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GDP IN VALUE AS A MEASURE FOR EVALUATING ANNUAL DATA FLOW INCREASE ON IOT

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Abstract: **The article deals with the problem of assessing the primary data load on the IOT, generated by the year. GDP in the money presentation has been used to estimate the amount of information that enters the network directly from things. Having advanced the postulate that the amount of data emanating from a thing is proportional to the product of its mass (thing) by its specific orderliness, it is concluded that it is possible to use a volume of the generated order principle. Dual model allowing to estimate objective thing's prices, has been proposed**

***Index Terms*: IOT, estimation, balance, GDP**

I. INTRODUCTION

In the old days of the planned, for medium– and long-term periods of time – Ukrainian economy – the task of preparing the initial data for the project of the republican component of the created State network of computer centers as the infrastructure of the Statewide automated system for planning and managing the national economy (one of the authors was privileged to participate in this ambitious, though not brought to the final implementation, project [1]). One of the basic indicators, on the basis of which the design (in particular, related to the financing of work) decisions were made, was the estimated annual volume of primary (coming directly from network users) data. These users were enterprises and organizations of the national economy, equipped with specially manufactured serial devices such as a subscriber station (EU), EC and SM computers, ASVT systems, Dnipro and the like.

The times of the planned economy, for most countries, have passed, so the development of the recently appeared (global) large-scale project, the creation of telecommunications and computer infrastructure, IOT occurs according to the laws of a market economy, and the allocation (or facilitation) of material and financial resources for the development of IOT in various budgets is hidden in sections on information technology, digitalization and the like. Nevertheless, it is necessary to prevent, by an adequate increase in the available computer and telecommunication resources, the possible increase in the information load coming from IOT subscribers, because the lag in the creation of the infrastructure of such a large-scale object, which is IOT in (our) individual country, can create the same large-scale problems for the latter in the near future.

As in the distant 70s of the last century, to create a rational infrastructure of the (state) IOT fragment, it is necessary to have as much as possible reliable and inexpensive in obtaining it, an assessment of the increase (increment) in the information load on the developing IOT, at least for a one-year period.

This article deals with the solution to this problem.

II. DEFINITIONS AND ASSUMPTIONS

Definition. A thing is called a physical object, in most cases equipped with a sensor and included, with the help of the latter, in IOT [2]. A thing generates a primary data stream of the corresponding intensity, measured by the amount of data generated per unit of time (a kind of bitrate). The C_2H_5OH molecule is a thing at the micro level; here, its model is connected integrally to an oxygen atom, two – and six carbon – hydrogen.

Assumption 1. The amount of data generated by an individual thing (by thing) is determined by the degree of its orderliness: a ton of coal equipped with one or another interface (with IOT) device in the hopper generates more data into the network than the same ton dissipated (disordered) at the TPS-5 in Kyiv.

Assumption 2. The amount of data generated by a set of equally ordered things is determined by their (things) quantity; at the same time, at a certain level of abstraction, the number of things can be represented by their mass.

III. SOLVING THE PROBLEM OF BUILDING A MODEL FOR ESTIMATING THE ANNUAL INCREMENT OF THE DATA FLOW ON IOT BASED ON GDP IN VALUE TERMS

By adopting the above assumptions we can introduce the ratio for the quantity of order P (mass order) introduced by the mass X (in the physical dimension):

$$P = pX,$$

where p is specific, i.e. reduced to unit mass, order. To separate entity (industry, country, region, etc.) the volume of the primary data in the IOT is determined over the year (possibly – proportional) produced (generated) with a total weight of things X (in the physical dimension) in accordance with the above relation.

In other words, [mass of order] = [degree of order associated with one thing, i.e. specific degree of order, specific ordering] • [mass of one thing] • [number of things] = [specific ordering of things] • [mass of one thing] • [number of things].

But in the (macro) economy there is, for some time now, the main (as opposed to the previously widely used physical measure) measure of the number of produced (generated) things, which, as we have already said, are the only data source for IOT:

$$Y = cX,$$

where c is the cost of a unit of mass X (price); the unit of monetary measurement of the production intensity – the source of information load on the network of the conventional unit is accepted in US dollars.

Thus, there are n producers of gross product, each of which (manufacturers) generates flows of primary data entering the network (determines the information load on the network).

The value Y, referenced to the year, which takes into account also produced services (ideas [3]) that are not, for IOT substantial, and there is GDP.

