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# Current challenges related to the consumer price index (CPI) in Ukraine

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## ABSTRACT

The purpose of this study is to contribute to the maintenance and compilation of the consumer price index (CPI) in the current extreme situation caused by the Russian military aggression against Ukraine. In these extreme conditions, official statistics is faced with the task of maintaining the regularity, completeness and quality of the production of statistical information, including the CPI, which is one of the key economic indicators. The interaction between the ideal and conditional concepts of the index and their practical implementation is considered as a potential source of compilation improvement. The author argues that the main factor of the modern criticism of the CPI is the systematic deviation of the practical form of the index from its theoretical foundations. One way to solve this problem is to use new sources of information, especially big data cash registers. In today's extreme conditions, cash data can extensively address the issue of limited and untimely access to primary data sources needed to compile the CPI, as well as promptly take into account the changes in consumption patterns caused by significant migratory flows from the dangerous areas, and changes in the supply offer due to the rupture of supply chains.

**Key words:** consumer price index (CPI), Russian military aggression against Ukraine, ideal concept of CPI, conditional concept of CPI, cash registers, Big Data.

## 1. Introduction

The study focuses on current challenges facing consumer price statistics in terms of the evolution of views on the nature of the price index in accordance with current capabilities of official statistics and, above all, technological provision, and how the latter radically changes opportunities and challenges in compiling the CPI. This issue is relevant not only in terms of the CPI methodology, but also in light of the current limitations in obtaining primary data due to the war unleashed by the Russian

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Federation against Ukraine. In conditions where the sources of primary information are partially or completely inaccessible, official statistics requires a revision of the entire paradigm of index compilation starting with the collection of primary data to the method of their aggregation.

The existing challenges for the Consumer Price Index (CPI) are due not only to the current crisis situation, but have formed against the background of the inherent problems of this statistical indicator, which has existed since its inception. The CPI is one of the oldest statistical indicators, which is always in high demand and scrupulous attention from society. The CPI has gone through various stages of its development, both in terms of theoretical justification and methodological provision, and in terms of its practical implementation (Stoevska, 2018). But despite numerous efforts to improve the quality of the index, the CPI continues to be exposed to numerous critical remarks from experts and the general public. The question rightfully follows as to why, for more than a hundred years, the CPI has continued to provoke criticism, and what is the source of the so-called "imperfection" of the CPI, as well as what may be the ways to solve the issues in modern conditions.

For Ukraine, the current period of the CPI development is especially important, because along with the constant search for ways to improve the formula of the index it has set the task of producing official statistics in extreme conditions of military aggression. There is a need to revise the classical approaches to determining information sources and methods of information acquisition, processing and aggregation. This is certainly facilitated by the rapid development of e-commerce in goods and services, web resources and information technology, production and accumulation of big data. Access to fundamentally new sources of primary information creates the opportunity to review the traditional practice of calculating the CPI.

The paper comprises seven sections. Sections 2 to 4 describe the development of ideal concept of the CPI and its conditional concept and argue the reasons for the deviation of the latter from the index number theory. Section 5 deals shortly with issues arising in practical implementation of the conditional CPI concept, while Section 6 considers new data sources and respective prospects for the CPI. Section 7 concludes the essential findings of the study.

## 2. General issues

The officially accepted formula for calculating and aggregating the CPI is the Laspeyres Index. And the central issue of the modern methodological approach to the CPI is the fact that according to current practice, both at the highest level of aggregation

and at the level of elementary indices, the CPI is not a true Laspeyres index (Guide complémentaire, 2004). In this regard, two questions arise:

1) Why is the Laspeyres formula recommended for calculating the aggregate CPI?
2) What is the reason that in practice there has been such a significant deviation from the chosen theoretical formula?

