive indebtedness may lead to loss of financial liquidity (Standar and Kozera, 2020, p. 2).
Financial	Personnel costs	Personnel expenditures to operating (current) expenditures in % /wages/	It is indicated that personnel expenditures are usually very rigid and difficult to reduce, especially in the short run. Their inflexibility might force LGs to issue debt (Balaguer-Coll et al., 2016, p. 517) due to the lack of resources for expected task delivery.
Socio-economic	Size	Log to the base 2 of total assets /assets/	In the literature the finance size of the unit is often expressed by the value of its assets (Gruszczyński, 2020, pp. 177, 200, 210). The liquidity level may be affected by the size of the entity (Kamiński, 2012, p. 79). Gore (2009, p. 204) indicated, as mentioned, that larger units tend to hold less cash.
Socio-economic	Growth of the number of working people	Dynamics of the number of employed persons in % /ch_employ/	Changes in this field affect the fiscal efficiency of the personal income tax (PIT), which is the main source of own revenues of counties in Poland. This factor also determines the financial autonomy of the unit (Jemna et al., 2013, p. 53) and income capacity.
Socio-economic	Average salary	Average monthly gross salary in relation to the national average in % /salary/	A variable determining the level of the wealth in the region (Patrzałek, 2019, pp. 91-92), and consequently the potential to obtain revenues from PIT. It affects the structure of expenses, including the scope of social assistance provided. Therefore, it is indicated that the level of the salaries determines the revenues from taxes, and finally the tax capacity.

Table 1, cont.

1	2	3	4
Socio-economic	Secondary school students	Number of students in secondary schools to the number of inhabitants in % /students/	The number of students determines the unit costs of their education, the amount of funds obtained in the form of the educational part of the general subsidy in Poland and the importance of expenditure on education in the budgets of the units. The increasing number of students may, however, cause an uneven increase in the costs of their education due to organizational conditions, e.g. the necessity/possibility of opening an additional class and/or teaching positions (Rzeszut, 2018; Zięba and Tobor, 2019). It should be added that in 2019 in counties in Poland, expenditure on education amounted to almost 37% of total expenditure (Galiński, 2021, p. 309). Budget rigidities, in contrast, include institutional and legal structures such as quasi-autonomous spending, e.g. expenditures on education, that are beyond the direct control of the authorities (Mattina and Gunnarsson, 2007, pp. 3, 22).
Socio-economic	Dynamics of the length of county roads	Percentage change of the length of hard-surfaced roads /roads/	Spending in the field of transport and communication is among the main budget categories in counties in Poland, among which road maintenance dominates. Hence, an increase of additional road infrastructure puts pressure on the budget (Swianiewicz, 2021, pp. 10-15). Furthermore, in the counties, expenditure on transport and communication account for more than half of their capital expenditures (between 2018 and 2020 this share was: 66%, 63% and 64% (RM, 2019, p. 103; RM, 2020, p. 105; RM, 2021, p. 107). Another problem is the deficit of funds for the maintenance of the roads (Ostrowska, 2017). Therefore, the mismatch between budget revenues and the increasing scope of transport tasks may disturb the payment capacity of the LGs.

Source: own study.

Furthermore, the author introduced a validation of the final models for calibration and discrimination ability by means of bootstrapping. Using 200 samples, the optimism-corrected discrimination and calibration statistics were presented. As a result, the following indexes were estimated (Harrell, 2015, p. 124): D_{xy} (Somers' rank correlation) as a measure of predictive discrimination, R^2 (Cragg-Uhler (Nagelkerke) pseudo-R^2), Intercept, the Brier score (the lower this score, the better the predictions are calibrated) and a slope (calibration slope), where less than one indicates overfitting, while a 'corrected' slope can be thought of as a shrinkage factor that takes overfitting into account (Harrell, 2015, p. 269).

Due to the analysis of the panel data (period: 2018-2020), the random-effects ordered logistic model (*re model*) was also applied. It may be also expressed in terms of a latent linear response, where observed ordinal responses Y_{it} are generated from the latent continuous responses (see Stata, 2021, p. 379; Cottrell and Lucchetti, 2022, pp. 202-203):

$$Y_{it}^{*} = X_{it}\beta + v_i + \varepsilon_{it}\,, \tag{5}$$

where Y_{it}^{*} is the observation on the dependent variable for cross-sectional unit *i* (the county in this research) in period *t*; X_{it} is a row vector with a 1 in the first element for the intercept and independent *p* variables observed for unit *i*-th in period *t*; β is a column vector of parameters, v_i is the individual specific random component and ε_{it} is an observation specific error.