A comparison of the two above ratios allows us to conclude that the desired value of P can be estimated by GDP, if we accept the following assumption.

Assumption 3. The value of c is proportional to the value of p, i.e. the price of a thing is determined by its ordering. The existing (re) flows of things produced during the year are well formalized by the V.V.Leontyev's model of interbranch balance, if we accept the following assumption.

Assumption 4. Every taken separately object (branch, country, region) carries one and only one re-division (ordering) incoming resource.

As a result, we have two blocks of balance equations: the first block describes the balance between sectors (objects) in material terms; the second block is the same in monetary terms (i.e. GDP).

If we introduce an additional assumption about the one-product flows of things, we can have a very simple and intuitive construction, as it was done in [4]. The numerical models based on real data from [5, 6] for various economic objects make one doubt that the values of c can be a representative estimate for p: there is no evidence that the productivity of object i for processing (ordering) of an incoming resource (represented by parameters of the technological matrix in the classical Leontyev model) allows one to achieve such ordering p calculated for all models by values of c.

This result was intuitively foreseen as a result of leisure observations. For example, we have assessments for GDP and similar indicators from [5]): in 2018, the Swiss produced products (GDP – face value per capita = $ 80.690) twice as much as German (GDP – face value per capita = 44 549 USA dollars), and that, in turn, is four times more than Russian (10 608 US dollars). Taking into account the fact that the produced services are included in the GDP does not reduce the excessive contrast of the picture of the achievements of the world territorial communities in the development of the material world (guidance of the world material order of things). It is not clear what technology should be according to which the Swiss, having received a cubic meter (weakly, but not to the zero degree) of ordered propane-butane, in such (estimated value c) degree to streamline it.

One can also doubt that the balance of achievements of countries (and, accordingly, each citizen of the country) in the matter of material development of the world (and, therefore, information loading of the Internet of things), measured using the above indicators (degree of orderliness of the latter) really reflects those changes in the material world in direction of its ordering, which are carried out by a specific object. Restoring order on a fixed subset of the set of elements that make up the mass can only be done by disordering some complement of the set of elements. In the example with Swiss GDP producers, the observed striking differences were explained (and are explained) by the striking difference in the efficiency of the (Swiss) technology of redistributing the order between the atoms of the gas cubic meter mentioned above. Introducing, for simplification, the concept of specific ordering as the strength (power) of bonds assigned to one atom (or unit mass of matter), we have a possible evaluation of the strength (quantity) of order as the product T of the number (mass) of atoms of a set by the strength (power) of bonds, assigned to one atom (or unit of mass), i.e. specific ordering. Similarly, a possible estimate of the order strength (quantity) on a set of disordered atoms (mass) can be estimated as the product D of the number (mass) of atoms of this set by specific ordering. The T / D ratio can serve as an indicator of (technological) development – in 2018, for the Swiss, this indicator is 8 times higher than it is for the Russian. If it can somehow be explained with a Russian (those who want to do it and do it aren't enough), but how can one explain the fact that the Swiss manage to produce twice as much "order" as German does during the working day? (to say that there is more "order" in Tissot than in Siemens?).

It is ordering that must give rise to the true price of a thing, and therefore, – and indirectly the amount of information associated with it. However, in practice, a ton of coal (a thing that has a certain fixed value) has different prices, if you count in Donetsk or Rotterdam !?

At the molecular level of consideration, an example of one thing is the C_2H_5OH molecule: [mass of one thing] is the total mass of atoms forming this molecule [degree of order associated with one thing, i.e. specific degree of order, specific ordering] can be measured by the degree of "approximation" of the binary relation existing in the molecule (binary valence bonds between atoms, see the structure of the molecule) R to the linear order relation L or to the lattice. This proximity can be very approximately estimated by the ratio of the total possible number of distinguishable bonds to the number of bonds forming a linear order, i.e. transitive fault power R; it is worth noting that this measure is a function of only the number of atoms that make up the molecule, and does not characterize the degree of ordering of the molecule itself, however, using this (naive) measure greatly simplifies the task of assessing the degree of specific ordering of a thing, similar to how the use of the logarithmic function greatly simplifies the estimation procedures of entropy.

At the macroeconomic level, the order mass index is currently measured as the product of the mass of matter and its value (cost), i.e. represents the material component of GDP: [mass of order] = [degree of order associated with one thing] • [mass of one thing] • [number of things] or, to simplify macroeconomic monitoring and calculations, [mass of order] = [degree of order associated with unit of mass of things] • [mass of things].

