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RELATIONSHIP BETWEEN FISCAL SUSTAINABILITY AND EFFICIENCY: EVIDENCE FROM LARGE CITIES IN POLAND

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ABSTRACT. Fiscal sustainability should be defined in the relation between public finances and sustainable economy. It requires a fiscal policy aimed not only at a fiscal balance, but also at the well-being of future generations, while taking the economic, social, environmental and institutional dimensions into account. The objective of this paper is to examine the relationship between fiscal sustainability and efficiency on the example of large cities in Poland in the period from 2008 to 2019. In order to obtain empirical results, a data envelopment analysis and panel data analysis were applied, and a fiscal sustainability index was constructed by means of a multidimensional approach. Based on a sample of 66 large cities in Poland, the results showed that there is a negative relationship between fiscal sustainability and efficiency. These results, however, relate to a specific period in the history of Polish cities when the local debt limits were tightened. The improvement in efficiency allowed local government units to allocate saved local expenditures to the partial repayment of previously incurred local debts. By doing so, Polish cities fulfilled tightened fiscal rules, but their service-level solvency decreased.

JEL Classification: H70, H72

Keywords: fiscal sustainability, local government, panel data analysis, data envelopment analysis

Introduction

The idea of 'sustainability' has attracted the attention of many economists since the moment modern economic ideas were created. This term is used in practically every scientific field and discipline, also in the area of economy and sociology, but even here it is not understood uniformly and is defined in different ways, depending on the research perspective (micro and macro, short and long term, static and dynamic, positive and normative, etc.).

Growing interest in the topic of fiscal sustainability appeared in the last twenty years of the 20th Century and in the period of the Great Recession. The crisis resulted in a significant growth in the public debt in many countries. All this increased the doubts as to whether public authorities are able to fulfil their tasks effectively while maintaining the long-term ability to meet financial obligations and stimulate economic growth.

Until recently researchers and practitioners were mostly occupied by the fiscal sustainability of general government, without breaking it down into individual subsystems,

including the local government units (LGUs). However, increasing financial dependencies between local and central authorities, as well as the specific institutional and fiscal conditions in which municipalities operate, have shown the importance of fiscal sustainability at the local level. LGUs are the most important suppliers of public services and have become the main drivers of sustainable development. It is confirmed by Agenda 21 (1992), which was adopted at the UN World Summit on Environment and Development (UN 1992) and is demonstrated in EU regional policy, which directs most structural funds to the regions and lower administrative levels.

Maintaining fiscal sustainability after the Great Recession has also become a challenge for local government units in Poland. The Polish public administration is based on a three-level structure: regional, intermediate and municipal. The regional level, with its 16 voivodeships (regions, provinces), was created by the Act on Voivodeship Self-Government, dated 5 June 1998. The intermediate level is made up of powiats (counties), which were abolished in 1975 and re-established in 1999. Nowadays, there are 314 counties (powiats). An average county in Poland has about 85,000 residents and covers the territory of about eight municipalities. Gminas (municipalities), re-established in 1990, are divided into three categories: urban municipalities, rural municipalities and mixed municipalities. Since 1998-1999, a group of 66 of the largest cities has been given the status of urban municipalities with county rights.

The LGUs in Poland are obliged to perform many crucial public tasks, e.g. education, social aid or healthcare. Moreover, the scope of local governments' competences is constantly being extended to include the most problematic and cost-intensive public tasks, without providing sufficient financial resources. Local governments have been assigned fiscally ineffective own revenues, comprised of just a few taxes, mostly of an obsolete and inflexible nature, based on the ad valorem tax base. The only source of tax revenues of the counties and regions are income tax shares, which are in fact 'flawed own revenues' characterized by the lack of local tax autonomy. Therefore, the local finance system in Poland is mostly based on transfers (in the form of grants and subsidies) from the central budget (Bury and Bury, 2008). Nevertheless, LGUs in Poland continue to be the most important investor in the public sector. Their investments constitute a driving force of the Polish economy and one of the key sources of gross domestic product (GDP) growth. Unfortunately, the lack of efficient sources of own revenues, the growing number of local government tasks, as well as the constant increase in

local government investments, have caused an increase in the subnational government debt in Poland, which in 2019 accounted for a little over 7% of the national public debt.

The financial troubles of the LGUs in Poland have intensified during the COVID-19 pandemic, which has once again drawn attention to the issue of fiscal sustainability. Local governments have been one of primary respondents in the fight against the COVID-19 disease. They have faced with an increase in demand for public services, but the stay-at-home orders issued to flatten the curve of the COVID-19 and the economic downturn associated with the virus have threatened the financial capacity of local governments to remain solvent and continue their response. Although it is too early to know the full extent of the impact of a pandemic on local government finances, some evidence indicates that many cities are currently facing severe fiscal pressure from the virus. Therefore, the question of how to maintain fiscal sustainability under the conditions of increasing public expenditure and falling tax revenues is still valid

Despite the growing significance of fiscal sustainability, researchers do not fully agree on the methods and tools to achieve it. The matter is not made easier by the age-old dispute between (neo) Keynesians and the classics (and neoclassics), focused on views of macroeconomic balance, market self-regulation and the state intervention in the economy. One of the solutions often proposed by policymakers is simply minimizing municipal outlays

in order to force local authorities to improve their operational efficiency and thereby enhance their fiscal sustainability (Kuhlmann & Bouckaert, 2016). This is based on the quite intuitive presumption that improving the efficiency of local government will result in a more financially sustainable sector. Some researchers also take this relationship for granted. However, as Drew *et al.* (2016) advocate, there are at least several reasons why municipal efficiency may not be associated with fiscal sustainability: 1) past performance may affect fiscal sustainability, demographic factors may impact financial sustainability, independent of municipal efficiency, 2) the size of infrastructure stock may also explain the lack of association between the efficiency and fiscal health of LGUs; and there are also 3) exogenous determinants, such as climatic and ecological factors, which cannot be controlled by the LGUs but affect fiscal sustainability.

Therefore, the relationship between fiscal the sustainability and efficiency of LGUs is worth empirical testing, which may be relevant for both scholars and policymakers. This research proceeds by using a sample of Polish 66 large cities in the period from 2008 to 2019. In addition, to better explain this relationship and to reflect the multidimensional nature of fiscal sustainability, eight partially indexed scores regarding fiscal sustainability were analyzed during the empirical analysis by applying a panel data analysis. Moreover, two control variables for the assessment of smart cities were taken into account, i.e. EU funds per capita and non-profit organizations per 10,000 inhabitants.