The selection of variables in the panel data models was consistent with the earlier described methodology. A likelihood-ratio test comparing a random-effects ordered logistic regression model (*re model*) with a standard ordered logistic regression model (*ologit model*) was performed. The result of this test indicates whether there is enough variability between units to favour the *re model* over the standard model (*ologit model*, Stata, 2021, p. 375). The results of fixed-effects ordered logistic regression models (*fe model*, Baetschmann et al., 2021, pp. 253-275), as a form of robustness check, were also presented. This model is expressed as:

$$Y_{it}^{*} = X_{it}\beta + \alpha_i + \varepsilon_{it}\,, \tag{6}$$

in which the time-invariant, individual-specific part of unobservables (α_i) is called the fixed effect (vector X_{it} does not include the intercept because α_i act as individual-specific intercepts; Baetschmann et al., 2021, pp. 255). Finally, the author estimated panel data models with a separate set of variables. Using the Wald test, the joint significance of the explanatory variables was checked. For the random-effects models, the proportion of the total variance given by the panel-level variance component (ρ) was measured (Hilbe, 2009, p. 500).

A separate scientific procedure was applied in order to detect any spatial relationships between the analysed LGs in the field of their financial liquidity. This results from the fact that, according to the first law of geography (developed by Tobler in 1970), everything is related to everything else, but near things are more related than distant things. In turn, the second law of geography indicates that a phenomenon external to an area of interest affects what goes on inside (Bettencourt, 2021, p. 295). Thus, the author estimated the three-years-average of the quick ratio of all the counties (including counties with city status due to the fact of their potential influence on the liquidity of the neighbouring counties) in Poland for the period 2018-2020, and examined a global spatial autocorrelation for the continuous data by means of Moran's index *I* ; Burt et al. (2009, pp. 553-554):

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(X_i - \bar{X})\left(X_j - \bar{X}\right)}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\sum_{i=1}^{n}\left(X_i - \bar{X}\right)^2}, \tag{7}$$

where *n* represents the number of areas (i.e. counties in this study), X_i is the value of the variable of interest for the area (i.e. the quick ratio of a county), and w_{ij} is an

element of the spatial weight matrix that represent the geographical relationship between all pairs of areas *i* and *j*. Moran's *I* is thus a measure of similarity between neighbouring areal units (counties in this paper). When the attributes are more similar (or dissimilar) between two neighbours, this index tends to be a larger positive (or negative) value. In contrast, when the relation between two neighbours is weaker, it is closer to 0 (Chi and Zhu, 2021, p. 25), thus it is analogous to the correlation coefficient (Porter and Howell, 2012, p. 93). In the article, the interpretation was adopted as in Campbell (2021, p. 169), taking into consideration the p-value. Hence, the positive and statistically significant level of Moran's *I* means that areas of closer proximity tend to be more alike than those far apart (Porter and Howell, 2012, p. 93); the queen's case contiguity weight matrix with order 1 was employed (Chi and Zhu, 2021, p. 29). To illustrate this estimation, a Moran's *I* scatterplot was presented to show different types of correlation, namely: 'high-high' (quadrant I) – clustering of high values; 'low-low' (quadrant III) – clustering of low values; 'high-low' (quadrant IV) – high value among low neighbours, which indicates on an outlier, 'low-high' (quadrant II) – low value among high neighbours, which also indicates on an outlier (Mitchell, 2014, p. 365). Therefore, Moran's *I* was used to analyse the spatial spillover effect (Huang, 2020, p. 540) and the scatterplot can reveal 'outliers' (filled squares in Figure 2).