The described allusions of ordering with the constructions of the theory of matrices and relations are (unnecessarily) cumbersome, complicate the understanding of the idea of constructing a model of balance in the generation of the material world (things), and therefore, for simplicity, the quantity of order is not associated with a system of atoms (things), but with each individual atom (thing) by attributing a thing to the degree of its (thing) inclusion in an ordered system, which, at a certain level of abstraction, is called the final product. The concept of the valency of an atom in chemistry, the valency (degree) of a vertex in graph theory – this is an indicator of the degree of “inclusion” of a thing (atom or vertex of a graph) in an ordered system.

IV. MODEL DESIGN

For each i-th subscriber, we introduce S_i, T_i, D_i which are the values proportional to the intensity of the thing flows actually generated, accumulated during the observation period, used by the i-th subscriber in the production process, respectively. As it was mentioned above, the law of conservation of matter is fulfilled in a balanced system:

$$X_{1S,1} + X_{21} + X_{31} + X_{41} + \ldots X_{n1} =$$
$$= X_{1,1D} + X_{1,1T} + X_{12} + X_{13} + X_{14} + \ldots X_{1n}$$
$$X_{2S,2} + X_{12} + X_{32} + X_{42} + \ldots X_{n2} =$$
$$= X_{2,2D} + X_{2,2T} + X_{21} + X_{23} + X_{24} + \ldots X_{2n}$$
$$\ldots$$
$$X_{nS,n} + X_{1n} + X_{2n} + X_{3n} + \ldots X_{nn} =$$
$$= X_{n,nD} + X_{n,nT} + X_{n1} + X_{n2} + X_{n3} + \ldots X_{n,(n-1)}$$

Here, $XnS_{,n}$ is the value proportional to the intensity of the thing flows generated by the subscriber itself n. If the subscriber is the country's economy, then $X_{nS,n}$ the essence is a value proportional to the intensity of the flow of extracted (per year) natural resources – mineral and biological, labor resources can also act as a data carrier (generator). $X_{n,nD}$ is a value proportional to the intensity of the thing flows used by a subscriber *n* in the production process. If the subscriber is the country's economy, then $X_{n,nD}$ is an essence of value proportional to the intensity of the consumed resource flows – own and borrowed; this may include, for example, hundreds of tons of mass (chemical) radicals of SO_3 scattered in the surrounding air and molecules of H_2SO_4 rom plant No. 512 of chemical technologies on the left bank of Kyiv in 1991 (an information source [4] for today does not provide statistics on this facility due to the untimely death of the latter).

As a rule, this is the value of the “destroyed” (dissipated) resource for energy production (in turn, spent on the production of things); and this part of “things” ceases to be associated with a particular subscriber. Nevertheless, further, within the article, we will assume that the mass represented by the variable of $X_{n,nD}$, does not leave the limits of the economy that generated it (see the assumption above). $X_{n,nT}$ is a value proportional to the intensity of the thing flows accumulated by subscriber *n* during the observation period. If the subscriber is the country's economy, then $X_{n,nT}$ is an essence of a quantity proportional to the intensity of the flow of things produced in a year (actually – the national wealth). In addition to this condition, the following is performed block by block, in relation to each subscriber.

For information flow from the subscriber of 1

$$C_{12}*X_{12} = B_{12}$$

$$C_{13}*X_{13} = B_{13}$$

...

$$C_{1n}*X_{1n} = B_{1n}$$

For information flow from the subscriber of 2

$$C_{21}*X_{21} = B_{21}$$

$$C_{23}*X_{23} = B_{23}$$

...

$$C_{2n}*X_{2n} = B_{2n}$$

...

For information flow from the subscriber of n

$$C_{n1}*X_{n1} = B_{n1}$$

$$C_{n2}*X_{n2} = B_{n2}$$

...

$$C_{n,(n-1)}*X_{n(n-1)} = B_{n(n-1)}$$

For $S_i, T_i, D_i \left(i = \overline{1,n}\right)$

$$C_{1S,1}*X_{1S,1} = S_{1S,1}$$

$C_{2S,2}*X_{2S,2} = S_{2S,2}$

...

$C_{nS,n}*X_{nS,n} = S_{nS,n}$

$C_{1,1T}*X_{1,1T} = T_{1,1T}$

$C_{2.2T}*X_{2,2T} = T_{2.2T}$

...