Finding out the answers to these questions is important for being able to go beyond the established limits of the index compilation in order to adapt it to modern extreme conditions. The choice of the theoretical formula of the index and the further departure from its classical form in practical statistical activities are due to the simultaneous coexistence of theoretical, methodological and practical principles of the CPI. The source of problems in the implementation of the CPI is in the plane of constant confrontation of theory and practice. In the latest, 2020 edition, the CPI manual states that in modern conditions, it is possible to use different conceptual frameworks to address fundamental issues related to the nature of the index. At the same time, it is the conceptual basis of the index and the scope of use that should determine the method of its compilation (Consumer price index manual, 2020). The path from index theorizing to its practical implementation can be outlined using the following three levels (Sillard, 2017):

- *Defining the ideal concept of the index*, which is not directly observed, but the existence of which is a postulate of current classical theories.
- *Defining a conditional concept* that is generally acceptable and complements the ideal concept with a number of formulated conditions, thus bringing it closer to reality.
- *Practical implementation of the conditional concept* through its empirical validation through a series of experimental observations and estimates followed by full-scale statistical observations and index calculations using real data.

It should be understood that the results obtained during its implementation of the last stage serve as a source of improvement not only for the conditional concept, but also for the ideal concept of the index. In this regard, W. Erwin Diewert and Robert J. Hill proposed concepts such as *a true index* and an *exact index*. The true index corresponds to the concept of an ideal index. Such an index represents a goal, namely a phenomenon that needs to be measured. The exact index, in turn, is a practical implementation of the conditional concept of the index, while the latter is a transitional link between true and empirical indices. That is, the exact index is considered acceptable if it corresponds to the true index under the existing conditions with a sufficiently high level of approximation (Diewert and Hill, 2010).

Intervention in order to adapt the CPI formula to the extreme conditions of war in Ukraine is possible at all three levels. The most radical changes obviously occur when

reviewing the theoretical foundations, namely the ideal concept of the index. But this is a very complex process, and below we will consider the conditions under which it becomes not only possible but also appropriate.

## 3. The ideal CPI concept

The ideal concept of the CPI is based on both the theory of consumer behaviour and the theory of indices, while its conceptual framework is the System of National Accounts (SNA).

The theory of consumer behaviour suggests that the individual with the existing budget constraints behaves rationally, and his/her preferences can be transitive, and the choice is always in favour of cheaper goods.

In the context of the CPI as an aggregate measure of price levels evolution, it is the behaviour of the *aggregate representative consumer* that is an abstract being that represents all households together with their consumption in a given economic area and during elementary periods of fixed duration.

Ideally, household consumption means *the actual consumption of households within market (monetary) transactions* freely agreed between the supplier and the buyer (so-called "market" consumption). *Actual household consumption covers all goods and services* purchased by households to meet their own needs, whether or not these purchases were subject to expenditure by households. Actual consumption is thus broader in scope than final consumption, which corresponds only to household spending on consumer goods.

Actual consumption is considered to occur in a certain economic area. That is, it is a *place of purchase of goods or services by a representative consumer to meet his consumer needs*, not the place of his residence. The ideal index assumes that *time of purchase and time of payment for goods or services coincide in time, and the period of consumption is as close as possible to the time of purchase and payment*. Consumer demand always takes the form of goods or services, such as certain products that are sold in a commercial entity in a certain economic jurisdiction during the elementary period.

There are two types of elementary periods: those that are well comparable and those that are poorly comparable. Between two *well-comparable periods, consumption needs are identical in nature*. Instead, the number of units consumed may vary. *Periods that are poorly compared are combined according to the index number theory*.

It is believed that the utility function, which characterizes the consumer's choice, is constant between two well-comparable periods. The budget for consumption is considered exogenous (wages received and savings available).

*The ideal concept of a consumer price index reflects a change in the budget between two well-comparable periods acceptable to a representative consumer to maintain a constant level of utility.*

On the other hand, between two points belonging to two well-comparable periods, the same consumer need can be met by two different products, due to either a change in product characteristics or the disappearance of a previous product from a particular market and, consequently, the emergence and choosing to consume its substitute. Two products that meet the same consumer needs at the two time periods do not have the same characteristics and may not provide the same level of usefulness for a representative consumer. In this regard, adjustments are provided to eliminate the impact of changes in the quality on the level of consumer utility. *The ideal index should reflect the change in unit price with a constant level of quality.*

Thus, the ideal consumer price index should measure *the overall price evolution of all products (goods and services)* consumed by a representative consumer, i.e. be the average value of the evolution of these products. But since the weight of each individual product for the aggregate representative consumer is different, the simple average for calculating the overall index does not take into account the economic weight of each product consumed. In 1812, Young was the first to suggest an approximate weighting of relative prices according to their relative price for the period selected for the study, but did not specify an exact formula for determining weights (Consumer price index manual, 2004).

