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THE MEASUREMENT OF REAL EXPENDITURE ON R&D FOR UKRAINE

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Abstract. The measurement of real research and development (R&D) expenditures is an issue for discussion, especially for countries with a high inflation, when general price indices do not correctly reflect trends in the cost of performing R&D. The aim of this paper is to present the procedure for the calculation of R&D price indices for Ukraine, which takes into account specific features of the country's research system. The paper analyses the theoretical background of the measurement of real R&D expenditures and methodological approaches to the calculation of R&D price indices. We have applied a Frascati Manual recommendation, according to which components of R&D expenditure are deflated by specific price indices. The experimental calculations of real R&D expenditures for Ukraine for the period 2001-2010 and the construction of R&D price indices are presented in this paper. The results obtained are new for Ukrainian statistics and they will be used in R&D statistics practice in Ukraine.

Keywords: research and development (R&D), R&D expenditures, R&D price index, R&D components, R&D deflator.

1. Introduction

A number of scientific publications are devoted to problems of the impact of R&D on economic growth and the estimation of real expenditure on R&D [1-10]. The measurement of the real impact of R&D on the growth rate of the economy is associated with procedures, which make it possible to convert current spending into spending in constant prices. Some researchers, for example Zvi Griliches have suggested that GDP deflator can be used for such calculations [2]. According to the opinion of other economists such as Mansfield, Romeo, Switzer, Jankowski and Cameron, the statement, that expenditure on R&D depends on prices in economy as a whole, are not relevant to the specific sectors [3-6]. For instance, under conditions of high inflation, the general price index (similar to GDP deflator) incorrectly represents changes of tendencies in expenditures on R&D. Thus, the above-mentioned scientists have proposed the construction of a special R&D price index.

This paper analyses the key methodological recommendations to construct and to calculate an R&D price index. It contains the results of research aimed at the development of the methodological approach to calculating an R&D price index for Ukraine. This approach will harmonise national and international methodologies, especially in the comparative analysis of data.

2. International experience in constructing R&D price indices

A common approach to R&D price index calculation in the countries of the Organization of Economic Cooperation and Development (OECD) is based on recommendations of the Frascati Manual [1]. The Frascati Manual suggests that deflators have to be used, as this helps to eliminate differences in prices. It also recommends the use of indices that allow changes in the weights of the components of R&D expenditure.

According to the recommendations of the Frascati Manual, the implementation of R&D price deflators is justified in conditions, when changes in expenditure on R&D deviate substantially from the dynamics of macroeconomic indicators or if the tendencies of change in expenditure on R&D are substantially different from similar expenditures in other sectors of economic activity.

The key recommendations of the Frascati Manual could be reduced to that the corresponding expenditures should be counted for the same sectors of economy. Attention should be focused on the cost of wages and salaries, which comprise almost half the total R&D expenditure.

The Frascati Manual proposes calculating R&D deflators by using weights calculated from specialized surveys, or using proxy price indices from national and international sources.

The basic approach to calculating of R&D deflator is to apply the combined index to all R&D expenditure. It could be calculated by using fixed or changing weights, and also by using the separate price indices of the individual expenditure items.

The R&D price index is calculated for different levels: for the whole GERD, for each sector of economy activity or, for instance, for scientific disciplines in the higher education sector.

A simple method to construct an R&D price index is to use Laspeyres and Paasche indices. However, the last version of Frascati Manual proposes to revise the recommendation to use these indices, because they do not provide reliable results. So Peter Hill, a famous specialist in the theory and practice of index implementation, stresses: "The tendency of Laspeyres and Paasche indices to diverge ("index number spread") over time is well known. A chain index should be used when the two situations being compared are dissimilar and when the linking can be achieved by passing through an intermediate point. Ideally, the intermediate situation would be one in which the pattern of relative prices would be approximated by some average of relative prices in the two situations being compared. In such case, chaining would reduce the index number spread between Laspeyres and Paasche" [1].

The Frascati Manual recommends applying a procedure of weighting by type of expenditure: current cost (labour costs, other current costs) and capital costs (expenditures on land and buildings; instruments and equipment).