$C_{n,nT}*X_{n,nT} = T_{n,nT}$

$C_{1.1D}*X_{1,1D} = D_{1,1D}$

$C_{2,2D}*X_{2,2D} = D_{2,2D}$

...

$C_{n,nD}*X_{n,nD} = D_{n,nD}$

If the object of balancing is the country's economy, then *Cij* is an essence of the price attributed to (unit) X_{ij}.

In addition, the following conditions are performed

$$C_{1,1T}*X_{1,1T}+C_{12}*X_{12}+C_{13}*X_{13}+C_{14}*X_{14}+\ldots+ +C_{1n}*X_{1n}=G_1$$

$$C_{2,2T}*X_{2,2T}+C_{21}*X_{21}+C_{23}*X_{23}+C_{24}*X_{24}+\ldots+C_{2n}*X_{2n}=G_2$$

...

$$C_{n,nT}*X_{n,nT}+C_{n1}*X_{n1}+C_{n2}*X_{n2}+C_{n3}*X_{n3}+\ldots+ +C_{n(n-1)}*X_{n(n-1)}=G_n$$

There are also satisfied non-negativity conditions for variables.

V. FEATURES OF MODEL DESIGNS

The above conditions are the essence of a system of nonlinear equations with the additional restriction of nonnegativity. Here, $n(n+2)$ variables of X, as much – of C and B; variables of S, T, D, G – on n. There are $n(n+4)$ total equations. As it follows from the foregoing, under S, T, D, G we understand the “material” parts of GDP as truly generating flows of primary data. Suppose that the efficiency of production technologies of things (processing resources, streamlining matter from the outside and inside, adding value to matter) are constants: $Cij = const$. Then we have a homogeneous SLAE with a matrix of structure coefficients as it was shown above. If the Subscribers of the Internet of things are territorial associations (state economies), it is natural to assume that the “mass of the state” (literally!) does not change over time or changes slightly (of course, in the context of the picture of changes in this indicator in many economies of other states, and not with respect to the “mass” of the state itself), or the mass of the substance that forms (possibly only potentially) its (state) “thing value” changes insignificantly, i.e. under the assumption $Cij = 1$ $(i, j = \overline{1,n})$:

$X_{21}+X_{31}+X_{41}+\ldots X_{n1}=X_{12}+X_{13}+X_{14}+\ldots+X_{1n}$

$X_{12}+X_{32}+X_{42}+\ldots+X_{n2}=X_{21}+X_{23}+X_{24}+\ldots+X_{2n}$

…

$X_{1n}+X_{2n}+X_{3n}+\ldots+X_{nn}=X_{n1}+X_{n2}+X_{n3}+\ldots+X_{n,(n-1)}$

The model was tested on the example of balancing, in the sense accepted in this article, of the five groups of the most resource-holding state associations. A fragment of the model is given below.

