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Improvement of financial management by local government: computer model implementation

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IMPROVEMENT OF FINANCIAL MANAGEMENT BY LOCAL GOVERNMENT; COMPUTER MODEL IMPLEMENTATION

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Abstract

We develop a computerized, optimization model for efficient financing of local investment and present its implementation improvement. The model supports better governance and improvement of financial management at the local government level. An example of real life long-term budget analysis, with the help of the model is presented. The analysis exemplifies good practice and observation of standards of efficient debt management in the area of long-term financial and investment planning (Bitner, Cichocki, 2008) and enhances quality of governance by local managers. These analyses also demonstrate ways of accessing maximum, feasible level of investment and maximum capacity of a municipality to borrow with all safety measures provided.

1. INTRODUCTION

Local government infrastructure projects require large outlays of money that are beyond the currently available resources of most local governments (LG). In Poland, as in many other new member countries of European Union (EU), we observe a substantial infrastructure gap as compared to old member countries of EU. There are less local infrastructure facilities, their quality is worse and related services are of poor quality. Therefore, the need for resources to invest in local infrastructure is very high. The rate of increase in investment results to a great extent from an inflow of funds, to local governments, from the EU budget. A pace of narrowing the infrastructure gap between Poland and „old EU countries", depends on the ability of LG in Poland to acquire EU funds, and ensure its own financial share, which is required when implementing projects, co-financed by European funds.
One solution to ensure the above own financial share, is to borrow the necessary funds. Borrowing places the burden of repayment on tomorrow's citizens and limits the future financial flexibility of a local government. Nonetheless, there are sound economic and public policy reasons for local governments to borrow for financing public infrastructure. Most public infrastructure is essential to the future economic prosperity of the community, and delays in its development mean economic opportunities foregone. Moreover, the long-lived nature of most public infrastructure means that future generations will use and benefit from current investment, making it appropriate that they help pay for a fair share of it (Rosen, 1995, Stieglitz, 1998). While there are economically sound reasons for issuing debt, its usage must be carefully analyzed and monitored over time to be sure that a municipality does not assume more debt that it can afford to repay. Therefore, the need for developing computerized models, which will support financial management and informed decision making regarding long-term financial analysis and determination of safe debt is large and growing.

The paper considers the design of budgetary policies by a municipality and a selection of an appropriate and safe amount of investment and borrowing to finance local infrastructure investment projects.

We develop a computerized, optimization model and implement the model to improve financial management at the local government level. The presented model facilitates management efficiency by local governments, ensures a safe, maximum capacity to borrow and serves the purpose of better governance, safe debt management and transparency of decision making with regard to finances.
The objective of the model is to support informed decision making, regarding investment and debt, under changing conditions of financial markets and uncertain results of applications, by LG, for EU funds. The model immediate objective is determination of a maximum capacity to invest by LG, with utilization of debt, subject to a number of conditions, which ensure:

1. a safe level of debt for a municipality, and satisfaction of constraints regarding debt, which result from the law on public finance (lpf): ratios of total debt to total revenue, and cost of debt service to total revenue, assume values below certain limits, given in the lpf
2. sufficient level of current (operating) expenditure and of operating surplus, which assure implementation of all LG own and delegated tasks, and allows to fund capital investment
3. LG budget liquidity in each period, over a total period of analysis (several years).

Each municipality has to determine a level of safe debt individually (its nominal value and values of debt indicators and debt service), based on the revenue structure, revenue projection, the value of operating surplus and on the past debt commitments.
Another objective of a LG could be maintenance of the ratio of investment expenditure in total expenditure at a high and stable level, for example above 30%, as presented in Figure 10.

We describe implementation of the model for improvement of management of local government finances and efficient LG budget management over a period of 7 years. Improvements include:

- assessment of a maximum feasible level of debt over time, and monitoring the debt, level and cost of debt service, in every time period and over the whole period of analysis
- computation of model solutions: investment, debt level, and structure of debt issue and repayment, for alternative levels of European funds, which are a source of financing investment and a contribution to the LG budget revenue
- computation of several LG budget revenue scenarios, depending on: the level of EU funds available for financing investment, growth rate of the economy, incidental revenues of LG (including sales of property), and revenue from debt proceeds; the level of EU funds depends on investment
- maintaining the operating expenditure at a level, which is not outstripping the growth in operating revenues, and allows the capital investment expenditure of LG to grow
- maintaining the operating surplus, which depends on the revenues and operating expenditures, at a high and stable level.

1. The implementation of the model exemplifies good practice and observation of standards of efficient debt management in the area of long-term financial and investment planning and select standard in the area of organizational and institutional procedures of debt management regarding continuous presence of a municipality manager on capital markets and cost efficient debt management (Bitner, Cichocki, 2008).

In the area of long – term financial and investment planning we included standards regarding:
(a) development, by LG, of a long-term Financial Plans, and a long-term Capital Investment Plans, for a period of minimum 7 years, (b) approval of these plans by the LG Council, what facilitates transparency and public decision making in decision making (c) development of long-term Financial Plan, and a long-term Capital Investment Plan in several scenarios, which should determine the lower and upper limits for investment expenditure (d) development, by LG, of debt proceeds projection, for a period of minimum 7 years, including the existing debt and future debt. The standards have been verified on real life data of a representative group of Polish LG.

The standards also demonstrate ways of assessing a maximum capacity of a municipality to invest and borrow with all safety measures provided. Implementation of the model presented in this paper

helps assess these capacities. Observation of these standards (Bitner, Cichocki, 2008), and implementing them in the model facilitates transparency of financial management and decreases a probability of corruption.

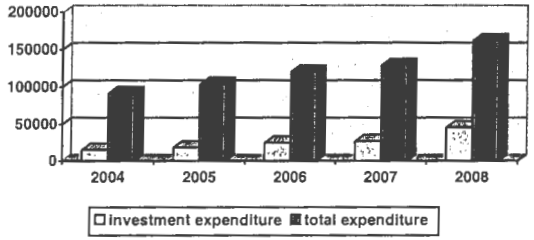
2. INVESTMENT AND DEBT OF LOCAL GOVERNMENT SECTOR IN POLAND AND IN EUROPEAN UNION

Investment projects implemented by institutions of public sector, to a large extent, contribute to the Gross Domestic Product (GDP) in all countries of European Union (EU). Financing local infrastructure investment is of vital importance to local societies, local economic development, and to bridging a large infrastructure gap between Poland and "old" EU countries. In addition, the local government finance sector plays an important role in redistribution of the state revenue.

Below, we highlight specific features of the local government finance sector. In Poland, its expenditure equals close to half of the state budget expenditure, however, the share of local government investment in public sector is very large. In the period of 2004-2007 capital investment expenditure of local government sector (LG) in Poland, on average, was twice as high as capital investment expenditure of the state budget. In Figure 1 we present the growth of LG investment expenditure.

The share of investment expenditure in total expenditure of local government sector (LG) grows steadily - from 16,5% in 2004 r. to close to 21% in 2007, and to 28% in 2008 (according to planned – to be implemented values). The share of investment expenditure to total expenditure by LG in Poland belongs to the highest in EU.

Figure 1. Capital investment expenditure and total expenditure of LG (mln PLN)

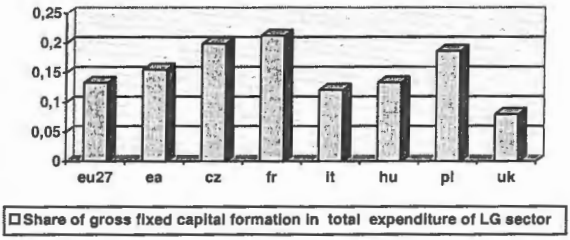


Source : Ministry of Finance

In addition, in 2007 in Poland, a ratio of investment of local government sector to GDP equaled 2,5%, and was the fourth highest in EU, after Ireland, Latvia and Rumania (average value of the ratio for all countries of EU, in 2007 equaled 1,5%). In 2006, only in Ireland this ratio of investment to GDP had higher value than in Poland. Also, the share of gross fixed capital formation in total expenditure of LG sector (contribution to construction of infrastructure facilities) is one of the highest in EU (see Figure 2).

