

## MODELING OF PRODUCTION TARGET FOR UKRAINE USING SYSTEM DYNAMIC METHOD

The main target of the model is to develop the system dynamics model about Production Target for Ukraine. The model shows how different parameters such as initial real Aggregate demand, inventories influence.

The time horizon in this model is 2006-2017. The data is annual. The main source of information on data was the official website of Ukrainian statistics <http://www.ukrstat.gov.ua>. Some data was also found on <https://data.worldbank.org/>

The desired production depends on aggregate demand and desired inventories. This simple model jumpstarts the production process by targeting the fraction of productive capacity that will be utilized. We can see how our model works:

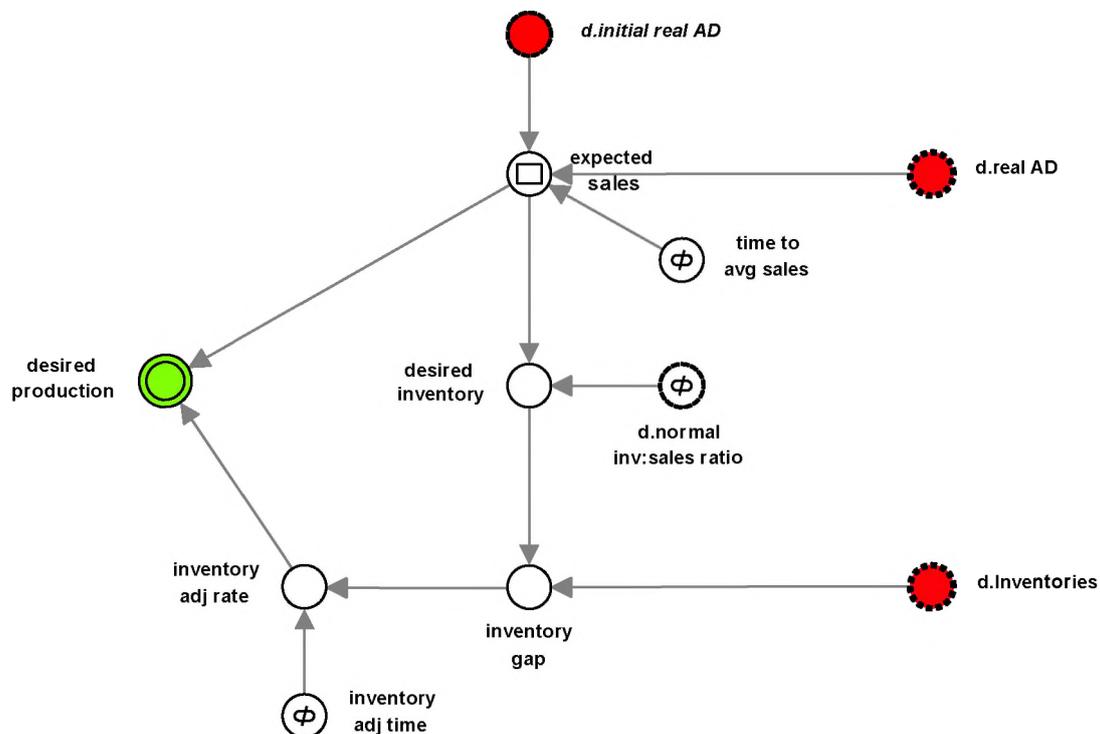


Figure 1. System Dynamics Model of Production Target

We look at the desired production model and the relationship between our data. At the same time we can see connection between expected sales. They depend on information about aggregate demand, and the information is averaged over time.

$$\text{Expected Sales} = \text{SMTH}(d.\text{real AD}; \text{time to avg sales}; d.\text{initial real AD}).$$

In the equation of expected sales we use SMTH function because we can't get the immediately full effect of real AD. And we assume that time to avg sales in Ukraine is 1/12 year.

