

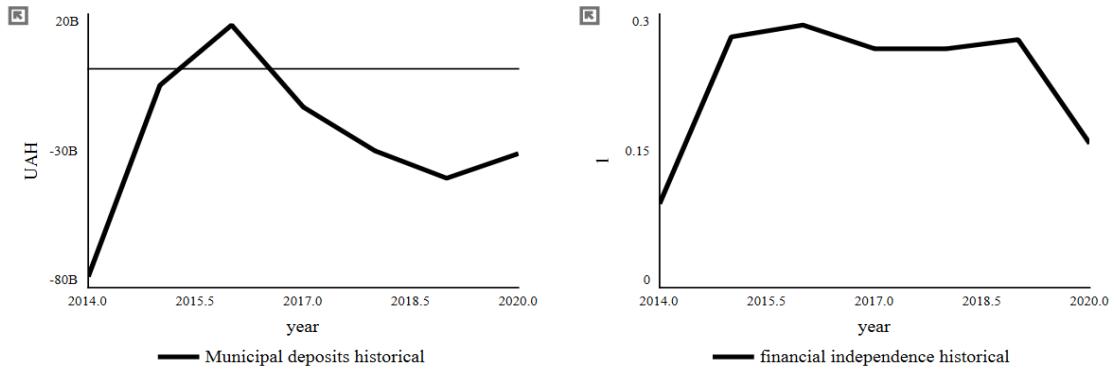
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## **THE EXPLANATORY SYSTEM DYNAMICS MODEL FOR ON-GOING RESEARCH OF FINANCIAL STABILITY OF LOCAL BUDGETS IN UKRAINE**

The problem of financial stability of local budgets in Ukraine and their independence from central government has been on public agenda since 2014–2015 time period when decentralization policies have been started to be implemented. Financial decentralization had a lot of goals – primarily, to ensure that local municipalities have enough resources to make changes towards sustainable growth, better standards of life, implementation of meaningful social and infrastructural projects in both rural and urban areas, and have financially stable local budgets, which are mostly independent from national government. Despite large shares of national tax revenue to be allocated to local municipalities, fully local taxes, transfers, and other decentralization policies, local budgets remain in chronic deficit and unable to freely pursue newly opened opportunities for local development. **Our goal** is to create the reliable data-based explanatory system dynamics model of this process (local budgets revenue and expenditures) for behavior of reference mode replication and further research of possible successful policies.

**Problem identification.** To introduce the problem of financial stability of local budgets we represented it with following reference modes – municipal deposits (accumulated deficit), and financial independence from government – a share of local tax revenue in total revenue (Fig. 1). Both based on Ministry of Finance data. The budgets were in surplus in 2016 – when financial decentralization policies implemented in 2014-2015 started effectively working, however, that did not keep the balance. Same goes for financial independence, which decreased recently.

The “feared” scenario would include further increase of deficit and fall into “debt trap” and, respectively, drop in financial independence. The “desired” scenario and reference for policy design is close to balance in deposits and independence from central government reaching 60-80% – target set by European countries [1].