Figure 2. Share of gross fixed capital formation in total expenditure of LG sector – in European Union and in select countries of EU (2007)[1]

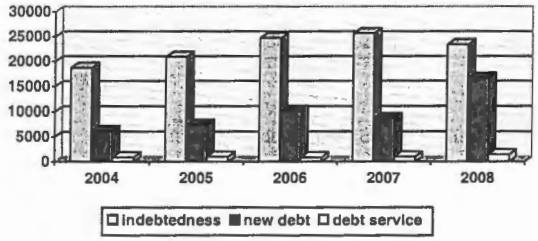
[1] Notation: eu27 – European Union (all countries); eu – euro zone countries; cz – Czech R.; fr – France; it – Italy; hu – Hungary; pl – Poland; uk – Great Britain.



Source: EUROSTAT

The growth in LG investment is accompanied in Poland by systematic increase in indebtedness, from 18,7 billion PLN in 2004 to 25,7 b. PLN in 2007 (a decrease in indebtedness in 2008, as seen in Figure 3., results from the fact that the data present only the level of indebtedness for 2008, assessed at the end of the second quarter, while the prevailing issues of debt take place in the last two months of the year. A decrease in new debt issues in 2007 results from cancellation of the pre-financing institution (pre-financing of projects from the state budget, before UE funds can be used for project financing - on reimbursement basis). In 2007, new debt issues, without pre-financing, increased by about 20%. One should note an unprecedented increase in new debt issues in 2008 - over 70% in comparison to 2007. Both, credits and municipal bonds were used for financing investment. Their values were estimated (planned) at the end of the third quarter of 2008. However, over 2004-2007, plans of debt issues were realized (implemented) in 85-90% on average. This means that the level of indebtedness in 2008, and in the following years will grow substantially[2].

Figure 3. Indebtedness of LG, new debt and cost of debt service



Source: Ministry of Finance

The rate of increase in investment exceeding the rate of growth of total expenditure result to a great extent from an inflow of funds, to local governments, from the EU budget. In 2006, local government investment expenditure co-financed with the EU structural funds, the Cohesion Fund (CF) and the Social Fund (we call them European projects), equaled over 30% of the total LG investment expenditure. The LG share in financing European projects equaled 36%, and the UE budget share – 64%.

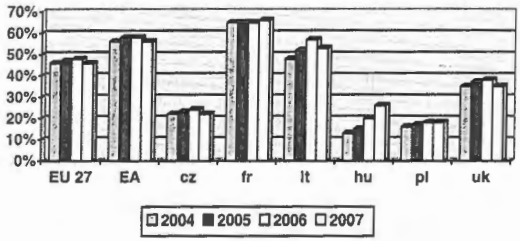
A pace of narrowing the infrastructure gap between Poland and „old EU countries", depends on the ability of LG in Poland to ensure its own financial share when implementing projects, co-financed by European funds. Securing own funds (own share) is a necessary condition for absorption of European funds over 2009-2013. The condition of ensuring own financial share for implementation

[2] The planned deficit in debt proceeds connected with credits and bonds to be issued by LG in 2008 amounts to 10 billion PLN.

of European projects requires that LG (cities, districts and regions) must use external resources, first of all debt.

The fast growth of new debt is the result of the need to ensure resources for own shares by LG, which is the condition to obtain the funds from EU. This phenomenon will be observed, consistently with the signed agreement with the EU, over the period 2009-2015. The national plan for 2007-2013 anticipates that in order to absorb the finances from the structural funds and the Cohesion Fund of EU, Polish LG will have to secure about 6 billion euro over 2007-2013. At the beginning of 2009 we can say that over 2009-2013 it will amount to over 1 billion euro yearly.
In spite of a large increase of LG indebtedness over 2004 – 2008 in Poland, debt is still a relatively minor source of financing investment. In Poland, the ratio of indebtedness (total debt) in relation to total revenue equaled 17,54% in 2007, and remained at a low level in comparison with other member countries of EU (in 2007, average value of the above ratio for UE equaled 45,69%).

Figure 4. Relation of indebtedness (total debt) to total revenue in European Union and in select member countries of EU



Source: EUROSTAT

The necessity to ensure external resource, including debt, for financing European projects creates new challenges for LG, regarding efficiency of debt management and effective management of LG finances. Transparency is yet another, very important element of financial management at local level.

Implementation of a computerized model supporting financial management, and observation of debt management standards, increases a probability of acquiring external resources, including EU funds and debt, and facilitates effective management of these resources. Analysis of debt management efficiency by LG is presented in Bitner, Cichocki, 2008.

3. THE MODEL FOR IMPROVEMENT OF FINANCIAL MANAGEMENT

3.1. Problem description

Municipality's revenue include tax revenue, fees and charges, state budget grants, and revenue from owned capital and property. The model developed in the paper fits current Polish and EU legal regulations. It bases on general framework of local government finance and debt management (Bahl, Lin, 1992; Cichocki, Kleimo, Ley, 2001; Josef, 1994; Leonard, 1996) and can be used, after minor changes, for efficient debt and finance management in any economy.

Financing an investment project with a help of debt creates a burden for the future generation (see discussion of an overlapping generation model in Rosen, 1995). However, when the project will benefit future generations, or if future generations are expected to be richer than the present one, then having them pay for the project *via* loan finance is appropriate.

Special grants and government subsidies for financing investment contribute to the local government revenue and impact values of model variables. In the model we observe the income effect (Stiglitz, 1998), through the influence of investment (level of investment expenditure) on values of projected LG revenue.

In Poland, the sources of funds that flow into a local government's (LG) budgets are defined at various levels of detail by: the Constitution of the Republic of Poland, the Law of Public Finance, the Law on the Revenue of Local Governments, and the Local Self-Government Act. Expenditures borne by units of local government are defined by the Local Self-Government Act according to the specificity and the scope of their responsibilities (tasks). Revenue from loan proceeds, from sales of capital shares owned by gmina and from previous year budget surplus are considered non-revenue, and serve to finance budget deficit. Likewise, the expenditure does not include amounts allocated for the repayment of loan principal - they also make up proceeds (non-expenditure).

In order to obtain an actual and undistorted picture of the financial status and financial management in a LG, one should base the analysis not exclusively on the revenue and expenditure, as defined in the law until July 2005 (Cichocki, 2004). The analysis must include additional financial flows defined in the budget as non-revenues and non-expenditures, as well as the actual cash flows between the LG and other entities.

The objective of the model is to maximize the total funds (from budget surplus and from debt) for financing investment. However, these funds, through imposition of appropriate constraints ensure satisfactory level of operating expenditures, budget liquidity, and safe and legally justified level of debt. Along with a capital improvement program, each local government should have a written debt policy establishing guidelines for the use of debt. These guidelines (Leonard, 1996; Joseph, 1994, Cichocki, Leithe, 1999, Bitner, Cichocki, 2008) should include:
1. Maximum amount of debt that can be issued each period
2. Specification of the types of long-term debt that will be issued (various credits and bonds)
3. The debt maturity schedule for each debt (issue and repayment structure)

Some Polish large cities and municipalities, each year approve a resolution regarding maximal, nominal value of debt they can issue, as well as practical levels of indicators of debt service to revenue, and the debt service to operating surplus (constraints (2) and (3) of the model). However, these cities, in most cases, do not know the nominal limits for the debt, as in their analysis they do not maximize the resources for investment. Their decisions are based on experience and intuition. The developed model will help LG calculate the nominal limits for the debt and investment. It will enable assessment of debt capacity of a municipality and determination of a safe level of debt, as well as of *debt structure* - bond covenants and loan terms- including repayment structure of debt.

The model encompasses dynamics (solutions of the model at time t impact solutions at time t+1), and includes feedback resulting from the contribution of EU funds to investment and to total LG revenue. The level of EU funds facilitates investment expenditure, and usually a high level of planned investment expenditure impact the amount of application for EU funds, and, in result, a level of EU funds, which add to the LG revenue.
The presented model has assisted over 20 Polish local governments in efficient financing of local infrastructure.

In the model we define notions of *gross* and *net* operating surplus, as well as the real financial yield, which in the 2005 Law of public finance is called "surplus on the current account" and starting 2006 functions in Polish regulations, and local government financial reporting.