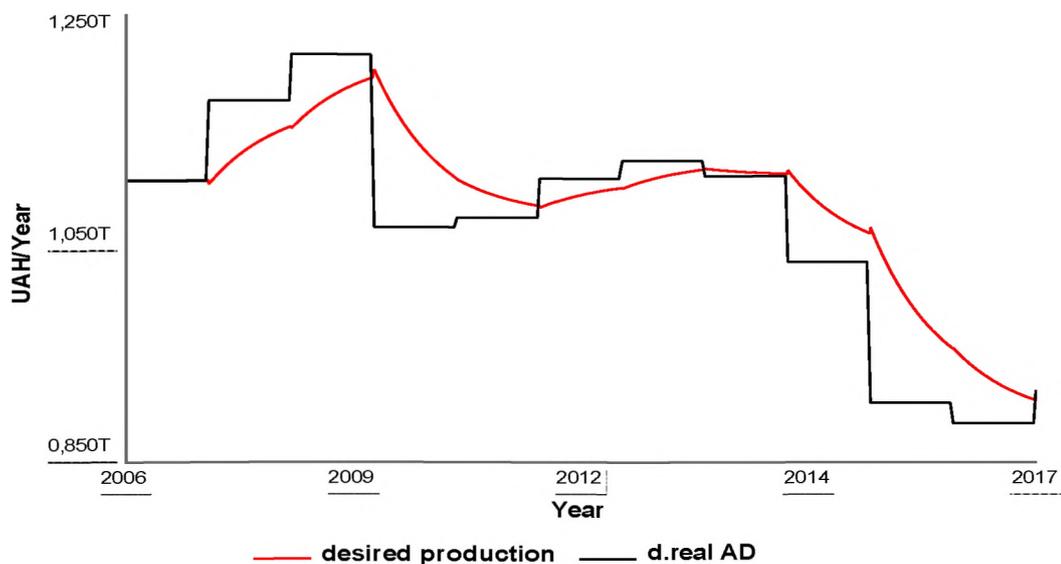
Meanwhile, expected sales influence other factors such as the desired inventory. Let's look at this in more detail. The desired inventory level is the quantity you want to be at once you replenish your stock. It leads to profit for the produces.

$$\text{Desired inventory} = d.\text{normal inv. sales ratio} * \text{expected sales}.$$

For Ukraine d.nominal inv.sales ratio = 4/52.

Our hypothesis is that the desired inventory depends on expected sales and our desired inventory sales ratio.

Based on our research, we have obtained this model of behavior:



**Figure 2. Result of System Dynamics Model for desired production**

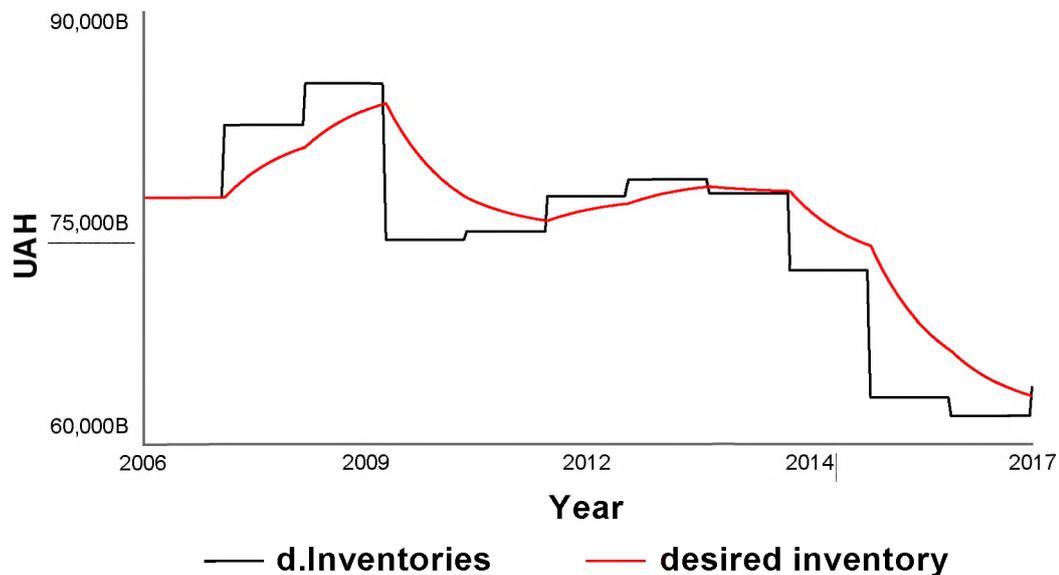
The figure shows historical data and simulated data of desired production. Desired production depends on expected sales and inventory adj rate. Real AD depends on consumption, investment, government and net export. The behavior is well replicated with the historical data.