The contribution of the paper is threefold. First, the efficiency scores of LGUs, i.e. 66 large cities, were calculated by applying a data envelopment analysis (DEA). In the second stage, the fiscal sustainability index by means of a multidimensional approach was constructed. Third, the model was evaluated to estimate the relationship between the fiscal sustainability and efficiency of LGUs, i.e. of 66 large cities, from 2008 to 2019 by applying a panel data analysis and using control variables.

The paper consists of the following parts. After a brief introduction, Section 1 contains a theoretical framework and literature review about the fiscal sustainability and efficiency of local governments. Section 2 outlines the data and methodology and explains the model. Section 3 consists of the empirical results. The final section presents the discussion, conclusion and recommendations for further research.

1. Theoretical background and literature review

The topic of fiscal sustainability and efficiency has in recent years attracted growing interest in research studies. Broadly speaking, fiscal sustainability refers to the relationships that exist between public finances and a sustainable economy. It is connected to multidimensional factors, such as financial, environmental and educational factors, as well as to a new stage of urbanisation known as smart city creation. The concept of a smart city development strategy lies within the domain of local authorities in Poland. Based on research by Sikora-Fernandez (2018) based on a case of 16 Polish cities, the highest potential for transforming into a smart city was recorded in Warsaw, Wroclaw and Opole for the year 2016. An essential factor in the sustainability of a smart city is smart governance (Bogdanov et al., 2019). Stanković et al. (2017) consider that the position of cities as units of local government is very important, and this is the first step to identify priorities in urban development strategies.

In the context of the recent economic and financial crisis, the significant increase in public debt in most countries has raised concerns about the ability of public authorities to effectively provide public services while maintaining short and long-term financial solvency. However, only a few research studies have examined the relationship between the fiscal sustainability and efficiency of local government units. In most research, only the efficiency

(Athanassopous and Triantis, 1998; Afonso and Scaglioni, 2005; Loikkanen and Susiluoto, 2005; De Borger and Naper, 2006; Afonso and Fernandes, 2008; Drew et al., 2015) or fiscal sustainability of the local government sector (Levine et al., 1981; Kloha et al., 2005; Chapman, 2008; Zafra-Gómez et al., 2009a; Navarro-Galera et al., 2016; Yoshida, 2020; Manasan, 2020) was examined. Skica et al. (2019) examined the efficiency of Polish municipalities by using a DEA. The analysis covered 2,044 Polish municipalities (urban, urban-rural and rural), based on 25 inputs and 14 outputs for the year 2016. The results showed that 85 per cent of the municipalities studied were efficient, while 15 per cent were inefficient. Among the inefficient municipalities, 45 per cent of the units are rural-urban, 39 per cent rural and 46 per cent urban. Based on the case of Croatia, Hodžić and Muharemović (2019) examined the efficiency scores for 20 counties in the 2009-2016 period by using a DEA, as well as the relationship between efficiency scores and exogenous determinants. The results showed that, among the exogenous determinants, such as population, population density, average registered unemployment rate, average annual wage for full-time jobs, expenditures for financial assets and debts, grant funding and county roads, only the annual registered unemployed rate and annual average wage for full-time jobs are statistically significant. Based on a case of 353 Finnish municipalities in the 1994-2002 period, Loikkanen and Susiluoto (2005) observed cost efficiency by using a data envelopment analysis for ensuring the general welfare and quality of public services, such as education, healthcare, culture and service activities. According to the results, there are differences in the efficiency scores among the municipalities. Moreover, the most efficient municipalities are based in south part of Finland, while the most inefficient ones are in the north. Afonso and Fernandes (2008) examined the efficiency of public spending based on a case of 278 Portuguese municipalities by using a DEA. For the input variable, they used a composite indicator of local government authority, which takes into account all municipality services provided by the local government. That composite indicator consists of national sub-indicators, such as education, cultural services, social protection, road infrastructure and waste management services.

An exception is research by Drew et al. (2016), where they found that there are positive associations between financial sustainability measures and municipal efficiency in New South Wales municipalities. In their research they measured the efficiency of municipalities by using a DEA with input and output variables. For the input variables, they used the number of staff in full-time equivalent units and material and other expenses, while the number of businesses, number of households, total length of roads and number of individuals were used for the output variables. In the second part of their research, the relationship between efficiency scores and financial sustainability ratios was examined by means of a regression analysis. A statistically positive significant relationship was recorded at an unrestricted current ratio and capital expenditure ratio, while negative statistical relationship was recorded by own source revenue ratio, the interest cover ratio and the debt service cover ratio.

Although, there are numerous definitions of the financial or fiscal sustainability of local governments, the South Australian Financial Sustainability Review Board (FRSB, 2005, p. 10) defines financial sustainability in local government as follows: "a council's long-term financial performance and position is sustainable where there is a continuation of the council's present spending and funding policies; developments in the council's revenue-raising capacity and the demand for and costs of its services and infrastructure and normal financial risks and financial shocks". According to the International Public Sector Accounting Standards Board (2011, p. 5), fiscal sustainability is "the ability of an entity to meet service delivery and fiscal commitments both now and in the future". Wójtowicz (2019) examined the impact of economic and social factors on the fiscal sustainability of 241 urban municipalities

in Poland in the 2004–2016 period. The economic and social factors, such as operating budget performance per capita, public debt per capita, company concentration, new-registered company concentration, unemployment, gross domestic product per capita, beneficiaries of social assistance benefits, dependent population at pre-working age, dependent population at post-working age, net migration and population density, were tested in a panel data analysis. The dependent variable was the fiscal sustainability of local government units. The results showed that most of the variables had a negative impact on local fiscal performance.

Based on an analyzed literature review, most research applied a DEA when evaluating the efficiency of local government, while a panel data analysis was utilized for the evaluation of the relationship between efficiency and fiscal sustainability (Drew et al., 2016). Following the model of Drew et al. (2016), this was the starting point for the evaluation of the relationship between the efficiency and fiscal sustainability of LGUs in Poland.

2. Methodological approach and data

The sample is a balanced panel composed of 66 Polish urban municipalities with county status during the 2008 – 2019 period, resulting in 792 observations. These are all the largest cities in Poland with a population (with some exceptions) of more than 50,000 inhabitants. They bear both municipal and county responsibilities. The reason for choosing this type of LGUs as research objects is that they are quite homogeneous, especially in terms of population and the size of infrastructure stock. This corresponds to one of the main DEA assumptions, which requires that the homogeneity of units be compared (Dyson *et al.*, 2001). In comparison with other LGUs, large cities with county status have relatively high financial autonomy to manage their expenditures and revenues in order to achieve fiscal sustainability by counteracting and offsetting cyclical impulses or stimulating local economic development. These LGUs perform a wide range of the most important public services (education, social services, public healthcare, utilities: water supply, sewerage and waste management, infrastructure: roads and public transport, municipal housing, environmental protection or job creation) that directly affect their financial performance, mainly through public spending. Therefore, it is interesting to determine whether there is a relationship between fiscal sustainability and efficiency in these territorial units.