The author estimated also the local indicators of spatial autocorrelation in order to search for 'clusters' or 'hot spots' – localised areas where the values of the variable (quick ratio) are significantly greater or significantly lower than average. Thus, the local indicator of spatial association I_i (LISA) was presented (Chi and Zhu, 2021, p. 28):

$$I_i = \left(X_i - \bar{X}\right) \sum_{j=1,\ j \neq i}^{n} w_{ij} \left(X_j - \bar{X}\right), \tag{8}$$

where w_{ij}, for ease of interpretation, can be row standardised. As a result, I_i is a measure of similarity between *i*th areal unit (a county) and its neighbours (Chi and Zhu, 2021, p. 28). Thus, the LISA for each observation shows the extent of significant spatial clustering around the observation (Lloyd, 2007, pp. 85-86), namely the county in this paper. The results of these statistics are visualised on the LISA cluster map. It depicts the four types of spatial association: 'high-high', 'low-low', 'high-low', 'low-high', which correspond to the Moran scatter plot's division (Serra-Sogas, 2009, p. 227). Therefore, the LISA statistics serve two purposes – they may be interpreted as indicators of local pockets of non-stationarity, and they may be applied to measure the influence of individual locations on the magnitude of the global statistic and to identify 'outliers' (Anselin, 1995, p. 93).

4. Empirical results

In the analysed period 2018-2020 in Poland in the counties (314 units), the average level of the quick ratio was 1.05 (standard deviation 0.78) in comparison to 0.75 (standard deviation 0.41) in the cities with county rights (54 units without metropolises) and 0.71 (standard deviation 0.32) in the metropolises (12 units). Therefore, there are significant differences in the field of the financial liquidity level at county layer in Poland (Figure 1). Moreover, in 2018-2020, the share of own revenues in total revenues and debt to total revenues were 37.52% and 21.46% in the counties in comparison to 49.48% and 37.31% in the cities, or 59.72% and 47.81% in metropolises. These differences meant that in this paper the logistic regression analysis involved the counties (314 units), which are homogeneous in terms of their financing structure (the cities and the metropolises have additional sources of revenues, e.g. local taxes, and are responsible for a broader scope of public tasks).

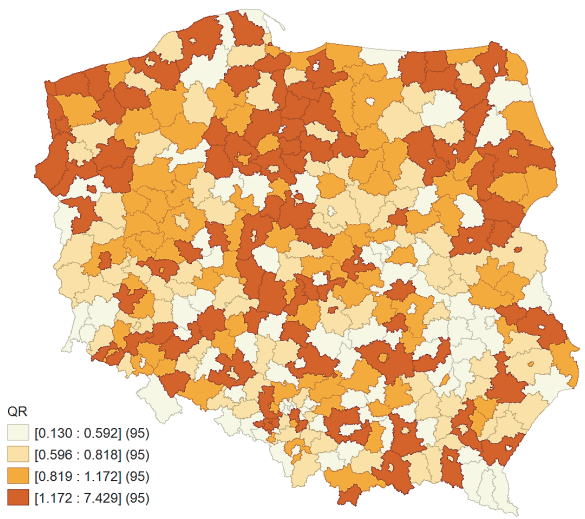

Fig. 1. The average level of the quick ratio (*QR*) in counties in Poland, 2018-2020, according to the quartiles

Source: own study.

According to the estimated model for 2018, five of the analysed predictors affected the level of financial liquidity of the counties (Table 1). All the variables passed the Brant test, so the ordered logistic regression was applied. Following the results, a one percentage point increase of the current revenues to current expenditures raised the odds of reaching a higher level of liquidity by 5.26%. In turn, a one percentage point growth of *debt burden* (total debt to current revenues) reduced the odds of achieving a better level of financial liquidity by 1.64%, *ceteris paribus*.

Similarly, a one percentage point increase in the share of personnel costs in current expenditure (*wages*) reduced the odds of achieving a higher level of liquidity by 3.65%, *ceteris paribus*. Moreover, in 2018 a one percentage point increase of the share of the secondary school students in the total population (*students*) reduced the odds of achieving a higher level of liquidity by 43.96%, *ceteris paribus*. The odds of attaining the better liquidity was also negatively affected by the percentage change of the length of hard-surfaced roads (*roads*). It is worth adding that in 2018 in Poland local elections were held.