The *operating surplus* - revenues in excess of operating expenditures – is not an official notion of the 2005 Law of public finance (lpf). It can be used to fund capital expenditures and is not needed

to fund operating expenditures. Thus, the available resources to fund capital public infrastructure projects consist of surplus current revenues, and the proceeds from borrowing (loans and bonds). *The net operating surplus* is defined as operating surplus less costs of spending for service of the existing and planned debt. The larger the level of these resources, the more funds available for financing investment.

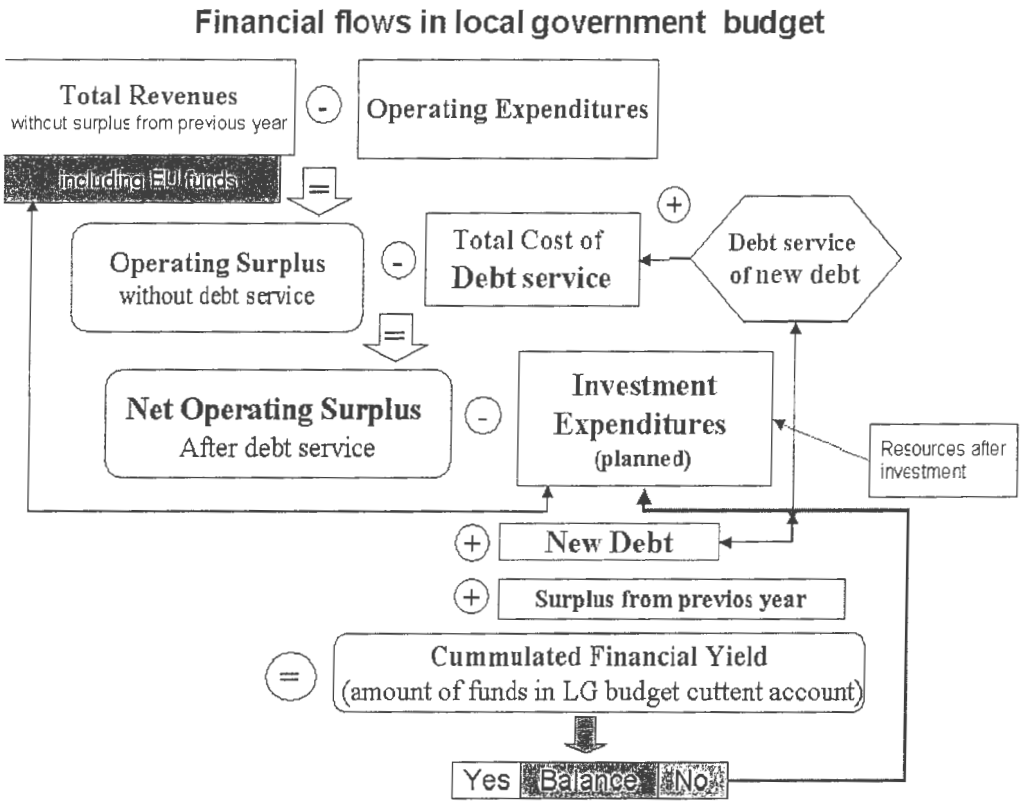
The maximum debt depends on constitutional and statutory limits (should be below these limits). These limits are often stated as a percentage of a jurisdiction's assessed valuation of revenue (Leonard, 1996; Cichocki, Leithe, 1999; Law of public finance, 2005). However, very often this percentage is selected arbitrarily. Mistakes can be made, which lead to so called *indebtedness trap*. The debt issuer must assess the effect of debt service outlays on future budgets to determine the safe (and practical) limits of debt service capacity.

The annual *real financial yield* (ARFY) determines an amount of funds which remain in the municipality's budget at the end of the fiscal year, without any surpluses from the previous year (Cichocki, 2001 and 2003, and Bitner, Cichocki, 2008). It equals *net* operating surplus less planned investment expenditures, plus newly borrowed funds, plus LG capital revenue. The *cumulative real financial yield* (CRFY) is defined as the sum of ARFY and the CRFY from the previous year. The newly borrowed funds added to the *net* operating surplus, and the value of CRFY (surplus funds) from the previous year could be, in all, used for financing investment.
The above described financial flows are presented graphically in Figure 1 (see also Cichocki, 2004).

When the surplus on the current account – value of cumulative real financial yield (SRFY) is negative (the model is not balanced), then, either the investment expenditure has to be decreased, or, the amount of debt must be increased, or both – in order to bring the CRFY to positive values. At the same time we must observe that new debt adds to debt service and, as a result, decreases the net operating surplus, and thus the amount of funds for financing investment excluding new debt.

The developed model helps determine limits of debt capacity nominally, and in relation to revenue, as well as limits of debt service capacity in relation to total revenue and the operating surplus. For any new debt we estimate how much new debt service would be added from a planned loan and bond issue to the existing debt service costs. Then, the combined total of projected new debt service payments is calculated, added to the costs of the existing debt service and we receive the total costs of debt service payments.

Figure 5. Financial flows in a local government



3. 2. Definition of model variables

Model variables are defined for all time instants $t = (t_0, t_1, .., T_N)$, where t_0 denotes an initial period of analysis (usually beginning of a budget year or first quarter of a budget year), T_N is the last period of analysis, and N is integer (number of quarters, or years). Model variables include:

- $ND_t = \{NC_t, NB_t\}$ - **a level of new debt** (credits and bonds) issued; This means time instants: $t = [tc_1, .., tc_m, tb_1, ..., tb_p]$, at which new credits NC_t and new bonds NB_t are issued, where m is a number of credit issues, and p is a number of bond issues; we additionally assume: $m \leq N$, $p \leq N$;
- $tr = [trc_1, .., trc_n, trb_1, ..., trb_q]$ - **time instants at which credits are repaid and bond issues redeemed,** where n, is a number of credits repayments RNC_t, and q is a number of bond repurchases RNB_t, $n \geq m$, $q \geq p$;
- $RND_t = \{RNC_t, RNB_t\}$ - **a level of each debt repayment, and/or repurchase of bond** issues
- Inv_t - **investment expenditures** for all $t \in \{t_0, T_N\}$.

Based on the above variables, which are the model solutions, and on some exogenous variables, we can calculate:

- $TRev_t$ - Total Revenue at the end of period t, for all $t \in \{t_0, T_N\}$
- TDO_t - Total Debt Outstanding (indebtedness) at the end of period t;
- DS_t - Debt Service over period t;
- OpS_t - Operating Surplus, equals Total Revenue less Operating Expenditure
- $OpSnet_t$ - *net* Operating Surplus, equals Operating Surplus less costs of debt service;
- $CRFY_t$ - Cumulative Real Financial Yield, defined by equation (6c) - the amount of funds available in the budget at the end of period t.

The above variables determine how much is borrowed and when, and how and when the debt is repaid.

In the model we define the following **exogenous variables**:

- D_{t0} - indebtedness (old debt), resulting from debt contracts concluded until t_0;
- DS_{t0} - Debt Service resulting from debt contracts concluded until t_0,
- Inv_{t0} - investment expenditures in period t_0,
- TDO_{t0} is a level of an initial debt outstanding, and repayment schedule of the old debt
- $IncRev_t$ - Incidental Revenue in period t, for all $t \in \{t_0, T_N\}$
- GDP_{t0}, at t_0, inflation, inf_{t0}, at t_0, and projections of GDP_t, and inf_t *for all t*, over $t \in \{t_0, T_N\}$; we make independent projections of GDP and inflation.

Exogenous in the model are also forecasts of:

- the interest rates: ic_{1t}, ..,ic_{mt}, and ib_{1t},...,ib_{pt} - charged for all credits and bonds (all debts), planned t be issued over $\{t_0, T_N\}$;
- $BRev_t$ - Basic Revenue at the end of period t, for all $t \in \{t_0, T_N\}$, where

$$BRev_t = BRev_{t-1}\,[1 + (GDP_t \times inf_t)\,\gamma]$$

Basic Revenue is verified by GDP growth and inflation growth, and corrected by local rate of growth, which is smaller than the growth rate of the economy, $\gamma < 1$, $BRev_{t0}$ - given.