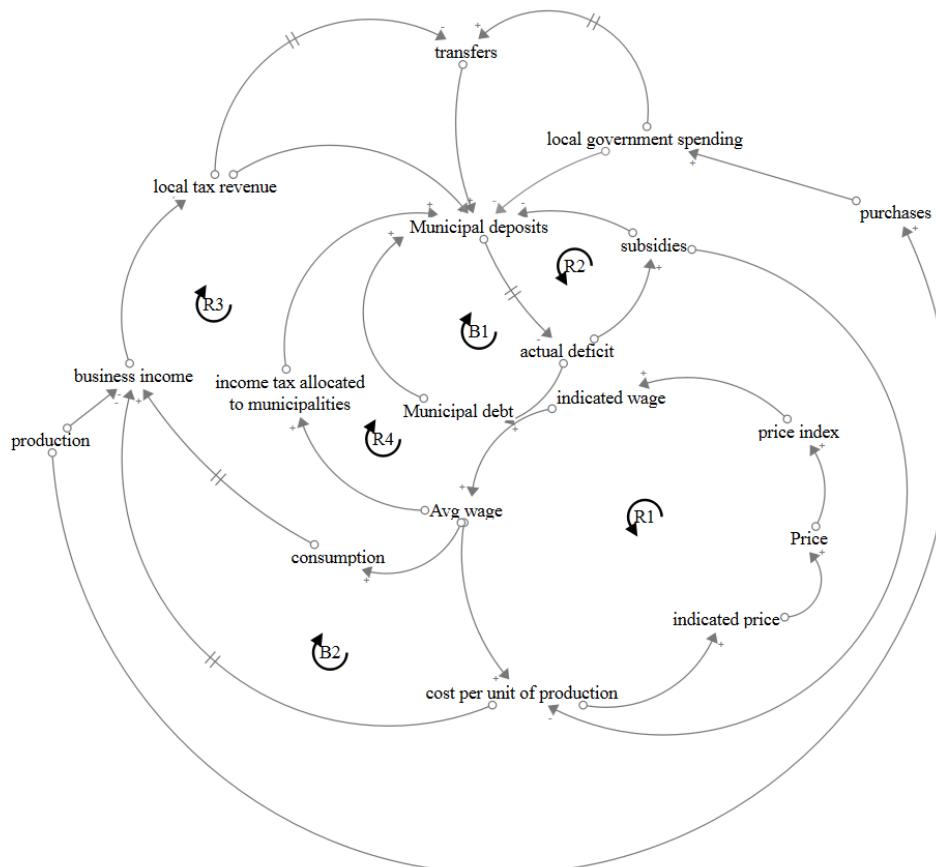
**Figure 1. Reference mode of behavior**

### Dynamic hypothesis.

The diagram contains 4 reinforcing feedback loops and 2 balancing ones. Explanation and logic behind each are provided below.

R1 – the wage and price reinforcing mechanism [2] – increase in average wage increase the cost per unit of production, which will then increase price, indicated wage and actual average wage (same if there is a decrease initially).

R2 – with a delay increase in municipal deposits will decrease the deficit and increase subsidies, since there are now available funds for that. Subsidies decrease the deposits as they are part of expenditures.