It is not always possible to carry out a survey of R&D input. In this case, OECD's experts recommend the use of proxy price indices for each type of expenditure. These indices can be taken from the national accounts of the country or from other sources.

The problem of estimating real R&D expenditure is a subject of research by the U.S. Bureau of Economic Analysis (BEA). The BEA's experts' conclusions are based on a model of the innovator, where the innovation is a result of R&D, and the price of innovation is equal to the expected discounted volume of profit associated with the adoption of the innovation. They propose calculating two indices for measuring real R&D expenditure [7]:

– an output price index for the part of total R&D expenditure from NAICS 5417 (North American Industrial Classification System, "Scientific R&D services") (using market-based data);

– an aggregate input-cost price index for the remaining R&D expenditure (where market-based data are unavailable).

The BEA's experts suggest the utilization of only one R&D price index for deflation of R&D expenditure is an issue for discussion, because most of the costs are financed by the state.

Thus, the analysis of international experience shows that there are several approaches to the calculation R&D price indices. In our paper, we consider the issue of applying this international experience (and the corresponding methodological approaches) to the calculation of R&D price indices for Ukraine.

3. Methodological approach to calculate R&D price index for Ukraine

The methodological framework of our study is the theoretical foundations of R&D statistics and international the recommendations of OECD for surveys on research and experimental development with consideration for the features of national statistics.

It is necessary to transform R&D expenditure in current prices to constant prices for measuring real R&D spending. We have applied a Frascati Manual recommendation to the construction R&D price indices for Ukraine.

Thus, R&D expenditure in Ukraine is divided into three types:

– wages &salaries expenditure (with deductions for social expenses);

– other current expenditure (material costs, other material costs and other current costs);

– capital expenditure.

The structure of R&D expenditure in Ukraine is presented in Table 1.

Table 1. The structure of R&D expenditure in Ukraine

%

Year / Type of R&D expenditure	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
R&D expenditure (total)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
wages & salaries costs (with deductions for social expenses)	67.2	71.1	67.2	68.7	71.6	63.9	66.9	67.2	69.5	68.1
other current costs (material costs, other material costs and other current costs)	29.1	24.4	27.8	26.1	24.8	32.2	29.2	29.1	28.7	30.0
capital expenditures	3.8	4.5	5.0	5.2	3.6	3.9	3.9	3.8	1.8	1.9

Calculation of the authors from [11]

To deflate wages and salaries costs we propose to use an index of real wages, which reflects changes in the purchasing power of the nominal wages during the reference period. It is compared to the base period and is calculated by divining the index for R&D nominal wages (which excludes income taxes of private persons and compulsory payments to the social security fund during a certain period) by the consumer price index (CPI) for the same period.

Material costs, other material costs and other current costs are aggregated into one indicator. This approach is based on the results of an OECD survey, which showed that the deflation of each type of cost is a rather complex procedure. Thus, other current costs are deflated by the industrial producer price index, which is an indicator of changes in time of the prices of industrial production.

As a proxy for price indices for capital costs, a price index for fixed capital investment was used. It was calculated as an aggregate index for prices of construction and assembly operations, machinery and equipment, other capital expenditure and expenses that include the shares of these components in the total amount of investments.

The proxy price indices, which were used to calculate the R&D price index, are presented in the Table 2.

Table 2. Input data for the deflation of R&D expenditure

Type of R&D expenditure	Proxy price index	Source of the information
Wages & salaries expenditure	Index of real wages	State Statistics Service of Ukraine Annual data
Other current expenditure	Industrial producer price index	
Capital expenditure	price index for fixed capital investment	

The procedure for the deflation of R&D expenditure is described by the formula:

$$V^{\,t}_{p^{t-1}} = \sum_{j=1}^{3} \frac{v^{\,t}_{p^{t},j}}{i^{\,t}_{j}}, \tag{1}$$

where $V^{t}_{p^{t-1}}$ – volume of R&D expenditure in the reference year at previous year prices;

$v^{\,t}_{p^{t},j}$ – volume *of j-th* type of R&D expenditure at current year prices;

$i^{\,t}_{j}$ – price index for *j-th* type of R&D expenditure in the reference year;

t – superscript indicating the year under review (accordingly, t–1 – to previous year);

j – subscript indicating separate type of R&D charges, j = 1, 2, 3.