- $OpExp_t$ - Operating expenditures, for all $t \in \{t_0, T_N\}$, where

$$OpExp_t = OpExp_{t-1}\,[1 + (GDP_t \times inf_t)\,\gamma 1]\text{, where usually, } \gamma 1 < \gamma,\ OpExp_{t0} \text{ - given.}$$

Thus, we generate prognosis of base revenues and operating expenditures.

3.3. Model constraints

Debt burden of an issuer (local government) depends on the gross amount of outstanding debt. There are no fixed standards for assessing an issuer's debt burden. However, there are many useful guidelines, which relate the debt and debt service to the anticipated revenue and taxable fixed assets. These guidelines are included either in legal regulations, city council resolutions or practical recommendations, both in international financial organizations, EU countries, in USA and in Poland (Cichocki, 2003, Cichocki, Leithe 1999, Debt Policy Handbook, 1994, Recommendations of „Government Finance Officers Association": 1995, 2003, 2005, Guidelines for Public Debt Management, IMF, 2001, Josef, 1994). In addition, debt burden is often evaluated on a per capita basis (Leonard, 1996; Cichocki, Leithe, 1999; Recommended Budget Practices, GFOA, 1999, Rehm H., Tholen M., Matern-Rehm S., 2005).

In the model we introduce two types of constraints. The first two constraints result from binding legal regulations in Poland; they include pledges of collateral or "coverage" requirements by which revenues must exceed debt, and debt service. The additional four constraints result from practice of financial management, recommendations formulated in the literature, and experience of the author

in cooperation with LG. These constraints ensure budget liquidity and continuity of investment financing.

3.3.1. Constraints resulting from legal regulations

Polish national Law on public finance require, at every time instant t (end of each year), that:

(1). Total debt outstanding (indebtedness), as a percentage of total revenues, does not exceed 60%

(2). The total debt service as a percentage of total revenues does not exceed 15%.

In Poland there is, by law, a requirement of quarterly financial reporting by LG.

The constraint (1) also regards the state budget: public debt can not exceed 60% of GDP. The law introduces a relational feedback between public debt and GDP, and debt issued by local government. For example, when the value of total public debt outstanding exceeds 55% of GDP, then debt service in local budget, by law, cannot exceed 12% of its total revenues. Any percentage of public debt to GDP over 50% imposes additional restrictions on new debt issuance and budget deficit of local governments.

When the value of total public debt exceeds 60% of GDP, then no deficit is allowed in the state and local government budgets. No debt can be issued and guarantees granted either by the state or local government, and a macro-economic program has to be introduced, which decreases public debt to GDP ratio to the level below 60% (better below 55%).

The above constraints, starting 2006, do not include debt issued for financing projects, which are co-financed with EU funds.

In many countries in western Europe and in the USA it is customary to issue debt, which is below 60 % of total taxable municipality's revenue.

3.3.2. Constraints resulting from practice of sound financial management

Although the legal ceiling for debt service is 15%, the affordable level for a particular municipality very often is less. *However, there is no one percentage that is right for all local governments and at all times. This value, different for each period, can be obtained only from solution of the presented model, for each municipality separately.*

Surplus revenues must be left for financing investment, and operating surplus cannot in all be spent for debt service. The values of following "efficient management" financial indicators (Cichocki, Leithe, 1999; Cichocki, Bitner, Szpak, 2001) are used in the model constraints:

(3). The total debt service as a percentage of operating surplus - should be less than a given positive number, usually smaller than one (not all funds of the operating surplus should be spent for debt service.

(4). Cumulated resources at the end of each period (CRFY) should be greater than a given percentage of the operating surplus, and, at the same time, must not exceed another, higher percentage of the operating surplus. For example, for large cities should be greater than 0,5% , and below 5 % of the operating surplus. (for small towns should be greater than approximately 2% of the total revenue and smaller than 6%-8%).

CRFY should ensure an amount of resources at t, for financing operating expenditures in the beginning of period t+1, when - at he beginning of a year, for about 10-12 days - LG do not receive any transfers from state budget, and have to relay only on revenues (funds) generated and maintained at the local level.

(5). Continuity of investment process must be secured, i.e. some investment are financed every period. When the combined total of projected debt service payments are very close to the value of operating surplus, then no new investment can be financed from net operating surplus, usually, for a

period longer than one year. In such a situation, financing investment from debt is possible only for a very short period.

In the model we define the net operating surplus (equality constraint 6a), and the operating surplus – as equality constraint 6b. They are the model variables.

Equality (6c) defines the cumulated real financial yield, which must be positive in the model, and the equality (6d) provides the definition of the debt service.

Safe debt management results from observing the values of indicators described in (3) and (4). Municipalities often plan financing large (often needed) investment from borrowed money, which later they can not repay - for which cost of debt service turns out to be higher than the municipality's operating surplus. Sometimes, very ambitious local governments start investment they can not afford, and which are not safe for their future budgets. Then, a LG (municipality) experiences "investment – indebtedness trap". As a result of too high investment and too high debt, the local government has to drastically decrease investment expenditures (number and scope of investment projects), often for several years, or even stop financing uncompleted investment projects.

3. 4. Model formulation

The model is formulated in a way, which provides safe methods of securing maximum funds for financing investment. Mathematical formulation is given below.

For every time instant t: $t = (t_0, t_1, .., T_N)$, find such values of investment expenditure, Inv_t, new debt $ND_t = \{NC_t, NB_t\}$, and levels of each debt repayment $RND_t = \{RNC_t, RNB_t\}$, and times $tr = [trc_1, .., trc_n, trb_1, ..., trb_q]$, $n \geq m$, $q \geq p$, at which credits and bonds are repaid, which **maximize planned new debt and *net* operating surplus** (access revenue and borrowed funds for financing investment)

$$Maximum\ \{ ND_t + OpS\ net_t \},$$

where the *net* operating surplus is defined by (6a) and (6b),
subject to the following constraints:

The ratio of total debt outstanding to total revenues is less than 60%:

(1) $\quad D_t / TRev_t < .60$, where

(1a) $\quad D_t = D_{t-1} + ND_t - R(N+Old)D_t$, $t = t_1, .., T_N$

where
$D_t = C_t + B_t$, and $D_{t1-1} = D_{t0}$.
C_t and B_t are cumulative values of credit debt, and bonds debt outstanding at year t,
D_{t0} is a level of an initial total debt outstanding (initial indebtedness).

$TRev_t = BRev_t + Inc\ Rev_t + EU\ Rev_t$,

where $BRev_t$ is basic revenue at time t, defined in section 3.2., and $Inc\ Rev_t$ denotes incidental revenues - one time revenues, for example from sales of property or special grants;
$EU\ Rev\ t = \beta Inv_t$, $0 \leq \beta < 0{,}85$ are revenues from EU, which depend on investment.

Total Debt Service to Total Revenue ratio is less than 15%:

(2) $\quad DS_t / TRev_t < .15, \quad t = t_1, .., T_N$

where DS_t is defined by equation (6d).

Total Debt Service can not exceed the Operating Surplus

(3) $DS_t / OpS_t \leq (1\text{-}a), \qquad 0 < a < .99$

Cumulative Real Financial Yield at the end of period t, $CRFY_t$ must be positive. It constitutes a portion of the Operating Surplus which ensures resources for financing operating, and sometimes investment expenditures,

at the beginning of period t+1.

(4a) $CRFY_t / OpS_t \geq f(a)$, where

$f(a) = 0.01 + 0.9\ a, \quad 0 < a < 0.99$, and

(4b) $CRFY_t / OpS_t \leq h(a)$, where h(a) is defined experimentally.

The resources at t, which can be used for financing investment are defined by

(5) $OpS\ net_t + ND_t + CRFY_{t-1} - f(a)\ OpS_t \geq Inv_t, Inv_t > 0,$

and are summation of the operating surplus, new debt at t, and cumulated real financial yield from previous year (at t-1). These funds must be positive.

The value of the *net* operating surplus at t, is defined as operating surplus minus costs of debt service

(6a) $OpSnet_t = OpS_t - DS_t, \quad OpSnet_t > 0,$

where the operating surplus (*gross* available resources, with funds for debt service included) are defined as total revenues minus operating expenditures;

(6b) $OpS_t = TRev_t - OpExp_t, \ t = t_1,.., T_N,$

where $TRev_t$ and $OpExp_t$ are exogenous variables, projected for every t, as described in section 3.2.