The concept of fiscal sustainability is complex and multidimensional. For the purpose of this research, a very broad definition of fiscal sustainability, determined in the context of the relation between public finance and sustainable economy, was adopted. It requires a fiscal policy aimed at the well-being of future generations, yet maintains the solvency of public authorities, takes into account not just strictly financial goals, but also the economic, social, environmental and institutional levels, leading to sustainable development which covers them all. Fiscal sustainability is very difficult to measure because it is not directly observable (Bisogno *et al.*, 2017). There are many different methods for evaluating the fiscal sustainability of local government units. The diversity of views is primarily caused by various research purposes and different data availability. In general, there are two main approaches. The first one is to use many separate financial indicators (Hendrick, 2004). The second approach is to use a composite Fiscal Sustainability Index (FSI), by means of which it is possible to measure the level of a financial situation and classify LGUs in their respective categories. This variable was used in this paper as the dependent variable. All the data were taken from the financial statements of local budgets.

For the purpose of this paper, a slightly adjusted and extended approach has been used, as proposed by Zafra-Gómez *et al.* (2009a) and modified by Bisogno *et al.* (2017), which is combined with the solvency orientation contained in the seminal paper by Groves *et al.* (1981) and developed by Berne (1992), Nollenberger *et al.* (2003); Honadle *et al.* (2004);

Wang *et al.* (2007) and Levine *et al.* (2013). Therefore, fiscal sustainability is represented by *cash solvency* (i.e. the capacity to generate cash to fulfil short-term obligations), *budgetary solvency* (i.e. the ability of local governments to generate adequate public revenues for the public tasks performed and to cover their financial obligations which arise during a given budgetary year), *service-level solvency* (to maintain the quality and quantity which ensure meeting the needs of the inhabitants at present and in the future) and *long-term solvency* (the ability to pay long-term financial obligations in a timely manner). As part of budgetary solvency, additional criteria were identified, such as*: sustainability, flexibility* and *invulnerability/resilience* (CICA 1997, 2009; Zafra-Gómez *et al.* (2009a, 2009b); Levine *et al.* (2013); Cuadrado-Ballesteros and Bisogno, 2018). Sustainability expresses the current ability of the local government to maintain the well-being of its citizens with the resources available. Flexibility reflects the ability to adapt to economic and financial changes by adjusting revenues, expenditures or the debt level (IPSASB, 2013). In this research, the criterion of invulnerability/resilience (meaning the extent of independency from external finance resources) has been replaced by *fiscal autonomy* (expressed by a high share of one's own revenues). Furthermore, to measure the fiscal sustainability, it is necessary to remember that this concept has its origins in the economy of sustainable development. For this reason, another criterion for assessing the fiscal sustainability of LGUs should be the ability to support the *municipal sustainable growth* and to counteract cyclical fluctuations in economic activity (Schick, 2005). Although the fiscal federalism theory argues local government should not be assigned responsibility for macroeconomic stabilization because of the lack of important macroeconomic management tools (e.g., monetary and exchange rate instruments), the observed contradictions between the central and local governments' economic interests as well as the higher public investment activity of municipalities, compared to that of the central authorities, are arguments for including the economic growth criterion in the analysis of the fiscal sustainability of LGUs (Carmeli, 2002).The last considered dimension of local fiscal sustainability is *intergenerational equity*. Sustainability requires that equity be respected over time. It must not compromise the ability of future generations to meet their needs (Dollery and Grant, 2011).

Table 1 summarizes the different indicators chosen and provides a short description and justification for the respective selection.

Table 1. Definitions and measures of fiscal sustainability

Denotation	Indicator	Definition	Justification for inclusion in the model	Link with fiscal sustainability
			CASH SOLVENCY	
CS	Cash solvency ratio	Budgetary revenues, budgetary proceeds and receivables divided by budgetary expenditures, outlays and liabilities	The cash solvency ratio on an accrual basis includes not only executed revenues and proceeds, but also those that will potentially fund (burden) the budget in the short-term (short-term receivables and liabilities). The inclusion of this indicator is particularly important when there are difficulties in settling short-term obligations.	+
			FLEXIBILIY	

F	Debt service capacity (flexibility) ratios	Annual repayments of loan principal and interest expenditures divided by total budgetary revenues	A high ratio suggests the "rigidity" of local budgets, which is the consequence of a high debt repayments and servicing.	-
			FISCAL AUTONOMY	
FA	Fiscal autonomy ratio	One's own revenues divided by the total budgetary revenues	This is the most popular indicator used to measure fiscal autonomy. Local governments have the ability to set the rates determining their local own revenues and can therefore determine the amount of revenue they raise and the level of expenditures that they finance.	+
			SUSTAINABILITY	
S	Sustainability ratio	Current budgetary revenues divided by current budgetary expenditures	Values exceeding 1 may suggest the sustainability of fiscal policy because the budget revenues collected in a cyclical manner (i.e. current revenues) fully cover the costs of local public services and at the same time the requirements of creditors are met without incurring new debt.	+
			SERVICE-LEVEL SOLVENCY	
S-LS	Service-level solvency ratio	Current budgetary expenditures per capita	This indicator provides information about the amounts allocated to the most important local public services, like education. Its higher values testify to high educational needs (associated with a large number of students). This is the case of cities investing in education by building, modernizing or renovating schools, employing teachers with higher qualifications or purchasing teaching aids.	+
			LONG-TERM SOLVENCY	
L-TS	Long-term solvency ratio	Total liabilities divided by total budgetary revenues	A high ratio suggests a local government is overly reliant on debt for financing its needs.	-
			ECONOMIC GROWTH	
EG	Capital expenditures ratio	Capital expenditures divided by total budgetary expenditures	A high ratio suggests a government is investing in its capital assets. Low levels of the ratio occur in those LGUs that allocate significant amounts to current tasks. This may reduce the revenues capacity in the future.	+
			INTERGENERATIONAL EQUITY	
EI	Operating surplus ratio	Operating surplus per capita	A high ratio suggests that the local government has the capabilities to generate sufficient cash to finance its operating activity in the future without relying on outside financing sources.	+

Source: *own compilation*

To create the composite FSI, the aggregation process proposed by Zafra-Gómez *et al.* (2009a) and updated by Bisogno *et al.* (2017) was used. Firstly, for each of the eight

indicators listed above, the corresponding 25th, 50th and 75th percentiles were calculated by using the values obtained as cut-off points in order to establish criteria for classification. Secondly, score were assigned, depending on whether the value of each ratio is higher or lower than the aforementioned percentiles. For ratios that are positively correlated with fiscal sustainability (i. e. CS, FA, S, S-LS, EG, EI), 1.0 point was assigned to those cities in which such ratios were higher than the 75th percentile, 0.5 points if the value was between the 50th and 75th percentiles, 0.25 points if the value was between the 25th and 50th percentiles and 0.0 points if the value was lower than the 25th percentile. In the case of indicators negatively correlated with fiscal sustainability (F and L-TS), 0.0 points were assigned for values exceeding the 75th percentile, 0.25 points for values between the 50th and 75th percentiles, 0.5 points for values between the 25th and 50th percentiles and 1.0 for values lower than the 25th percentile. To obtain an aggregate FSI for each city, the points obtained for each of the eight partial indicators in each year were added. Each city could achieve a maximum of 8.0 points. A higher level of FSI indicates the better fiscal sustainability of the city.