$X_{1S,1}+X_{21}+X_{31}+X_{41}+X_{51}=X_{1,1D}+X_{1,1T}+X_{12}+X_{13}+X_{14}+X_{15}$

$X_{2S,2}+X_{12}+X_{32}+X_{42}+X_{52}=X_{2,2D}+X_{2,2T}+X_{21}+X_{23}+X_{24}+X_{25}$

$X_{3S,3}+X_{13}+X_{23}+X_{43}+X_{53}=X_{3,3D}+X_{3,3T}+X_{31}+X_{32}+X_{34}+X_{35}$

$X_{4S,4}+X_{14}+X_{24}+X_{34}+X_{54}=X_{4,4D}+X_{4,4T}+X_{41}+X_{42}+X_{43}+X_{45}$

$X_{5S,5}+X_{15}+X_{25}+X_{35}+X_{45}=X_{5,5D}+X_{5,5T}+X_{51}+X_{52}+X_{53}+X_{54}$

$X_{21}+X_{31}+X_{41}+X_{51} = X_{12}+X_{13}+X_{14}+X_{15}$

$X_{12}+X_{32}+X_{42}+X_{52} = X_{21}+X_{23}+X_{24}+X_{25}$

$X_{13}+X_{23}+X_{43}+X_{53}=X_{31}+X_{32}+X_{34}+X_{35}$

$X_{14}+X_{24}+X_{34}+X_{54}=X_{41}+X_{42}+X_{43}+X_{45}$

$X_{15}+X_{25}+X_{35}+X_{45}=X_{51}+X_{52}+X_{53}+X_{54}$

$C_{12}*X_{12} = 7.82$

$C_{13}*X_{13} = 15.70$

$C_{14}*X_{14} = 1.89$

$C_{15}*X_{15} = 282.09$

$C_{21}*X_{21} = 4.00$

$C_{23}*X_{23} = 6.00$

$C_{24}*X_{24} = 2.17$

$C_{25}*X_{25} = 120.83$

$C_{31}*X_{31} = 9.60$

$C_{32}*X_{32} = 9.42$

$C_{34}*X_{34} = 2.22$

$C_{35}*X_{35} = 286.51$

$C_{41}*X_{41} = 0.0$

$C_{42}*X_{42} = 8.30$

$C_{43}*X_{43} = 31.35$

$C_{45}*X_{45} = 213.45$

$C_{51}*X_{51} = 359.903$

$C_{52}*X_{52} = 518.18$

$C_{53}*X_{53} = 562.57$

$C_{54}*X_{54} = 1.40$

$C_{1S,1}*X_{1S,1} = S_{1S,1}$

$C_{2S,2}*X_{2S,2} = S_{2S,2}$

$C_{3S,3}*X_{3S,3} = S_{3S,3}$

$C_{4S,4}*X_{4S,4} = S_{4S,4}$

$C_{5S,5}*X_{5S,5} = S_{5S,5}$

$C_{1.1D}*X_{1,1D} = D_{1,1D}$

$C_{2,2D}*X_{2,2D} = D_{2,2D}$

$C_{3,3D}*X_{3,3D} = D_{3,3D}$

$C_{4,4D}*X_{4,4D} = D_{4,4D}$

$C_{5,5D}*X_{5,5D} = D_{5,5D}$

$C_{1,1T}*X_{1,1T} = 3590.5$

$C_{2.2T}*X_{2,2T} = 5679.84$

$C_{3,3T}*X_{3,3T} = 4260.62$

$C_{4,4T}*X_{4,4T} = 332.338$

$C_{5,5T}*X_{5,5T} = 12911.579$

$C_{1,1T}*X_{1,1T} + C_{12}*X_{12} + C_{13}*X_{13} + C_{14}*X_{14} + C_{15}*X_{15} = 3898.0$

$C_{2,2T}*X_{2,2T} + C_{21}*X_{21} + C_{23}*X_{23} + C_{24}*X_{24} + C_{25}*X_{25} = 5812.84$

$C_{3,3T}*X_{3,3T} + C_{31}*X_{31} + C_{32}*X_{32} + C_{34}*X_{34} + C_{35}*X_{35} = 4568.37$

$C_{4,4T}*X_{4,4T} + C_{41}*X_{41} + C_{42}*X_{42} + C_{43}*X_{43} + C_{45}*X_{45} = 585.438$

$C_{5,5T}*X_{5,5T} + C_{51}*X_{51} + C_{52}*X_{52} + C_{53}*X_{53} + C_{54}*X_{54} = 14353.632$

The analysis of this particular model showed that there is no one that generates initial data from the flow of things in order to satisfy the condition of material (duffel) balance (such as Leontyev's inter-branch in physical terms). Particular interest, in our opinion, should be the **inverse** problem, which consists in the following. The estimates of the annual increment of the data flow on IOT are known, coming from each object and calculated taking into account Assumption 1, i.e. p values are set for all objects. It is necessary to determine such values of *c* that the balance condition is fulfilled (by the criterion of maintaining mass order). You can find the values of c by easily reducing the problem to a mathematical programming problem with an objective function such as that used in the least squares method. The values of *c* thus obtained will represent, in our opinion, the objective prices (values) of things.

VI. CONCLUSIONS

The GDP indicator in value terms, containing only aggregated, indirect information about the intensity of the real physical flow of manufactured things, and derivatives from it, can be used to estimate the annual increase in the primary information load on the Internet of things, but taking into account the systematic error introduced by it.

GDP as a measure of the produced order introduces an error in assessing the annual increase in the information load and therefore more accurate than the increment of the primary annual information load on the Internet of things, expressed as the value of GDP, should be considered as the annual increment of mass order.

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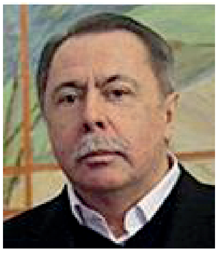

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