Figure 3 shows historical data of inventories in Ukraine and desired inventory, that simulated by model.

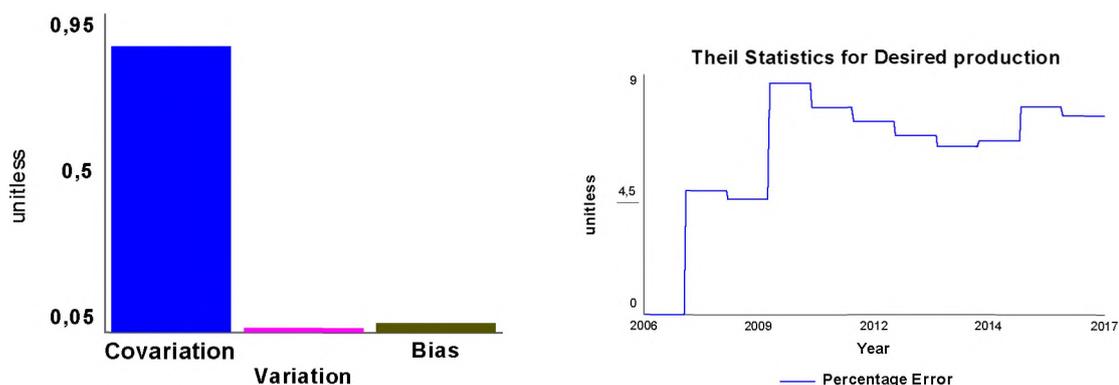
We can test our model using Theil statistics. We explored our model on covariance, variation, and bias.

We have big covariation error 85%, Variation and Bias error less than 1%.

Data for 2014 are given without taking into account the temporarily occupied territories of the Autonomous Republic of Crimea and the city of Sevastopol, since 2015 - also without part of the temporarily occupied territories in Donetsk and Luhansk regions.



*Figure 3. Result of System Dynamics Model for desired inventory*



**Figure 4. Decomposition of Theil statistics and RMSE for Production Target model**

In conclusion, we can say that our models work correct, it shows us the real behavior of desired production but it's hard to collect data, or data didn't show reality. We described our hypothesis and how desired inventory depends on expected sales and desired inventory sales ratio. Realized that every parameter in our sub-models has a big influence on desired production.

#### *References*

1. Deflator GDP: <https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS?end=2018&locations=UA&start=2006>
2. Wheat, D. I. (2007). The Feedback Method: A System Dynamics Approach to Teaching Macroeconomics. PhD thesis, University of Bergen.
3. Sterman, J. D. (2000). Business Dynamics. McGraw-Hill Companies.
4. Official site of the State Statistics Service of Ukraine [Electronic source] – Access mode: <http://www.ukrstat.gov.ua/>.
5. Official site of the National Bank of Ukraine [Electronic source] – Access mode: <https://www.bank.gov.ua/>
6. Burdett, K. and Mortensen, D. T. (1998). Wage Differentials, Employer Size, and Unemployment. *International Economic Review*, 39 (2), 257- 273.
7. Лук'яненко, І., Віт, Д. (2017). Системний аналіз формування державної політики в умовах макроекономічної дестабілізації.
8. Лук'яненко, І., Віт, Д., Оліскевич, М. (2020). Фінансова політика в умовах тінізації та дисбалансів на ринку праці: методологія та інструментарій.