Following economic theory, DEA and Free Disposal Hull are nonparametric methods. In 1957, Farrell laid down the foundations of DEA, which was later developed by Charnes *et al.* (1978). The first model, the model of Charnes *et al*. (CCR) (1978), measures efficiency under the assumption of constant returns to scale, which was later extended by Banker *et al*. (BCC) (1984) to allow variable returns to scale. The purpose of DEA within these two models is to measure the efficiency and productivity of decision-making units (DMUs) within a set of comparable decision-makers. According to the theory, the DMU is relatively efficient if the input-oriented optimal solution or the output-oriented optimal solution is equal to 1.

To obtain empirical results, the efficiency scores of the CCR and BCC models were used as independent variables. The results are presented in Appendices 1 and 2. All the data were taken from reports on budget execution by local government units collected by the Polish Ministry of Finance (MF). The list of variables used in the DEA analysis for both models is presented in *Table 2*.

Taking into account that many previous studies have shown that economic and demographic factors have a significant effect on fiscal sustainability, five control variables were selected as factors that may influence the level of fiscal sustainability in the local governments under study. These are (1) GDP per capita (GDP_pc); (2) unemployment (UN) and (3) net migration (NM), (4) non-profit organizations per 10,000 inhabitants (Nonprf) and (5) EU funds per capita (EUfunds).

Table 2. List of variables and definitions

INPUTS		
Variable	**Definition**	**Source**
Wages and salaries	Current expenditure, resulting from wages and salaries, incl. social security contributions	Reports on budget execution by LGUs – MF
Materials and services	Current expenditure on purchase of materials and services	Reports on budget execution by LGUs – MF
Borrowing	Expenditure on public debt servicing	Reports on budget execution by LGUs – MF
Investment property	Investment property expenditure	Reports on budget execution by LGUs – MF
OUTPUTS		
Population	Number of inhabitants	Local Database of the Central Statistical Office (BDL GUS)

Business	Number of business entities registered in the REGON (Polish Business Registry)	Local Database of the Central Statistical Office (BDL GUS)
Schools	Number of schools for children, youth, and adults	Local Database of the Central Statistical Office (BDL GUS)
Roads	Total length of roads (in km)	Local Database of the Central Statistical Office (BDL GUS)
Municipal wastewater	Municipal wastewater discharged (in cubic decimetres)	Local Database of the Central Statistical Office (BDL GUS)
Social welfare	Number of stationary social welfare facilities	Local Database of the Central Statistical Office (BDL GUS)
Social premises	Number of social premises	Local Database of the Central Statistical Office (BDL GUS)

Source: *own compilation*

Prior research has concluded that the GDP is positively related to tax revenues. However, the GDP may have a negative impact on public debt. Therefore, the GDP could influence fiscal sustainability, but it is not clear if that variable is a driver or a risk factor (Rodríguez Bolívar et al., 2016).

Unemployment plays a negative role regarding fiscal sustainability because higher levels of unemployment would lead to LGUs having a greater need for financial resources, and therefore to becoming more indebted (Zafra-Gómez et al., 2009b).

Net migration may affect local fiscal sustainability as immigrants can influence the level of public debt through a greater demand for public service (Zafra-Gómez et al., 2009b). On the other hand, the more inhabitants, the wider the economic base and potentially higher tax revenues of the LGUs.

In addition to the above, previous studies have concluded that the level of the so-called "smartness" (organizational and human resources; capabilities; goals) may affect the fiscal sustainability of LGUs (Wällstedt et al., 2014). Smart cities have a high quality of life; pursue sustainable economic development through investments in human and social capital, as well as in traditional and modern communications infrastructure (transport and information communication technology); and manage natural resources through participatory policies (Thuzar, 2011). Therefore, two additional control variables for the smart city assessment have been taken into account: EU funds per capita (EUfunds) and non-profit organizations per 10,000 inhabitants (Nonprf). The first variable reflects the ability of local authorities to apply for grants successfully, which is a manifestation of the administrative skills, efficiency of management, transparency and compliance with procedures as well as effectiveness of control and monitoring. The number of non-profit organization shows the ability of cities to deal with market failures. The power of NGOs, civic organization and community centers consists in their effective co-creation of economic, cultural, social and sport environments, and their special influence on strategic development questions and public affairs.

In order to examine the statistical relationship between fiscal sustainability and efficiency in 66 large Polish cities in the 2008 - 2019 period, we empirically tested the two following models:

$$FSI_{it} = \beta_0 + \beta_1 BBC_{it} + \beta_2 GDPpc_{it} + \beta_3 UN_{it} + \beta_4 NM_{it} + +\beta_5 EUfund_{it} + \beta_6 Nonprf_{it} + +\eta_i + \varepsilon_{it} \quad (1)$$

$$FSI_{it} = \beta_0 + \beta_1 CCR_{it} + \beta_2 GDPpc_{it} + \beta_3 UN_{it} + \beta_4 NM_{it} + \beta_5 EUfund_{it} + \beta_6 Nonprf_{it} + \eta_i + \varepsilon_{it} \quad (2)$$

where *i* is the ith urban municipality and *t* is the time (year), η_i - refers to unobservable heterogeneity (a particular characteristic of the cities that are invariant over time), εt is the disturbance term and other variables entered into the model are those previously defined.

To better explain this relationship, we have also analysed the association between our eight partial indexes of fiscal sustainability (i.e.: *I_ Cashslv, I_ Flx, I_ Fiscaut, I_Sust ,I_Srvslv, I_ Lgtslv , I_Ecgr , I_, Inteq*) and BCC and CCR efficiency scores have been also anayzed.