The R&D price index $I^{R\&D}$ is calculated as a ratio of the deflated R&D expenditure to the volume of R&D expenditure at previous year price ($V^{t-1}_{p^{t-1}}$):

$$I^{R\&D} = \frac{V^{\,t}_{p^{t-1}}}{V^{\,t-1}_{p^{t-1}}} \cdot 100\ \%, \tag{2}$$

After constructing the R&D price index, we can calculate an R&D deflator. It should be noted that issues of using deflators in different economies are under discussion. For instance, Russian experts propose to use implied deflator, because irregular change in the prices of different groups of goods and services are frequently observed [5, 6]. The R&D deflator is an implied deflator, which demonstrates the change of R&D expenditure and is calculated as the ratio of the volume of R&D expenditure at current prices to the volume of R&D expenditure at previous year price:

$$I_d^{R\&D} = \frac{V^t_{p^t}}{V^t_{p^{t-1}}} \cdot 100\%. \quad (3)$$

We can also calculate an R&D deflator by the ratio of the R&D expenditure index (growth rate) to the R&D price index:

$$I_d^{R\&D} = \frac{I^V}{I^{R\&D}} \cdot 100\%, \quad (4)$$

where the index I^V is calculated as ratio of R&D expenditure in current price for the reference year to those for the previous year:

$$I^V = \frac{V^t_{p^t}}{V^{t-1}_{p^{t-1}}} \cdot 100\%. \quad (5)$$

We construct time series by using both chain-linked and fixed base indices. We use the chain method to calculate indicators for the reference year in previous year prices. To calculate indicators in constant prices we use the fixed base method, according to which the selected year will be a base for comparison.

After having developed the above-mentioned methodological approach, we have conducted experimental calculations of R&D price indices and R&D deflators for Ukraine for a period of 2001-2010. Data for 2001 (prices of 2001=100%) were used as a base for comparison, because in Ukraine data on the all types of R&D expenditure in the required format have been collected only since 2001. The results of measuring the real volume of R&D expenditure in Ukraine are presented in Table 3.

Table 3. Deflated R&D expenditure in Ukraine

(mln. USD)

Indicators / Year	R&D expenditure, in current prices	R&D expenditure deflated by proxy indices	
		in previous year prices	in 2001 prices
2001	394.3	332.4	394.3
2002	423.5	389.9	391.8
2003	557.5	495.3	458.9
2004	703.5	572.1	468.6
2005	901.2	759.3	481.4
2006	1022.7	900.5	481.1
2007	1217.7	1038.9	488.7
2008	1042.2	907.5	555.4
2009	976.6	922.5	509.8
2010	1129.9	1095.3	568.3

Calculation of the authors from [11, 12]

The R&D indices, which were calculated for Ukraine for the period 2001-2010 in 2001 price, are presented in figure 1. Our calculations show that the nominal value of R&D expenditures in current prices has increased by a factor of 4.3. However, the real volume of R&D expenditure has increased by a factor of only 1.4, under calculations in constant prices. Such a significant difference has emerged due to impact of price changes. According to our estimates, the volume of R&D expenditure rose by a factor of 2.9 purely due to increasing prices.