Table 2

Determinants of the liquidity level of counties in Poland in 2018 – ordered logistic regression

Variable	Coeff.	Std. err.	p-value	Odds ratio e^{β}	VIF
Current balance	0.0513	0.0213	0.0160	1.0526	1.29
Debt burden	-0.0165	0.0070	0.0187	0.9836	1.14
Wages	-0.0372	0.0182	0.0411	0.9635	1.14
Students	-0.5791	0.2463	0.0187	0.5604	1.28
Roads	-0.1455	0.0667	0.0291	0.8646	1.02
cons (1)	13.5027	7.2326	0.0619	-	-
cons (2)	12.3259	7.2286	0.0882	-	-
cons (3)	11.1027	7.2238	0.1243	-	-
LR test: χ^2 (5) = 42.52, p-value < 0.0001			Brant test: χ^2 (10) = 8.72, p-value = 0.56		
Goodness-of-fit measures:					
McFadden R^2 = 0.049 Cragg-Uhler (Nagelkerke) R^2 = 0.135 Count R^2 = 0.369			AIC = 844.057 AIC/N = 2.688 BIC = 874.052		

Source: own study.

Judging from D_{xy} and R^2 there was a moderate amount of overfitting of the model for 2018, however the slope shrinkage factor is not troublesome (Table 2). Hence, the coefficients could be multiplied by 0.8528.

Table 3

Validation of results of ordered logistic regression for 2018

Statistics	Index orig.	Training	Test	Optimism	Corrected index
D_{xy}	0.2917	0.3073	0.2724	0.0349	0.2568
R^2	0.1351	0.1607	0.1189	0.0419	0.0932
Intercept	0.0000	0.0000	-0.0085	0.0085	-0.0085
Brier Score	0.2288	0.2248	0.2329	-0.0081	0.2369
Slope	1.0000	1.0000	0.8528	0.1472	0.8528

Source: own study.

Similarly to the model for 2018, in the process of the model estimation for 2019 all the variables passed the Brant test, therefore the proportional odds model was also applied (Table 3). As a result, the *current balance* and *financial autonomy* positively influenced the odds of attaining the higher liquidity level. As in the previous year, in 2019 a one percentage point increase of the share of students in the population reduced the odds of achieving a better liquidity position, *ceteris paribus*. At the same time, the bigger the unit (*size*), the smaller the odds for a higher liquidity level (Table 4).

Table 4

Determinants of the liquidity level of counties in Poland in 2019 – ordered logistic regression

Variable	Coeff.	Std. err.	p-value	Odds ratio e^{β}	VIF
Current balance	0.1110	0.0223	<0.0001	1.1174	1.36
Own revenues	0.0283	0.0129	0.0286	1.0287	1.23
Size	-0.2445	0.1383	0.0770	0.7831	1.19
Students	-0.4634	0.2119	0.0288	0.6291	1.37
cons (1)	-4.7799	3.7660	0.2044	-	-
cons (2)	-6.0060	3.7695	0.1111	-	-
cons (3)	-7.3311	3.7779	0.0523	-	-
LR test: χ^2 (4) = 68.33, p-value < 0.0001			Brant test: χ^2 (8) = 11.05 , p-value = 0.20		
Goodness-of-fit measures					
McFadden R^2 = 0.078 Cragg-Uhler (Nagelkerke) R^2 = 0.209 count R^2 = 0.366			AIC = 816.247 AIC/N = 2.600 BIC = 842.493		

Source: own study.

The validation process of the model for 2019 revealed its minor overfitting, e.g. the pseudo-R^2 dropped moderately (Table 5). The slope shrinkage factor is not worrying, and the coefficients can be multiplied by 0.9538.

Table 5

Validation of results of ordered logistic regression for 2019

Statistics	Index orig.	Training	Test	Optimism	Corrected index
D_{xy}	0.3278	0.3384	0.3207	0.0177	0.3101
R^2	0.2086	0.2179	0.1998	0.0181	0.1905
Intercept	0.0000	0.0000	-0.0038	0.0038	-0.0038
Brier score	0.2217	0.2188	0.2245	-0.0057	0.2274
Slope	1.0000	1.0000	0.9538	0.0462	0.9538

Source: own study.