The cumulative Real Financial Yield at the end of period t is defined as

(6c) $CRFY_t = OpSnet_t + ND_t - Inv_t + CRFY_{t-1}, \quad CRFY_t > 0.$

The costs of debt service are calculated for each credit and each bond issue separately. The interests are computed on cumulative credit outstanding at time t (credit outstanding at time t-1 plus new credit at time t, minus credit repayment at t), and on cumulative bond issues outstanding at time t.

Debt Service is defined as

(6d) $DS_t = R(N+Old)C_t + RB_t + i\,c_t [TCO_{t-1} + NC_t - RNC_t] + i\,b_t [TBO_{t-1} + NB_t - RB_t]$,

where $DS_{t1} = DS_{t0} + NDS_1$, and DS_{t0} is an initial debt service resulting from commitments made prior to time t_0.

TCO_t is cumulative value of credit, which remains to be repayed in year t, and TBO_t denotes cumulative value of bonds to be repayed in year t. We calculate interest on both credits and bonds. The values of NC_t denote new credits, and $OldC_t$ - old credits (issued prior to t_0).

Debt service includes costs of service of both, the existing "old" debt, and the new debt, and therefore the interests ic_t and ib_t are vector values and vary for each credit and each bond issue.

The values of total revenue, operating expenditure and investment expenditure: $TRev_t$ and $OpExp_t$ are exogenous in the presented model and have to be projected over the period of time, over which we solve the model, $t = t_0, \ldots, T_N$ - usually, over a period of the longest debt maturity.

As a result of the **model solution** we obtain, for each time instant $t = t_0, \ldots, T_N$, values of investment expenditure - Inv_t, values of new debt - ND_t (credits and bonds), which the LG issues at times $t = [tc_1, .., tc_m, tb_1, ..., tb_p]$, and values of debt repayments (principals) - RND_t, at times $t = [trc_1, .., trc_n, trb_t, ..., trb_q]$, $n \geq m$, $q \geq p$.
Thus, after solution of the model we have instances $[tc_1, .., tc_m, tb_1, ..., tb_p]$ of taking credits and issuing bonds.

The above values satisfy the constraints (1) – (6), and approximate a maximum capacity to borrow, which is safe for future municipality's budgets. Then, for given optimal values $OpSnet_t$ and ND_t we calculate values of the indicators (1) - (4), which together with the nominal value of new debt determine a practical limit of debt for each individual municipality.

It turns out that safe levels of indicators (1) and (2), in most cases, are well below the levels determined administratively by law.

4. MODEL IMPLEMENTATION; EXAMPLE OF A SOLUTION OF THE MODEL

This section presents and discusses solutions of the model used for budget projection over 2008 – 2014. The projection includes determination of a feasible, close to maximum investment expenditure and a safe level of debt in a LG, under assumption that a 30% reserve in credit potential of this LG is observed (the values of debt and debt service to revenue indicators must be at least 30% below their maximum values). We solve the model over a period of 2008 – 2014. The year 2007 is as initial optimization period.

In the solution procedure of the model we first check if the constraints (1) - (3) are satisfied. When the constraints (1) - (3) are satisfied, then, we check for constraint (4). When the constraint (4) is not satisfied and the CRFY is negative or below the value resulting from (4), we must bring the CRFY to the appropriate positive value. Then, for positive values of CRFY, which satisfy constraints (1) - (4), we compute maximum investment expenditure, which in turn satisfy inequality (5), and the values of. The level of safe debt allows for computation of the resulting values of financial indicators – the constraints defined by relations (1) - (3).

4.1. Exogenous variables of the model

Below, in Table 1, we present values of exogenous variables, and projections of select values of these variables (basic revenues and operating expenditures).

Table 1. Exogenous variables, and their projections

Model Variables [thousands PLN] \ **Year**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Basic Revenues excluding incidentals	33 185,7	35 342,4	37 639,2	40 085,3	42 382,2	44 810,7	47 378,3	50 277,0
Local revenue growth indicator, γ	0,75	$\gamma < 1$						

Share of Investment financed from EU	0,07	0,72	0,72	0,72	0,40	0,40	0,35	0,35
Operating Expenditures, without interest	30 538,6	31 597,1	32 692,2	33 825,4	35 117,5	36 459,0	37 851,7	39 395,6
Local operating expenditures growth indicator - $\gamma 1$	0,5	$\gamma 1 < \gamma$						
GDP growth rate [%]		5,5	5,5	5,5	4,0	4,0	4,0	4,0
Inflation [%]		3,0	3,0	3,0	3,5	3,5	3,5	3,5
Interest rate		Vary for individual credits						
Reserve in Credit Potential		Customary: between 0 and 0,5; selected for every year						
Rate of Investment co-financed from EU	0,05	$0 < \alpha < 0,85$, selected for every year						
Share of Investment eligible for EU financing	0,97	$0,8 < \alpha 1 < 1,0$, selected for every year						
Old debt contracts Indebtedness	Determined for every year, depending on concluded contracts							
Initial values for 2007	As presented in section 3.2							
Old Debt repayments	Schedule of repayment from old debt contracts							
Interest on Old Debt	From individual credit and bond contracts							

Source: own computations and operating expenditure projections, based on data received from the LG (years 2004-2007), and macroeconomic data

Old debt is the debt resulting from debt contracts concluded prior to the projection period (in the example, until the end of 2007).

We present values of exogenous variables over the eight year period: 2007-2014. They include: basic revenue, operating expenditure, GDP growth rate, inflation, interest rates on credit, rate of total investment expenditure, which will be co-financed from EU funds, initial values for the year 2007, and other values described in section 3.2.

We analyzed the period of 2004 - 2007 to prepare a prognosis of the above exogenous variables over 2008-2014. We check past behavior of the LG revenue and of financial indicators which appear in constraints (1) - (4) of the model. The past values of the analyzed LG budget and the basic revenue, which includes incidental revenues, for example from sales of property, are presented in Figures 6. We also analyzed, over 2004 – 2007, values for select financial indicators: operating expenditure to total revenue, operating surplus to total revenue, and investment expenditure to total expenditure of the LG. The projections of these indicators over 2008-2014 are presented in Figures 8-10. The projections of the LG revenue with, and without EU funds are presented in Figure 7.

4.2. Model Solutions

In Table 2 we present, for a small Polish town, values of select, important solution of the model (select model variables), in consecutive years - over the period of analysis: *the investment expenditure, total revenue, operating surplus and the net operating surplus, the level of new debt, and the resulting debt service for the total debt (indebtedness), the indebtedness level, and the cumulated real financial yield.* Additionally, we show the budget deficit. Some of these values we presented in Figures 7 - 14.

The level of new, safe debt is the maximum debt level that can be achieved under assumed conditions. We do not present here debt repayment structure, neither debt repayment by category of debt. The period, in which capital is repaid and interest paid – exceeds the time of analysis. Some repayments take place in 2019.

Table 2 presents model solutions in more detail, and in a way which shows how the consecutive model variables are calculated, consistently with the financial flows of the LG budget presented in Figure 5. For example, we can easily calculate values of the Cumulative Real Financial Yield (CRFY) in year t, which equals Annual Real Financial Yield (RFY) in year t plus the CRFY in the previous year (t-1). We can also see how the investment expenditures are calculated, or the net operating surplus. The investments, in year t, equal the sum of the net operating surplus and the new debt in year t, plus the CRFY in the previous year (t-1), and minus the CRFY in the current year (year t).

In computer calculations we take into account credit remissions for concessionary credits (used for financing environmental infrastructure) and guarantees extended by local governments (they are part of the LG debt service).