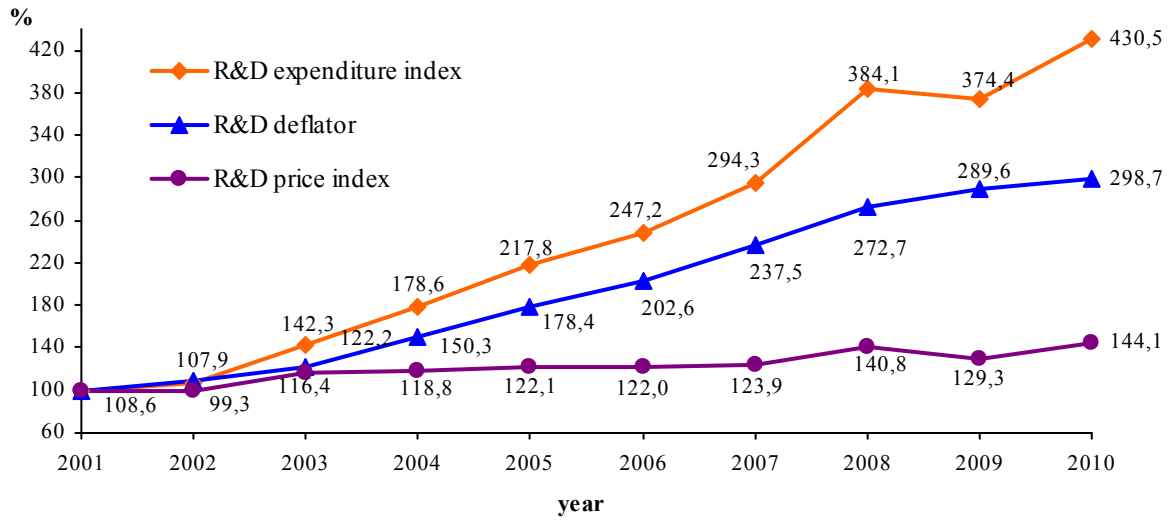

Fig 1. R&D expenditure index, R&D price index and R&D deflator for Ukraine during 2001-2010, 2001=100% (calculations of the authors from [7, 8])

4. Conclusions

The use of deflators in a transition economy is a complex problem. This is due to the fact that changes in different sectors can be very uneven, even during the period of data collection (usually years). As a result, a suitable proposal for a transitional economy with a relatively high level of inflation (10% and above) is to use the simplified approach. The utilization of more complex analytical tools can lead to serious distortions in the values of the resulting data, which describe the dynamics of the corresponding processes. However, taking into account that official data on the GDP deflator are provided with an almost annual delay, the method, which uses the price index for certain types of expenditure can be applied more quickly, because it is possible to receive required data at the beginning of the year.

The proposed methodological approach to measuring the real amount of R&D can be used for the calculations of expenses in separate scientific disciplines, types of economic activity, and also for the total expenditure as a whole, as discussed above.

The implementation of the proposed method will improve the Ukrainian statistical methodology and harmonise the national and international methodologies, especially in the comparative analysis of data on R&D expenditure in Ukraine and other countries.

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REALIŲJŲ IŠLAIDŲ MOKSLINIAMS TYRIMAMS IR EKSPERIMENTINEI PLĖTRAI UKRAINOJE VERTINIMAS

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Santrauka. Realiųjų išlaidų moksliniams tyrimams ir eksperimentinei plėtrai (MTEP) vertinimas ypač svarbus tokiose šalyse, kurioms būdinga didelė infliacija, kai bendri kainų indeksai nebeatspindi MTEP sąnaudų kitimo tendencijų. Šio straipsnio tikslas – pristatyti Ukrainos MTEP kainų indeksų skaičiavimo procedūrą, atsižvelgiant į šalies mokslinių tyrimų sistemos ypatumus. Straipsnyje analizuojamas realiųjų išlaidų MTEP vertinimo teorinis pagrindas ir MTEP kainų indeksų skaičiavimo metodika, taikant vadovo „Frascati Manual“ rekomendaciją, pagal kurią išlaidų MTEP komponentai defiliuojami naudojant tam tikrus kainų indeksus. Pristatomi eksperimentiniai realiųjų išlaidų MTEP Ukrainoje skaičiavimai 2001–2010 metais ir MTEP kainų indeksų sudarymo eiga. Gauti rezultatai bus naudojami rengiant šalies MTEP statistiką.

Reikšminiai žodžiai: moksliniai tyrimai ir eksperimentinė plėtra (MTEP), MTEP išlaidos, kainų indeksas, komponentai, MTEP defliatorius.