As far as the model for 2020 is concerned, ordered logistic regression (variables passed the Brant test) was also applied. Thus, a one percentage point increase of the *current balance* raised the odds for a better level of the liquidity by 8.49%, *ceteris paribus*. In turn, a one percentage point increase of *debt burden* reduced the odds for a better liquidity level by 1.61%, *ceteris paribus*. Similarly, the growth of *wages*, *students* and *size* negatively affected the odds of the liquidity level improvement (Table 6). It is worth mentioning that in this year the financial situation of LGs was affected by the COVID-19 pandemic.

Table 6

Determinants of the liquidity level of counties in Poland in 2020 – ordered logistic regression

Variable	Coeff.	Std. err.	p-value	Odds ratio e^{β}	VIF
Current balance	0.0815	0.0221	0.0002	1.0849	1.21
Debt burden	-0.0162	0.0077	0.0364	0.9839	1.05
Wages	-0.0579	0.0198	0.0034	0.9437	1.28
Size	-0.2591	0.1458	0.0756	0.7717	1.21
Students	-0.6244	0.2178	0.0041	0.5356	1.35
cons (1)	4.3314	4.6766	0.3544	-	-
cons (2)	3.1039	4.6720	0.5065	-	-
cons (3)	1.7853	4.6702	0.7023	-	-
LR test: χ^2 (7) = 71.30, p-value < 0.0001			Brant test: χ^2 (10) = 13.11, p-value = 0.22		
Goodness-of-fit measures					
McFadden R^2 = 0.082			AIC = 815.280		
Cragg-Uhler (Nagelkerke) R^2 = 0.217			AIC/N = 2.596		
count R^2 = 0.395			BIC = 845.275		

Source: own study.

Using 200 bootstrap replications, the validation of the model for 2020 showed that, as with previous regressions, it was slightly overfitted (Table 7). The slope shrinkage factor is not troublesome, and the coefficients can be multiplied by 0.9275. Moreover, the Bier score was slightly corrected. In comparison to the other models, in 2020 the predictions were more discriminating, as indicated by the level of D_{xy}.

Table 7

Validation of results of ordered logistic regression for 2020

Statistics	Index orig.	Training	Test	Optimism	Corrected index
D_{xy}	0.3615	0.3764	0.3532	0.0231	0.3384
R^2	0.2167	0.2296	0.2054	0.0242	0.1925
Intercept	0.0000	0.0000	-0.0012	0.0012	-0.0012
Brier Score	0.2127	0.2093	0.2160	-0.0068	0.2195
Slope	1.0000	1.0000	0.9275	0.0725	0.9275

Source: own study.

The influence of the *operating balance*, *fiscal autonomy* and the share of students of secondary schools in the population on the liquidity level between 2018 and 2020 were also confirmed by the estimated random effects panel data models (Table 8). It is worth adding that in 2018-2020 there were strong and significant correlations between the *students* and the share of expenditures on education (the correlation coefficient was 0.6098, 0.6568, and 0.6616, respectively). The Wald tests indicated that the included variables were jointly statistically significant in these models. According to the reported likelihood-ratio test, there is enough variability between the random-effects ordered logistic regression (*re model*) over the standard ordered logistic regression (LR test: *re model* vs. *ologit*). The value of ρ for the *re models* suggests that individual variation accounts for most of the variance. The above factors, as financial liquidity predictors, are also significant in the fixed-effects ordered logistic regression models (*fe models*).

Note that in 2018 there was a very weak, positive, and significant (p-value 0.05) correlation between the dynamics of students and the *size* of the unit (correlation coefficient $r = 0.1511$). Moreover, the *size* of the unit was positively and significantly correlated with the dynamics of the population between 2018 and 2020 ($r = 0.3603$ in 2018, $r = 0.3319$ in 2019, $r = 0.3090$ in 2020).

Table 8

Determinants of the liquidity level of counties in Poland between 2018-2020 – panel data models