To estimate our two models, the dynamic panel estimator proposed by using the dynamic system generalized method of moments (SGMM) estimator (Arellano and Bover, 1995) was applied. This estimator makes it possible to control the possible endogeneity between the variables and the error term as well as heteroscedascity and serial correlation problems. The SGMM estimator uses the lagged levels of independent and control variables as instruments, which are uncorrelated with the error term. The most appropriate instruments are the closest lags, since the furthest cannot contain information on the current value of the variables. The closest lags are *t-1* and *t* for endogenous and pre-determined variables. The validity of the instruments is tested by using the Arellano-Bond test for AR(2) in first difference. The Sargan test of over-identification restrictions was abandoned, because a robust estimator of variance (vce robust) was used. In this situation, over-identifying restrictions are valid.

3. Results

The results of the two empirical models are presented in *Tables 3* and *4*. In the first model (1), the BCC efficiency score (with increasing returns to scale) impacts negatively on FSI (β = -1.1924, p<0.1). It suggests that a 1% increase in the BCC indicator will lead to a -1.19% decrease in the composite index of fiscal sustainability. This would be consistent with evidence from Bisogno *et al.* (2017) who proved that LGUs that are more efficient in providing public service tended to have the lowest financial health.

However, the explanation of this negative relationship requires an in-depth analysis of the relationships between the BCC and the partial indicators of the FSI. By observing *Table 3*, statistically significant associations between the BCC efficiency scores and the following indices were observed: *I_Cashslv* (β= -0.4334, p<0.1), *I_Flxb* (β= -0.7657, p<0.01), *I_Srvslv* (β= -0.0675, p<0.1), I_Fiscaut (β= 0.3752, p<0.05) and I_Lgtslv (β= 0.5268, p<0.05).

Table 3. The association between aggregate FSI (and partial indicators) and BCC efficiency score

Variables	FSI	I_Cashslv	I_Flxb	I_Fiscaut	I_Sust	I_Srvslv	I_Lgtslv	I_Ecgr	I_Inteq
BCC	-1.1924*	-0.4334*	-0.7657***	0.3752**	-0.0386	-0.0675*	0.5268**	-0.8350	-0.0802
GDP_pc	-0.0001	-0.0001	0.0001	-0.0001*	-0.0001	0.0001**	-0.0001	-0.0001	-0.0001
UN	0.0001	-0.0001	-0.0001	0.0001	0.0001	0.0002	-0.0001	0.0001	-0.0005**
NetM	0.0023*	0.0004	-0.0010	-0.0007	0.0009	-0.0013*	0.0018**	0.0003	0.0003
Nonprf	-0.0064	0.0281	-0.1692***	0.0758	0.0643	-0.1171**	0.0714	0.0810	0.1182*
EUfunds	0.0004*	0.0001	0.0000	-0.0002**	0.0001	-0.0000	0.0001***	0.0003***	0.0001
_const	3.0522***	0.7205***	1.3789***	0.1614	0.1623	-0.0594	-0.3288	0.4996	0.0596

Arellano-Bond for zero autocorrelation in first difference errors	Pr >z = 0.0046	Pr >z = 0.0451	Pr >z = 0.1619	Pr >z = 0.0074	Pr >z = 0.0576	Pr >z = 0.0787	Pr >z = 0.0550	Pr >z = 0.4683	Pr >z = 0.0771

*WC -robuststandard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Source: *Authors' calculation*

The first negative relationship may at first appear confounding, because the improvement in efficiency is usually caused by a decrease in local public expenditure (inputs). The reduction of local expenses should, however, be associated with the growth of cash solvency, as these expenditures are a component of that ratio's denominator. However, one must remember that the counter of this indicator, in addition to budget revenues, also includes budgetary proceeds (such as credits and loans, securities and surpluses form previous years), as well as receivables, and the denominator, in addition to local expenditure, also includes budget outlays (representing repayment of credit and loans or redemption of securities, among others) and short-term liabilities. The negative relationship between efficiency and cash solvency may therefore result from the fact that more effective cities allocated a certain part of saved expenses to partial repayment of debts incurred earlier. This led to a relative deterioration of the cash solvency ratio in these LGUs against the background of other municipalities studied (due to an increase in one of the components of the liquidity ratio denominator, i.e. budgetary outlays). This conclusion seems to be supported by the next observed negative relationship between efficiency and budget flexibility (I_Flxb β = -0.7657, p <0.01). The increase in efficiency leads to a reduction in the share of repayments of loan principal and debt servicing costs in total revenues. This result coincides with previous findings that effective local governments devote more public funds to pay off their liabilities (Drew *et al.*, 2016).

This suggestion is also confirmed by a positive relationship between efficiency and long-term solvency (I_Lgtslv β = 0.5268, p <0.05), indicating that the higher the efficiency, the lower the municipality's debt in relation to its total revenues is. The BCC efficiency ratio presents negative relationships with service-level solvency (I_Srvslv β = -0.0675, p <0.1). Thus, the higher the efficiency, the lower the ability of local government units to maintain the adequate quantitative and qualitative level of public services desired by their inhabitants. Therefore, the restrictive fiscal policy pursued by large Polish cities in the research period led to an improvement in the efficiency and local public debt repayment, but it was achieved at the cost of weakening the service-level solvency. Therefore, fiscal sustainability means not only keeping local debt at a low level, but above all the ability of LGUs to continue to perform public tasks that meet the needs of the local community. In relation to the other partial indicators of fiscal sustainability, a statistically significant positive relationship between efficiency and fiscal autonomy (I_Fiscaut β = 0.3752, p <0.05) was indicated. This means that cities in which their own revenues constituted a significant part of total revenues were more inclined to allocate their resources effectively. This conclusion is consistent with the results obtained by other researchers (Drew *et al.*, 2016), which state that LGUs with low fiscal autonomy and strong dependence on fiscal transfer tend to have increases in expenditures disproportionate to increases in other revenues.

To sum it up, the negative relationship between the BCC efficiency score and the aggregated FSI is primarily a consequence of the fact that the increase in efficiency is accompanied by a decrease in the cash solvency ratio and budgetary flexibility, which is influenced by the observed tendency towards repayment of debts incurred by cities. Although this trend is positive for the long-term solvency of LGUs, it reduces their ability to fulfill their

tasks and public functions to residents efficiently. It should be further explained that the observed tendency to repay local governments' debts in Poland was mostly affected by the entry into force of new statutory debt limits in 2011-2014.

In the case of the second of the panel data models (2), the relationships observed in the first model were confirmed, although the statistical strength of these associations was slightly weaker.