Table 2. Select Model Solutions (Variables)

Model Variables [thousands PLN]\ **Year**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total REVENUES	37 260,5	57 047,3	73 391,6	77 452,6	58 920,1	55 052,2	56 946,1	59 909,9
REVENUES from EU funds	212, 67	22 990,5	35 096, 5	34 372, 9	8 930	7 030,8	6 640,2	6 796, 4
OPERATING EXPENDITURES, without interest	30 538,6	31 597,1	32 692,2	33 825,4	35 117,5	36 459,0	37 851,7	39 395,6
OPERATING SURPLUS	6 721,8	25 450,2	40 699,3	43 627,2	23 802,6	18 593,2	19 094,4	20 514,3
DEBT SERVICE, including interest	3 980,8	28 361,4	4 083,3	4 874,8	4 653,6	4 535,1	4 847,2	5 570,1
INTEREST	450, 0	635 ,75	833, 12	976, 87	925, 87	874, 87	865, 25	816, 95
Net OPERATING SURPLUS	2 741,0	22 614,0	36 616,1	38 752,4	19 149,0	14 058,1	14 247,2	14 944,2
IINVESTMENT EXPENDITURES	8 399,6	30 002	45 800	45 800	20 000	18 000	17 000	17 400
NEW DEBT (Credits and Bonds)	4 568,8	7 100	9 250	7 000	3 000	2 000	2 600	2 400
Annual RFY	-759, 34	-287, 96	66, 07	-47, 61	2 148, 97	-1 941, 9	-152, 75	-55, 77
Cumulative Real Financial Yield CRFY	300,49	12, 53	78, 60	30, 99	2 179, 96	238, 03	85, 28	29, 511
Budget Surplus\Deficit	-2 127, 8	-5 187, 6	-5 933, 8	-3 149, 6	2 876, 74	-281, 69	1 229, 1	2 297, 34

Source: own computations and projections, based on data received from the LG (year 2007)

In Table 3, for the same small Polish town, we present computed values the model constraints, the values of financial indicators. These indicators include: "legal indictors", which appear in constraints (1) and (2), and the "management indicator" represented in the model by the constraint (3). Additionally, a very important value of the operating surplus as a percentage of revenue is presented.

Consistently with the request of the LG, we have assumed approximately 30% reserve regarding creditworthiness of the city budget. That means that we assume in the model that the total level of indebtedness - amount of the planned and the existing debt outstanding as a percentage of revenue ratio is below 42% over the whole period 2008-2014, and the total debt service as a percentage of total revenues, over the period 2008-2014, will assume values below 10,5%.

Table 3. Financial Indicators [in %]; Model constraints: (1) - (3)

Years INDICATORS [%]/ (Model Constraints)	2007	2008	2009	2010	2011	2012	2013	2014
Total Debt to Revenue (1)	37,8	32,81	33,68	35,92	45,98	46,19	42,23	36,21
Debt Service to Revenue (2)	10,82	5,04	5,56	6,29	7,90	8,24	8,51	9,30
Debt Service to Operating Surplus (3)	59,22	11,14	10,03	11,17	19,55	24,39	25,39	27,17
Operating Surplus to Revenue	18,04	44,61	55,46	56,33	40,40	33,77	33,53	34,24

Source: own computations and projections, based on data received from the LG (year 2007)

The value of the indicator of the total indebtedness (total debt outstanding) as a percentage of revenue (which appears in constraint (1) is below the legal ceiling of 60 % over the whole period 2008 – 2014, and it is also below 42%, when we exclude investment projects co-financed from EU. Thus, we have approximately 30% reserve regarding debt to revenue ratio. In 2008-2014 the value of the indicator assumes values of 32,8% to 46,19% for all investment projects. The share of debt outstanding in revenue for all investment projects is 14 percentage points below the level determined by law. When we exclude investment projects co-financed from EU, the maximum value of this indicator is below 40%.

The total debt service as a percentage of total revenues equals 9.3% in 2014, or less. We observe over 30% reserve regarding debt service to revenue ratio - for all investment projects.

The town indebtedness is very safe. The starting assumption of the calculation, which was to maintain about 30% of reserve regarding creditworthiness of the town is satisfied. The share of debt service in revenue could grow by another 5,5 percentage points before it reaches the upper limit of 15%.

The city officials could come to the conclusion that they could use new debt to finance additional investment in the period 2008 - 2014.

However, before they would come to such a conclusion, they would have to check if the town has *enough funds for debt service.* The values of the indicator of debt service to operating surplus must be below 1 (below 100% in Table 3) over the whole period 2008 - 2014. Also, as a result of too low operating surplus, the value of the indicator (4) - the cumulated real financial yield could be relatively high in relation to operating surplus. This could mean additional arbitrage costs.

In the analyzed town, the operating surplus in relation to total revenues grows to 56,33% in 2010, and then, decreases to 33,53 in 2013, and 34,24% in 2014 (Fig. 9).

A decrease in the operating surplus in relation to total revenues is very often a sign of increasing indebtedness. The value of the operating surplus to revenue below 10% is dangerous for any city.

In the case of he analyzed town, the cost of anticipated debt service does not exceed 28% of the operating surplus (see Table 3), and the constraint (3) of the model is satisfied. We can say that the indebtedness of the town is very safe.

The presented financial and debt policy can be implemented but it would require assumed funds from the EU, as shown in Table 1. Then, the investments expenditures can be implemented as shown in Fig. 12, and the value of investment expenditure to total expenditure indicator can be maintained above 30%. It can assume values above 50% in 2009 and 2010, but in these years the town receives large sums of money from EU and issues large debt (Figure 10). The town reduces investment expenditures by half from year 2010 to year 2011. However, starting 2011 it receives much lower funds from EU (over 4 times lower), and issues debt which is less then half of the 2010 debt (see Table 2 and Figure 11).

The indicators of the operating surplus to revenue, the debt service to operating surplus, and the CRFY to operating surplus help assess real financial situation of a municipality, ensure financial liquidity, and help determine a safe level of debt.
Each municipality has to determine a level of safe debt (its nominal value and values of indicators (1) - (4)), *individually,* based on the revenue structure and revenue projections, the value of its operating surplus, and on past debt commitments.

In the model, as in the real life financial analysis, one should consider, and compute, various scenarios considering number of investment projects (the level of investment expenditures), that LG managers plan to implement over future years. This, to a large extent, depends on the amount of EU funds, that the LG will manage to acquire each year for financing investment.
Therefore, it is very practical to compute several scenarios of investment financing, or at least two scenarios, which would determine upper and lower limits for the EU funds that can be acquired, for the level of investment expenditures, and appropriate level of debt required to secure own share for financing investment. These limits, would determine space for possible usage of funds that the local government can apply for, and eventually receive.
In Figures 15 and 16 we present a comparison of an optimistic scenario, presented in the paper, and a pessimistic scenario, which shows the minimum level of EU funds that the LG, in its opinion, can receive from the EU over 2008-2014. Below, we show the values EU funds, resulting investment expenditures and new debt (credits) for both scenarios.

Table 4. Comparison of the model solution for the optimistic and the pessimistic scenarios

Values [thousand PLN]\ Year	2008	2009	2010	2011	2012	2013	2014	2009-2014
EU funds – optimistic scenario	22 990,5	35 096, 5	34 372, 9	8 930	7 030,8	6 640,2	6 796, 4	98 860
EU funds – pessimistic scenario	8 207,1	15 315,3	15 595,2	5 639,3	5 230,3	5 505,6	6 444,9	53 746
Investments–optimistic scenario	30 002	45 800	45 800	20 000	18 000	17 000	17 400	164 000
Investments–pessimistic scenario	18 002	27 700	28 800	15900	15 200	16 000	16 500	120 100
Debt – optimistic scenario	7 100	9 250	7 000	3 000	2 000	2 600	2 400	26 250
Debt – pessimistic scenario	7 100	10 000	9 200	4 000	4 000	4 000	3 000	34 200

The investments in the pessimistic scenario are lower than in the optimistic scenario - by about 17,5 million PLN in 2009 and in 2010, and by 2,7 m. PLN yearly (on average) over 2011-2014. This is the result of lower EU funds: by about 19,5 m. PLN yearly in 2009 and 2010, and by 1,4 m PLN yearly (on average) over 2011-2014. At the same time the debt in the pessimistic scenario is higher, on average, by about 1,5 m. PLN yearly.
The pessimistic scenario determines minimum yearly values of EU funds, investment expenditure and debt, which helps to implement the investments, but it also approximates the total minimum values, over eg. 2009-2014, of the EU funds (they equal 53,74 m. PLN), which are needed for implementation of investment at the level of 120,1 m. PLN. In order to safely implement such an investment policy debt has to be issued over 2009-2014 (34,2 m. PLN).
It is assumed that the share of investment which are financed from the EU equals: 50% in 2009 and 2010, and 30% in the years 2011-2014. The EU covers 85% of the total cost of an investment.
In the optimistic scenario, when the LG will acquire 98,86 m. PLN from the EU funds, the investments could be as large as 164,0 m. PLN, and the total debt issued over 2009-2014 will equal 26,25 m. PLN (will be larger than in the pessimistic scenario).
The space between 53,74 m. PLN and 98,86 m. PLN from the EU is a safe range for investment expenditure, which optimistically can be as high as 164,0 m. PLN over 2009-2014.