Variable	Model 1		Model 2		Model 3	
	re model	*fe model*	*re model*	*fe model*	*re model*	*fe model*
Current balance	0.1226*** (0.0227)	0.0738*** (0.0279)	0.1054*** (0.0230)	0.0598** (0.0279)	0.0947*** (0.0229)	0.0705** (0.0292)
Own revenues	-	-	0.0725*** (0.0164)	0.0749*** (0.0208)	0.0796*** (0.0170)	0.1012*** (0.0266)
Students	-	-	-	-	-1.7152*** (0.3292)	-1.5039* (0.8305)
Wald test	[<0.0001]	[0.0081]	[<0.0001]	[0.0001]	[<0.0001]	[0.0001]
AIC	2,099.590	531.328	2,081.113	517.421	2,054.439	512.134
BIC	2,123.830	535.928	2,110.201	526.621	2,088.375	525.934
P	0.7696	-	0.7738	-	0.7679	-
LR test: *re* vs. *ologi*t	[<0.0001]	-	[<0.0001]	-	[<0.0001]	-
VIF min-max	-		1.08-1.08		1.11-1.18	

Note: 1) ***, ** and * denotes statistical significance at 1%, 5% and 10% levels respectively; 2) standard errors are presented in parenthesis; 3) results of statistical tests reported as p-value.

Source: own study.

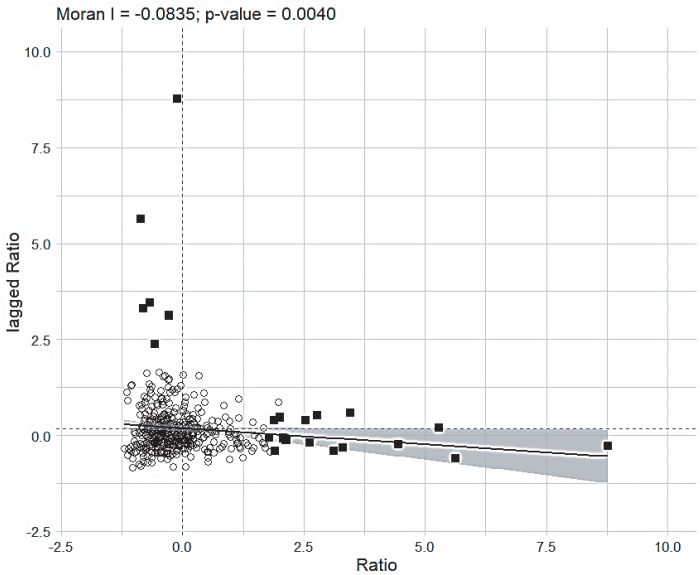

Fig. 2. Moran's *I* scatterplot for the average ratio of cash to short-term liabilities and special funds in counties in Poland, 2018-2020

Source: own study.

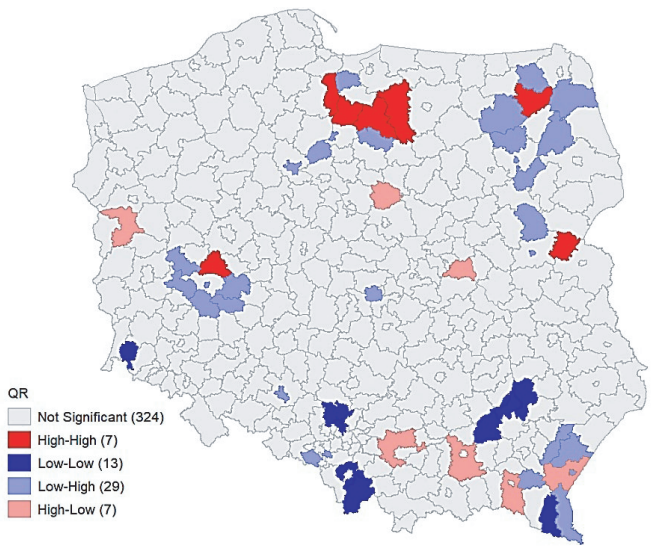

Fig. 3. LISA cluster map for the average ratio of cash to short-term liabilities and special funds (QR) in counties in Poland, 2018-2020

Note: number of the units in the parentheses.

Source: own study.

As far as the spatial correlation of the liquidity of the counties between 2018 and 2020 is concerned, the estimation of Moran's *I* (Figure 2) showed a very weak negative -0.0835 but a significant relation (*p*-value 0.0040). Hence, 'neighbours' are the units with different values of the cash to short-term liabilities and special funds.

According to the LISA cluster map for the *QR* (three years' average) (Figure 3) only in 29 'low-high' cases and 7 'high-low' ones was there a negative spatial correlation on the financial liquidity ratio. In the northern part of Poland, four counties formed a cluster, in which entities with prominent levels of the three years average quick ratio (*QR*) were accompanied by entities also with high levels of this indicator. However, as was mentioned, in most of the significant cases there were units with the low ratio surrounded by counties with the high liquidity ratio.