Table 4. The association between aggregate FSI (and partial indicators) and CCR efficiency score

Variables	FSI	I_Cashslv	I_Flxb	I_Fiscaut	I_Sust	I_Srvslv	I_Lgtslv	I_Ecgr	I_Inteq
CCR	-1.2318**	-0.2333	-0.3483*	0.2002*	-0.2372	-0.0790**	0.2245*	-0.6479***	-0.1690
GDP_pc	-0.0001	-0.0001	0.0001*	-0.0001*	-0.0001	0.0001**	-0.0001	0.0001	-0.0001
UN	0.0006	-0.0001	-0.0001	0.0001	0.0001	0.0001	-0.0001	0.0001	0.0001**
NetM	0.0014*	-0.0001	-0.0003	0.0005	0.0007	-0.0014	0.0018**	-0.0005	-0.0002
Nonprf	0.0277	0.0288	-0.1715***	0.0743	0.0656	-0.1237	0.0776*	0.0951	0.1236*
EUfunds	0.0004**	0.0001	0.0007	-0.0002**	0.0000	-0.0001	0.0001***	0.0003***	0.0001
_const	2.7910***	0.5058***	0.9749	0.3718**	0.3261	-0.0694	-0.0622	0.2551	0.0968
Arelando-Bondfor zero autocorrelation in first difference errors	Pr >z = 0.0037	Pr >z = 0.0464	Pr >z = 0.1648	Pr >z = 0.0081	Pr >z = 0.0479	Pr >z = 0.0490	Pr >z = 0.0443	Pr >z = 0.3609	Pr >z = 0.0681

*WC -robuststandard errors in parentheses; * p<0.1; ** p<0.05; *** p<0.01
Source: *Authors' calculation*

The link between the CCR efficiency score (with constant returns to scale) and fiscal sustainability is also negative with a bit higher correlation coefficient (FSI β = -1.2318, p <0.05). Compared to the first model, the relationships between efficiency and cash solvency as well as long-term solvency turned out to be statistically insignificant. The CCR efficiency score presents a weaker statistically significant relationship with budgetary flexibility and fiscal autonomy, whereas the negative relationship between efficiency and service-level solvency turned out to be stronger than in Model (1). Moreover, the negative relation between efficiency and economic growth in Model (2) turned out to be statistically significant (I_Ecgr β = -0.6479, p <0.01). The last interaction indicates that reducing budgetary expenditure (leading to improved efficiency) not only causes a deterioration in the level of public service offered to citizens, but also weakens the future development capacities of cities, including the establishment of smart cities.

Regarding the observed relationships between the control variables and the aggregated FSI in both panel data models, the positive impact of net migration (NetM in Model 1: β = 0.0023, p <0.1; in Model 2: NetM β = 0.0014, p <0.1) and EU funds (in Model 1, EUfunds β = 0.0004, p <0.1; in Model 2 EUfunds β = 0.0004, p <0.05) on FSI should be emphasized. The population growth, and thus the increasing number of taxpayers, has a positive impact on long-term solvency, reducing the share of local government debt in budget revenues. However, the more citizens, the greater the expenses for public service delivery, and, consequently, the lower service-level solvency. On the other hand, EU funds translate into an improvement in the long-term budgetary solvency, allowing the reduction of pressure on

incurring new debts, as well as stimulating economic growth by providing financing for many local government investments.

Conclusion

The recent economic crises and acceleration of the local government debt growth in Poland have heightened the need to improve the allocation of resources and to limit public sector borrowing. This article aimed to investigate the relationships between two of the most important issues from the LGUs' point of view, i.e. fiscal sustainability and efficiency. Previous research studies have mainly focused on each issue individually. Authors like Drew *et al.* (2016); Cuadrado-Ballesteros and Bisogno (2018); Bisogno and Cuadrado-Ballesteros, (2018) and Prior *et al.* (2019) made the attempt to analyze the link between these two phenomena. However, only Drew *et al.* (2016) directly referred to efficiency and fiscal sustainability, while other authors only examined the efficiency or financial situation. Furthermore, these authors explored the relationship between efficiency and separate indicators reflecting various aspects of fiscal sustainability, rather than using the aggregate indicator. This prevented the assessment of the cumulative impact of efficiency on fiscal sustainability being included.

This article is the first attempt at evaluating the relationship between the efficiency and fiscal sustainability of 66 large cities in the 2008 – 2019 period. The empirical results of this analysis proved the negative relationship between fiscal sustainability and efficiency. This is due to the weakening of flexibility, the service-level solvency and the ability to support the economic development of local government units. However, these results relate to a specific period in the history of Polish cities, when the binding debt limits in Poland were tightened. The results confirm those obtained earlier by Bisogno and Cuadrado-Ballesteros (2018) in relation to Italian local government units. They showed that, in general, the more efficient LGUs are in providing public services, the worse their financial health is. This referred in particular to the efficiency regarding managing capital expenditures. Nevertheless, the current research proved this inverse association regarding both categories of expenditures, i.e. both current expenditures and investments. The findings on the positive relationship between efficiency and flexibility supports the observations obtained by Drew *et al.* (2016), who reported that efficient councils tend to make higher principal repayments, thus paying off their debt.

The novel aspect of this study is its innovative research procedure, which included three main stages. In the first stage, a nonparametric linear programming method for assessing the efficiency of decision-making units (DMUs), i.e. large cities, was applied. This made it possible to identify the most efficient units in a given set, without assuming any type of functional relationship between the input and output factors. In the second stage, by using the multidimensional comparative analysis, the synthetic FSI was constructed, which made it possible to assess it in individual Polish cities compared to their reference groups. The innovativeness of this research consisted in going beyond the standard indicators used for the evaluation of the financial situation of LGUs and extending the analysis to include measures related to aspects that are usually neglected, such as: budget sustainability and flexibility, service-level solvency or intergenerational equity. This attitude towards the issue matches the new, recently emerging paradigm of the science of economics and finance, i.e. sustainable public finance. In the third stage, by using the panel data analysis, the relationship between the efficiency and fiscal sustainability of large cities, together with other control variables, were estimated. The panel data models made it possible to obtain more accurate inference than cross-sectional models.

The theoretical arguments considered in previous research indicate that, in general, higher long-term solvency is positively associated with efficiency, due (at least in part) to the lower interest spending and higher efficiency resulting from decreased financial costs (Prior *et al.*, 2019). It was found that an increase in efficiency is associated with a decrease in the share of public debt in total budget revenues.

The implications drawn from the present study are clear and important from the standpoint of local government management and financing. In a context of more stringent fiscal rules, it should not be forgotten that the main function of local government is performing public functions in the quality and quantity which allows for the meeting of the needs of the inhabitants at present and in the future. Improvement of efficiency should not be obtained only thanks to savings in local government expenditures (inputs) at the same level of outputs (public service). One should strive to achieve higher outputs at a given input level and to improve the quantity and quality of outputs, all the more so as local public needs are constantly increasing. Limiting fiscal policy mainly to the unreflective paying off of old debts may threaten the sustainable development of the local community not only in fiscal, but primarily in economic, social, demographic and environmental dimensions. Moreover, this research clearly shows that, to increase the fiscal sustainability of LGUs in Poland, urban development strategies, including smart city strategies, are inevitable. In this study, the "smarter" cities are, the higher long-term solvency and economic growth capacities they have. According to Fineberg (2013), to maintain all relevant funding for local public service delivery, it is necessary to conduit the local strategic partnership.