**Figure 2. Causal loop diagram for simplified financial stability of local budgets model**

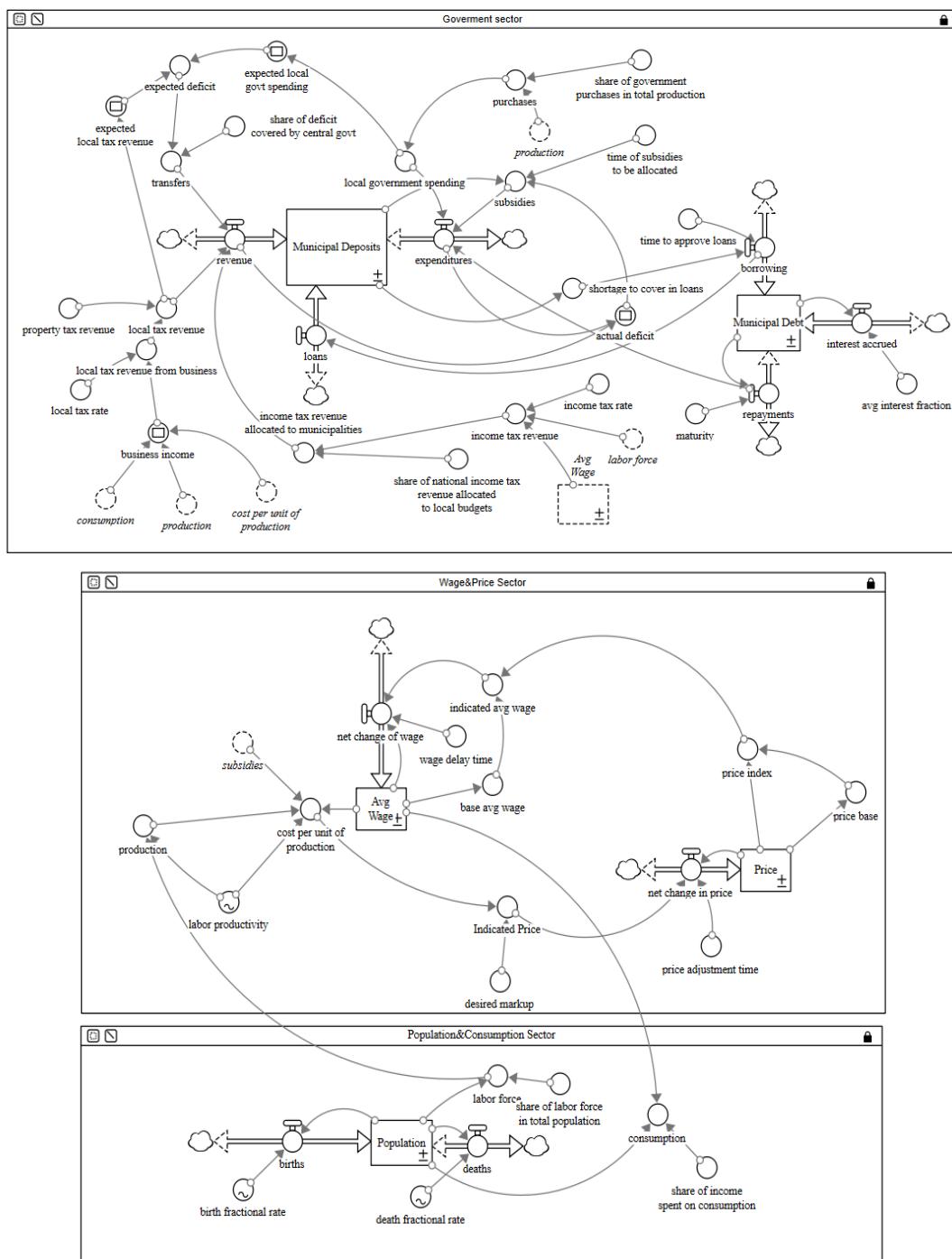
R3 – increase in average wage increases the amount of consumption, which increases profits of business who are local tax (revenue to deposits) payers.

R4 – increase in average wage will also increase income tax revenues allocated to municipalities as a fixed share of total income tax revenues.

B1 – “debt trap” that means that higher deficit drives higher borrowing and debt, repayments from which drive higher spending and deficit.

B2 – increased cost per unit of production (result of R1 loop) will decrease business profits, which are the base for local tax revenue.

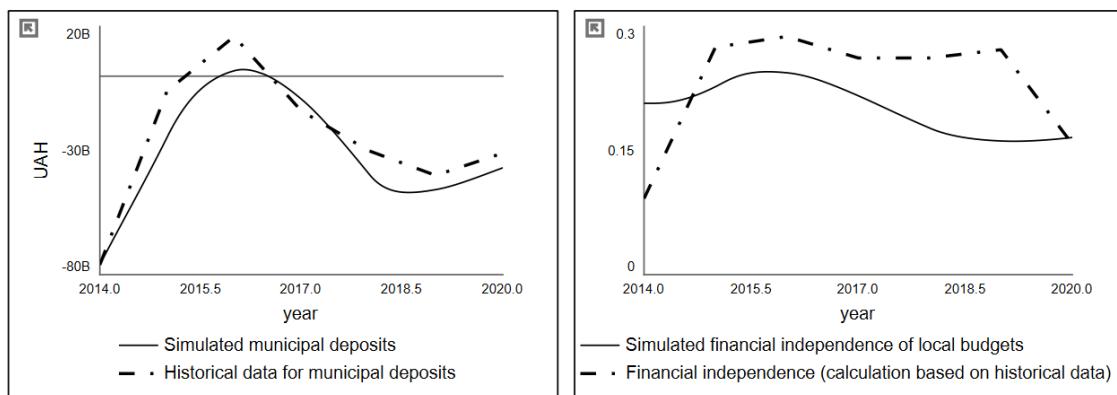
### Current results.