Discussion and conclusions

The above considerations and the empirical results show that the level of financial liquidity of the examined LGs is affected both by internal and external factors, which have a financial, economic and social nature. Primarily, local authorities should ensure a balanced position in the operating part of their budget. Thus, the greater the operating surplus (the positive difference between current revenues and current expenditure), the more favourable the odds for a better level of financial liquidity appear. In addition, to improve financial liquidity it is crucial to increase the share of own revenues in the total. Hence, both hypothesis H1 and hypothesis H2 were confirmed. These outcomes are also in line with the aforementioned study of Gore (2009, p. 195), who showed that units with more state funding tend to hold less cash. Therefore, it is important to increase the fiscal efficiency of the taxes as well as limit the growth of current spending. Local authorities and policymakers should be aware that liquidity is significantly affected by the financial autonomy of these units. This fact ought to be included in the strategic planning at local level and the legislative processes at central level. It is important to stem an increase of fixed costs, especially the share of personnel expenditures in current expenditures, to achieve a better liquidity position. The estimation of the logistic regressions revealed that in some cases the size of the unit determines its level of financial liquidity, which is consistent with the other findings in the public and business finances. Thus, larger units can hold less cash, which relates to the findings of Hoque et al., (2022, p. 614) and Gore (2009, p. 195), who applied a different variable (the population) as a proxy of the 'size effect' and revealed the same relations. This may result from the better fiscal efficiency of larger units influencing higher fiscal autonomy, and the range of public tasks or the internal organizational processes of finance management, which are aimed at optimising the cash holdings. Hence, small units can maintain a higher liquidity level due to precautionary motives. In some years, the debt burden might

affect the lower probability for a better liquidity level – in Poland this concerned the election year and the year of the outbreak of the COVID-19 pandemic; therefore, LGs may experience liquidity problems during this kind of situations.

As far as the external factors are concerned, the demographic structure determines the liquidity position of LGs, which affects the level and the scope of their public tasks and expenditures. In the counties, in which the proportion of expenditure on education is large, the greater the number of secondary school students in the population, the worse the odds for the higher liquidity level. Thus, hypothesis 3 (H3) was also confirmed. The increasing number of students may cause, as already mentioned, an uneven increase in the costs of their education due to organizational conditions and is strongly correlated with the expenditures on education. On the other hand, there are high numbers of the students in the large-sized units, which might result from their greater urbanisation, which in turn, determines the level of their financial autonomy and the tax capacity. Thus, these units maintain relatively less cash holdings due to constant budget inflows and the larger range of public needs. The level of financial liquidity is also associated with the development of the local infrastructure, especially the road network, which requires significant financial outlays. Hence, the estimation confirmed the comment by Swianiewicz (2021) that an extensive road infrastructure puts pressure on the authorities to secure their operational expenditures and their funds for its maintenance, therefore the above factors should be included in the process of financial planning. However, the scope of the liquidity predictors and their influence can change, which requires constant monitoring. In addition, there are individual factors, specific to each entity, that affect its financial liquidity.

The findings showed that in Poland in the counties there was a very weak, negative spatial correlation of the liquidity in the analysed period, which results in the confirmation of hypothesis 4 (H4). In most of the significant cases, as was demonstrated, there were units with a low liquidity ratio surrounded by entities with a high liquidity ratio. The negative values of the LISA statistics indicate that there were different patterns, i.e. ‘low-high’ and ‘high-low’, among the LGs in the field of the liquidity position, hence these indicators revealed the phenomenon of ‘outliers’ in the context of liquidity. Nevertheless, there are no sizeable associations between these units in the field of their financial liquidity – as a result, there is not a significant spillover effect of the liquidity problems at local level.

To sum up, at local public level, both internal and external factors determine the liquidity position of LGs. There are significant financial, economic and social predictors which should be included in the cash flow predictions. Additionally, in some cases there are spatial relationships concerning liquidity. The proximity of units may affect their financial position. This aspect of local finances is thus affected by the specific characteristic of each unit and its functioning in the spatial structure.

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