These issues seem to be a key challenge, given that local governments must increase spending on programs and services in response to the COVID-19 outbreak, and the expectation that Poland may fall into recession as a result. In these adverse circumstances, when striving to maintain fiscal sustainability, there is a temptation to focus only on long-term solvency while other dimensions of sustainability are ignored. However, fiscal sustainability is expressed primarily in the ability of local authorities to provide public services, including the financing of COVID-19 related programs. The only response to fiscal pressure from the coronavirus pandemic seems to be greater involvement of the national government, which should strengthen cooperation with local authorities to ensure that their tasks are carried out.

However, since the analysis in this paper was limited to large Polish cities during a period of tightening of fiscal policy, future research should investigate the same question in other local government systems with reference to other socioeconomic contexts. More broadly, these results demonstrate the need for further research on the determinants of municipal financial sustainability.

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Appendices

Appendices 1. The results of BCC model

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Biała Podlaska	0,810	0,892	1,000	0,971	0,976	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Białystok	0,884	0,901	0,917	0,809	0,850	0,919	0,841	1,000	0,990	1,000	0,956	0,933
Bielsko-Biała	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Bydgoszcz	0,862	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Bytom	1,000	1,000	1,000	0,954	0,964	0,958	1,000	1,000	0,879	1,000	1,000	1,000
Chełm	0,981	0,829	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Chorzów	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Częstochowa	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Dąbrowa Górnicza	1,000	1,000	0,792	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,881	1,000
Elbląg	1,000	1,000	1,000	0,946	0,928	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Gdańsk	1,000	0,955	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Gdynia	0,883	1,000	0,855	1,000	0,927	0,843	0,886	0,950	1,000	0,906	0,860	0,877
Gliwice	1,000	1,000	0,875	0,956	0,961	0,881	0,902	0,885	0,888	0,897	1,000	0,796
Gorzów Wielkopolski	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,993	0,995	1,000	1,000
Grudziądz	0,990	0,851	0,921	1,000	0,919	0,900	0,960	0,966	1,000	1,000	1,000	1,000
Jastrzębie-Zdrój	1,000	1,000	0,924	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Jaworzno	0,785	0,669	0,720	0,906	0,930	0,869	0,997	0,849	0,851	0,869	1,000	1,000
Jelenia Góra	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Kalisz	0,764	0,718	0,907	0,986	1,000	0,946	0,966	0,952	0,965	0,959	0,823	0,827
Katowice	1,000	1,000	0,949	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,973
Kielce	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Konin	0,787	0,758	0,780	0,788	0,701	0,715	0,736	0,734	0,742	0,740	0,746	0,667
Koszalin	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,999	1,000
Kraków	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Krosno	0,767	0,722	0,758	0,848	0,866	0,884	1,000	0,944	0,994	0,951	1,000	1,000
Legnica	0,850	0,839	0,821	0,982	0,924	0,983	1,000	0,918	0,912	0,918	0,997	1,000
Leszno	0,786	0,813	0,948	1,000	0,913	1,000	1,000	1,000	1,000	1,000	0,785	0,756
Łódź	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Łomża	1,000	0,964	1,000	0,958	0,985	0,974	1,000	1,000	1,000	1,000	1,000	1,000
Lublin	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,839	1,000
Mysłowice	0,834	1,000	1,000	1,000	1,000	1,000	1,000	0,955	0,897	1,000	1,000	1,000
Nowy Sącz	0,937	0,856	1,000	1,000	1,000	1,000	1,000	0,967	1,000	1,000	1,000	1,000
Olsztyn	1,000	1,000	1,000	1,000	0,996	1,000	1,000	0,991	1,000	1,000	1,000	1,000

Opole	0,703	0,781	0,732	0,924	0,893	0,827	0,849	0,924	0,828	0,853	0,830	0,806
Ostrołęka	1,000	0,804	0,812	0,928	0,818	0,860	1,000	1,000	1,000	1,000	1,000	1,000
Piekary Śląskie	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Piotrków Trybunalski	0,977	1,000	0,854	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Płock	0,570	0,587	0,663	0,856	0,732	0,741	0,720	0,709	0,705	0,736	0,553	0,635
Poznań	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Przemyśl	1,000	1,000	1,000	1,000	1,000	0,856	0,955	0,892	1,000	1,000	0,957	1,000
Radom	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Ruda Śląska	0,884	0,886	1,000	1,000	1,000	1,000	0,935	0,973	0,915	0,928	0,982	1,000
Rybnik	1,000	1,000	1,000	0,875	0,884	0,857	0,904	0,940	0,867	0,864	1,000	1,000
Rzeszów	0,805	0,741	0,840	0,804	0,797	0,779	0,809	0,799	0,854	0,939	0,871	0,873
Siedlce	0,996	0,865	0,976	0,907	0,875	0,977	1,000	0,944	1,000	0,981	1,000	1,000
Siemianowice Śląskie	1,000	0,899	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Skierniewice	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,914	1,000
Słupsk	0,991	0,950	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Sopot	1,000	1,000	0,936	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,930	0,897
Sosnowiec	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Suwałki	1,000	0,850	0,914	0,883	0,873	0,881	1,000	0,975	0,921	0,970	1,000	1,000
Świętochłowice	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Świnoujście	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,983	0,864	1,000
Szczecin	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tarnobrzeg	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tarnów	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,960	1,000	1,000	1,000	1,000
Toruń	1,000	1,000	0,997	0,971	0,978	1,000	1,000	1,000	1,000	1,000	0,959	0,995
Tychy	1,000	1,000	0,726	0,987	0,975	0,893	0,977	0,994	0,921	0,942	0,917	1,000
Wałbrzych	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,764	0,815
Warszawa	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Włocławek	0,793	0,794	0,728	0,825	0,836	0,807	0,944	0,926	0,896	0,903	0,915	0,925
Wrocław	1,000	0,998	0,954	1,000	0,985	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Zabrze	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Zamość	0,873	0,888	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,980	1,000	1,000
Zielona Góra	0,841	0,940	0,771	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,790	0,728
Żory	1,000	1,000	0,934	1,000	1,000	1,000	1,000	1,000	0,981	1,000	1,000	1,000