Figure 6. Revenue of local government

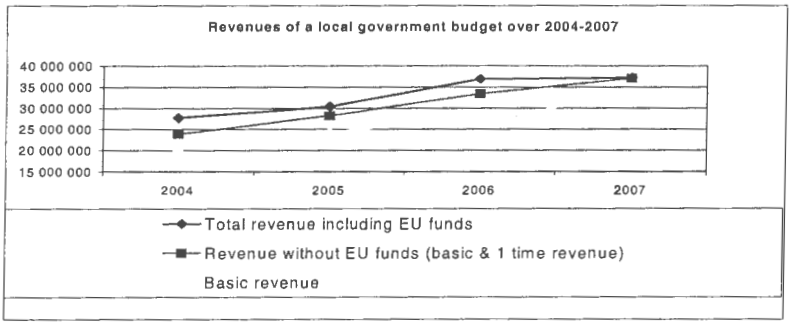


Figure 7. Revenue of a local government; Projection over 2008-2014

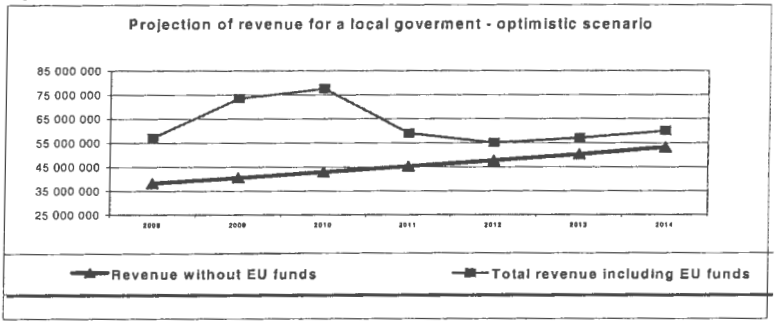


Figure 8. Ratio of Operating expenditure to total revenue [%]; Projection over 2008-2014

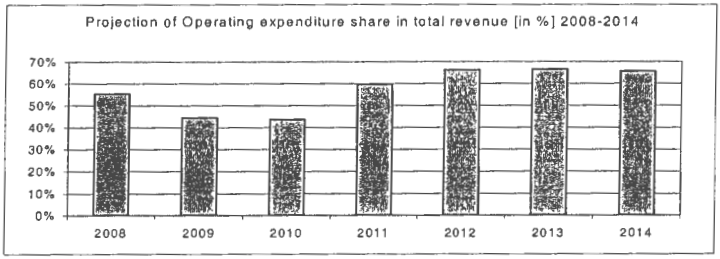


Figure 9. Ratio of Operating surplus to total revenue [%]; Projection over 2008-2014

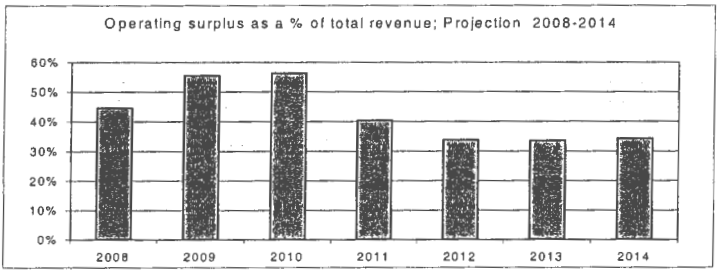


Figure 10. Ratio of investment expenditure to total expenditure [%]; Projection over 2008-2014

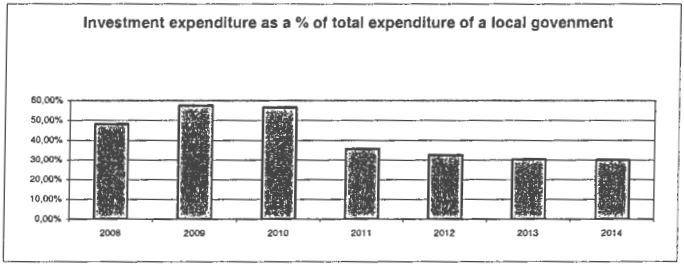


Figure 11. New debt, in [PLN] – optimistic scenario

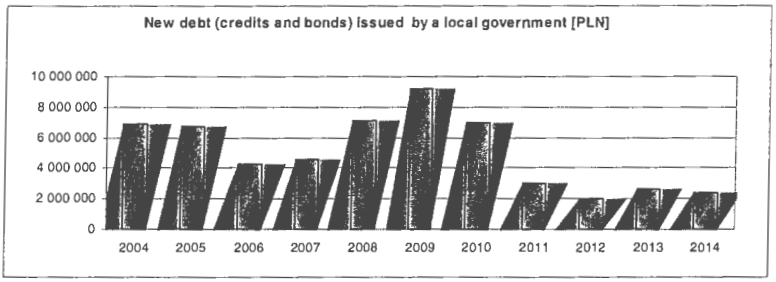


Figure 12. Sources of financing investment expenditure of a local government – optimistic scenario

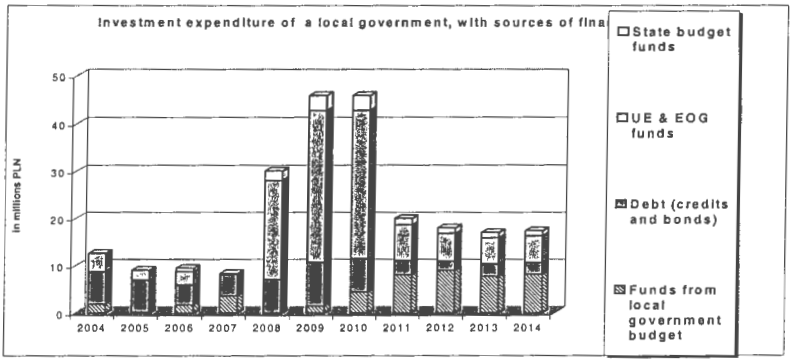


Figure 13. Indebtedness to total revenue ratio [in %] – optimistic scenario projection: 2008-2014

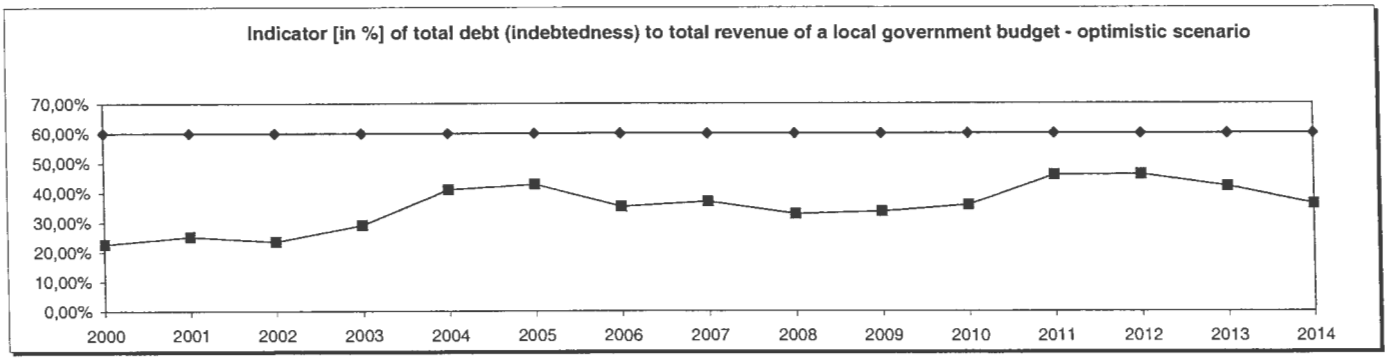


Figure 14. Cost of debt service to total revenue ratio [in %] - optimistic scenario projection: 2008-2014