**Figure 3. Stock and flow diagram by sectors (explanatory model)**

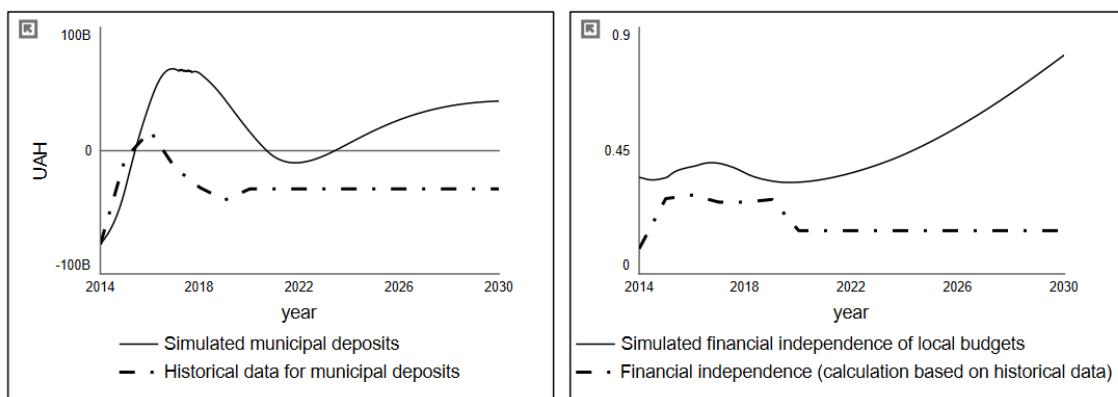
The model structure was built following the descriptions of the reference mode of behavior, which was corroborated with Ministry of Finance data and literature. Other mechanisms and variables not included in the research as considered model boundary or could be added to later versions. The model was found to be dimensionally consistent with all parameters having a “real-world” meaning for being included. Partial-model testing was carried out for all sub-structures using extreme condition tests, which produced resulting behaviors that were reasonable and expected. Reference mode was replicated to some extent (Figure 4). At this research stage the model has been proven as valid.

The model starts with 2013 as data for initial values. From 2014 to mid-2015 the accumulated deficit decreased as wage, prices and consumption were rising along with diminishing production because of decreasing population and labor force. This stimulated growth of business income and, even though the municipalities still covered the accumulated shortage with loans and had repayments, the income from business and income tax grew with higher rate due to newly set shares of national tax allocated to local budgets and local tax rates. The surplus peaked in the beginning of 2016 and triggered subsidies allocation since the budgets now had funds for it. Increasing labor productivity and subsidies decreased the cost per unit of production, which started the process of price index and average wage diminishing too (R2). That means lower tax revenue. Growth in labor productivity results in higher spending, which activates the “debt trap”. Mid-way of 2018 as production reaches its maximum, spending starts decreasing again to the point when revenue and loans as inflows exceeded and deposit stock started growing again. Financial independence does not show a perfect fit; however, the behavior mode is similar. At the second half of simulation transfer started to grow and prevailed in the revenue which decreased the share of local tax.



**Figure 4. Simulated vs historical data**

**Policy and further research.** The results of sensitivity analysis show that good leverage points to intervene in the system as a possible policy included the share of expected deficit covered with transfers, wage delay time and share of government spending in production (equivalent of GDP in the model). We ran a scenario with a combination of possible policies - share of expected deficit covered with transfers from 80% to 50%, wage delay time from 1.2 years to 0.4 years and share of government spending in production from 18% to 12%. Results of this simulation over 2014-2030 time horizon show growing financial stability and 80% independence by the end of simulation (Figure 5), which matches the desired reference mode too.



**Figure 5. Policy simulation result.**

We are planning to expand our model and endogenize some part of it as well as do more analysis and sensitivity testing to see more possible policies. We also want to recalibrate it to rural local budgets in Ukraine only and do further sustainability research on villages in Ukraine and their social and financial state to see how new European concepts as policies can help Ukrainian villages.

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