Source: *Authors' calculation*

Appendices 2. The results of CCR model

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Biała Podlaska	0,800	0,869	0,967	0,956	0,965	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Białystok	0,804	0,781	0,690	0,776	0,768	0,758	0,769	0,812	0,821	0,841	0,882	0,836
Bielsko-Biała	1,000	1,000	0,979	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Bydgoszcz	0,718	0,886	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,886	0,933
Bytom	1,000	0,904	0,833	0,898	0,886	0,885	0,995	0,908	0,862	0,932	1,000	1,000
Chełm	0,980	0,804	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Chorzów	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Częstochowa	0,991	0,904	0,940	0,975	0,940	0,930	0,988	0,971	0,969	0,987	0,898	0,887
Dąbrowa Górnicza	1,000	0,969	0,718	0,984	1,000	1,000	0,932	0,958	0,968	1,000	0,879	1,000
Elbląg	1,000	1,000	1,000	0,944	0,921	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Gdańsk	0,946	0,650	0,644	0,965	0,984	0,943	0,893	0,962	0,901	0,968	0,968	0,979
Gdynia	0,826	0,921	0,654	1,000	0,924	0,824	0,886	0,930	0,966	0,875	0,855	0,874
Gliwice	1,000	1,000	0,662	0,942	0,954	0,859	0,898	0,867	0,868	0,886	0,774	0,777
Gorzów Wielkopolski	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,983	0,995	1,000	1,000
Grudziądz	0,841	0,729	0,809	0,987	0,912	0,899	0,959	0,965	1,000	1,000	1,000	1,000
Jastrzębie-Zdrój	1,000	1,000	0,919	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Jaworzno	0,780	0,625	0,717	0,899	0,916	0,869	0,985	0,847	0,847	0,866	0,895	1,000
Jelenia Góra	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Kalisz	0,703	0,685	0,869	0,971	1,000	0,946	0,961	0,951	0,958	0,955	0,815	0,827
Katowice	0,908	0,826	0,703	0,959	0,970	0,924	0,937	0,949	1,000	1,000	0,859	0,815
Kielce	1,000	0,975	0,814	1,000	0,990	1,000	1,000	0,968	0,987	1,000	1,000	1,000
Konin	0,784	0,757	0,766	0,788	0,700	0,715	0,733	0,731	0,742	0,739	0,746	0,654
Koszalin	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,996	1,000
Kraków	0,906	0,732	0,991	1,000	1,000	1,000	0,947	0,983	0,945	0,957	0,808	0,891
Krosno	0,759	0,709	0,723	0,799	0,796	0,834	0,893	0,923	0,994	0,935	0,948	1,000
Legnica	0,849	0,839	0,820	0,968	0,918	0,958	0,984	0,901	0,903	0,911	0,993	1,000
Leszno	0,781	0,811	0,948	1,000	0,911	1,000	1,000	1,000	1,000	1,000	0,718	0,688
Łódź	1,000	0,899	0,906	1,000	0,972	0,867	0,909	0,920	0,892	0,914	1,000	0,990
Łomża	1,000	0,936	1,000	0,958	0,980	0,968	1,000	1,000	1,000	1,000	0,921	1,000
Lublin	0,950	0,699	0,760	0,877	0,870	0,835	0,826	0,831	0,824	0,854	0,759	0,749
Mysłowice	0,825	1,000	1,000	1,000	1,000	0,987	0,950	0,942	0,896	1,000	1,000	0,964
Nowy Sącz	0,860	0,799	0,872	1,000	1,000	1,000	1,000	0,881	1,000	1,000	1,000	1,000
Olsztyn	0,981	0,948	0,998	1,000	0,982	0,972	0,975	0,965	1,000	1,000	1,000	1,000

Opole	0,697	0,770	0,723	0,919	0,882	0,825	0,848	0,860	0,828	0,848	0,829	0,805
Ostrołęka	1,000	0,798	0,768	0,879	0,801	0,839	0,971	0,992	1,000	1,000	0,997	0,991
Piekary Śląskie	1,000	0,972	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Piotrków Trybunalski	0,966	0,938	0,854	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Płock	0,514	0,521	0,597	0,813	0,694	0,710	0,683	0,696	0,675	0,715	0,513	0,552
Poznań	0,945	0,920	0,826	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Przemyśl	1,000	0,989	1,000	1,000	1,000	0,839	0,931	0,888	1,000	1,000	0,948	1,000
Radom	0,948	0,772	0,744	0,899	0,805	0,804	1,000	0,868	0,910	0,943	1,000	1,000
Ruda Śląska	0,697	0,659	0,902	0,934	0,863	0,893	0,898	0,855	0,832	0,850	0,963	1,000
Rybnik	1,000	1,000	1,000	0,860	0,867	0,843	0,895	0,861	0,838	0,841	1,000	1,000
Rzeszów	0,761	0,713	0,803	0,785	0,771	0,773	0,795	0,796	0,811	0,852	0,848	0,843
Siedlce	0,994	0,857	0,967	0,907	0,837	0,948	1,000	0,888	1,000	0,960	1,000	1,000
Siemianowice Śląskie	1,000	0,841	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Skierniewice	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,993	1,000	0,854	0,969
Słupsk	0,962	0,932	0,935	1,000	0,975	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Sopot	1,000	1,000	0,889	0,901	0,963	0,955	0,865	1,000	1,000	1,000	0,808	0,796
Sosnowiec	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Suwałki	1,000	0,827	0,872	0,867	0,871	0,875	0,984	0,960	0,920	0,968	0,999	1,000
Świętochłowice	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Świnoujście	1,000	1,000	1,000	0,955	0,948	1,000	1,000	0,956	0,850	0,776	0,745	0,920
Szczecin	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tarnobrzeg	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tarnów	1,000	1,000	1,000	1,000	1,000	0,944	1,000	0,943	0,962	0,993	1,000	1,000
Toruń	0,904	0,885	0,913	0,969	0,973	0,977	0,994	0,988	0,983	0,997	0,934	0,922
Tychy	1,000	1,000	0,703	0,985	0,973	0,892	0,974	0,977	0,898	0,920	0,911	1,000
Wałbrzych	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,757	0,804
Warszawa	0,729	0,696	0,715	0,945	0,917	0,951	0,955	1,000	1,000	0,946	0,878	0,908
Włocławek	0,793	0,720	0,716	0,825	0,832	0,806	0,940	0,906	0,885	0,894	1,000	0,863
Wrocław	0,734	0,613	0,670	0,936	0,944	0,939	0,912	0,943	0,953	0,976	0,792	1,000
Zabrze	1,000	0,993	0,848	1,000	1,000	0,990	1,000	1,000	1,000	1,000	1,000	1,000
Zamość	0,862	0,864	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0,979	1,000	1,000
Zielona Góra	0,816	0,896	0,768	1,000	1,000	1,000	1,000	1,000	1,000	0,988	0,773	0,727
Żory	1,000	1,000	0,868	1,000	1,000	0,985	0,964	0,974	0,970	1,000	0,999	0,938

Source: *Authors' calculation*