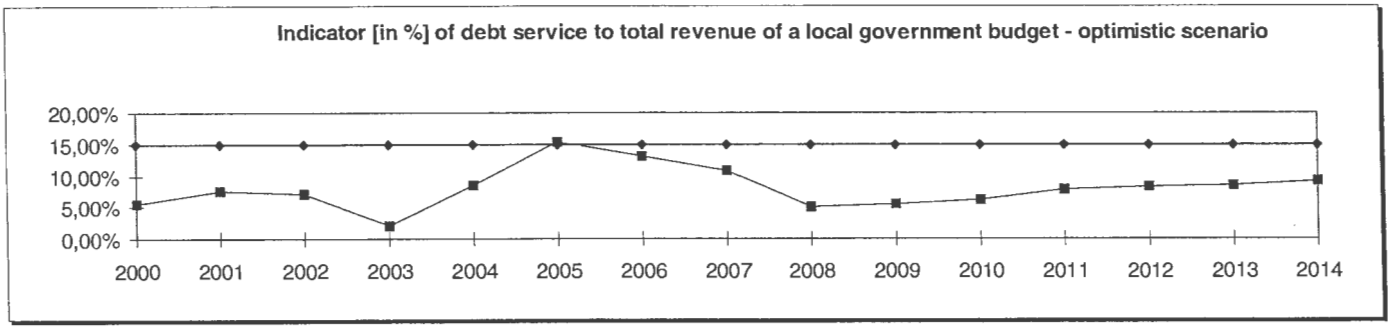


Figure 15. Comparison of optimistic and pessimistic scenarios: EU funds and investment over 2008-2014

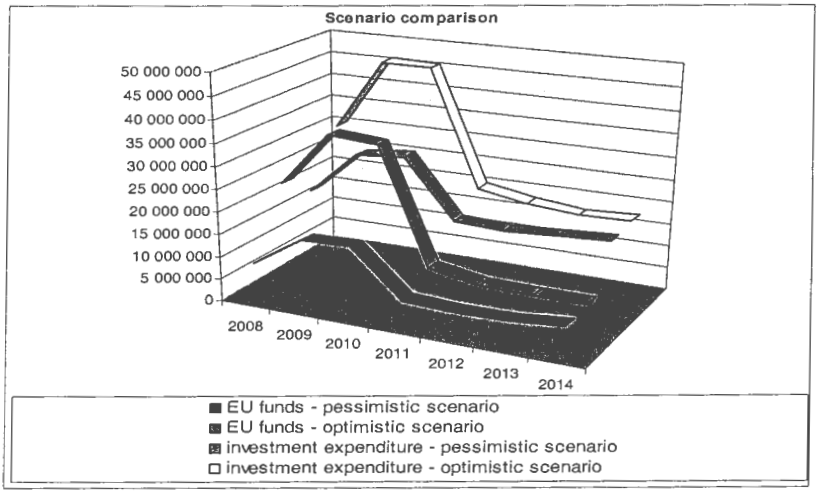
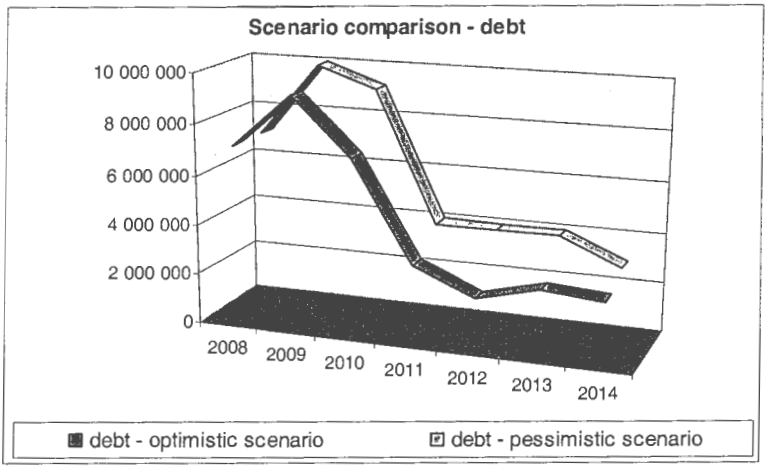


Figure 16. Comparison of optimistic and pessimistic scenarios: debt over 2008-2014



5. CONCLUSIONS

The necessity to ensure external resources, including debt, for financing investment projects, creates new challenges for local governments. Effectiveness in acquiring funds from the UE budget is required, as well as efficiency and transparency of debt and of financial management in general. The need to carry out various analyses with regard to enhancing both, the effectiveness and financial management efficiency, as well as transparency of decision making is growing.

The model facilitates better governance, helps develop mechanisms, which justify, support and explain decisions of LG (city) managers regarding acquiring external funds, including debt, and financing investment, and also helps determine limits to investment and safe borrowing.

The development of a Long-term Financial Plan (LtFP), as presented in the model, with operating elements of long-term debt management, and of a long-term Capital Investment Plan (CIP), coordinated with the LtFP and approved by the LG Council, is the basis of an efficient and transparent financial management. The LtFP development with implementation of the model increases a probability of acquiring external resources, including EU funds and debt, and of effective management of these resources.

The standards regarding long – term financial and investment planning and some debt management procedures, which are described in Bitner, Cichocki, 2008, are observed in the presented model, and base on good practices regarding debt management in countries of EU, and in the USA - the most developed municipal capital market.

There are two major factors, which determine the necessity and importance of design and operation of the LtFP and computer tools supporting long-term financial management. First, any local government has to determine, over several year period, amount of funds which are required for financing current and delegated tasks (operating expenditures). Second, LG has to determine, over at least 3-4 year period, investment expenditure – an amount of funds required for financing future investment, which must be selected at a level ensuring budget liquidity each year and over a long-time period. The issued debt should be coordinated with the operating surplus and ensure budget liquidity, and, on the other hand, it should meet the investment needs. Debt resources add funds available for financing investment and can contribute to economic development of a municipality. LG should develop debt proceeds projection, for a period of minimum 7 years, including the existing debt and debt planned in future (Bitner, Cichocki, 2008).
The LtFP scenarios, at least two of htem, determine upper and lower limits for EU funds, the level of investment expenditures, and appropriate level of debt required to secure own financial share for financing planned investment.

Each municipality has to determine a level of safe debt individually (its nominal value and values of debt indicators and debt service), based on the revenue structure, revenue projection, on the value of operating surplus to revenue indicator, and on past debt commitments. Debt service in relation to total revenues is a measure of the burden of debt that has been assumed by a LG. Debt service is a fixed obligation that commits LG resources for many years into the future. This is included in the model, as well as another requirement that the periods in which cash flows resulting from borrowings appear should match time schedule of investment disbursement.
In addition, consistently with one of the standards in Bitner, Cichocki, 2008, a municipality should be continuously present on capital markets. Continuous presence on capital markets reflects the standpoint of an experienced manager, who is able to take advantage of all potential market sources of financing investment in a way that is safe to municipal budget. The presence on capital markets enable potential investors (a municipality) to "grow accustomed" to a bank-lender, and to financing conditions proposed by the lender (Kurish, Tigue, 1993; Joseph, 1994; "Method of Sale", GFOA 1994). Single (one time) debt issue creates a risk of negative arbitrage.

The implementation of the computer model by LG managers will help meet requirements of the changing capital market and can be also treated as complementary to assessment of municipal creditworthiness by a rating agency. The model implementation and continuous presence on capital markets helps LG managers to acquire EU funds over 2009-2013, which will narrow the infrastructure gap between Poland and „old EU countries".
The experience in implementation of the model by a local government will help review financial activities and financial policy, and will strengthen the position of LG managers locally, and both on the capital market on the market of rating agencies.

The developed model was constructed based on literature, international experience and practice in the area of debt and financial management, and on over 12 year period of personal cooperation of the author with local government, first of fall regarding local and public finance.

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