Hence, *the ideal consumer price index should be a weighted average value, the weight of which reflects the consumption structure of the aggregate representative consumer and, at the same time, does not distort the real dynamics of prices.*

In turn, as the average value of changes in the level of value consumed by the aggregate consumer, the ideal price index must demonstrate such an important property as *associativity*, therefore the ability to aggregate (disaggregate) from any level - price level, elementary indices, sub-indices to the highest level of aggregation.

In order to be able to compare poorly comparable periods, the ideal index should also be compiled into time series, in which any two levels can be compared both in the direction of past periods and in the direction of future periods. The main properties required to compile time series are *transitivity (or circularity) and reversibility.* Due to transitivity, it is also possible to find unknown values of the time series having, for example, the final value of the price level and the chain of indices. Reversibility, in turn, allows moving the base year in a dynamic series of indices, as well as in the direction of past and future periods. There are two paradigms for compiling time series (Balk, 2004): by directly comparing the levels of a data set and by constructing chain indices. The choice of paradigm depends on the chosen formula of the index.

The formula of the ideal price index is generally accepted to be a positive function, hence to demonstrate such property as *monotony* (von Auer, 2004).

Different approaches have gradually been developed to find an index formula that can best meet the requirements formulated for the ideal CPI concept. Today, there are two major schools for measuring inflation in the consumer sector of the economy: the Consumer Price Index (CPI) and the Cost of Living Index (CPI).

Most economic indices, including price indices, are based on the Divisia index, named after the French economist François Divisia, who in 1926 proposed a theoretical construct for building index number series for continuous market data on prices and quantities (Hulten, 2008). But in reality, economic data metrics are discreet, not continuous. Therefore, the reference to Divisia dynamic index numbers are usually the time series that exploit the Divisia's idea but are built for discrete time periods, which can be done using various formulas discussed below.

The general argument for choosing an index formula corresponds to three key approaches, such as the economic approach, axiomatic approach and stochastic approach (Diewert, 1995).

### *Consumer price index*

**The economic approach** assumes that the CPI aims to detect changes in the level of prices for consumer goods, regardless of the dynamics of consumed quantities of these goods between the two comparative periods, which is achieved by neutralizing the impact of quantitative changes on prices. To solve this problem, the general proposition is to fix the vector of quantities between these two periods.

The question naturally arises: the quantity of which consumed goods should be recorded? It is clear that the number of products circulating in the consumer market is immeasurable, and it is not possible to observe absolutely all goods sold and bought by the population. In this regard, Scottish economist Joseph Lowe in 1823 proposed for the first time the use of the so-called fixed set of quantities (products), in his own words – "reference standard" or "reference table". This means that a certain list is deliberately formed within certain groups of products, the amount of which should be recorded between the two time periods selected for comparison. And it is for products from this list that regular price registration and the CPI calculation are carried out. Therefore, *the economic approach is based on the hypothesis of the existence of a representative consumer basket.*

However, in Lowe's price index, the fixation of quantities is not limited to a specific period. It is assumed that you can use any fixed set of quantities, even hypothetical, that do not apply to any actual period of time. Due to this, the Lowe index can be used not only for comparisons of price dynamics over time, but also for spatial comparisons. And it is due to this that the Lowe price index, as well as elementary (unweighted)

indices, *well demonstrate the properties of transitivity and reversibility*. It should be noted that the Lowe indices are very widely used in economic statistics, and price indices are only part of the Lowe index family (Hill, 2010).

It should be understood, however, that the abstract nature of the quantitative vector in the Lowe index is not only its strength, but also its vulnerability. Weighting individual indices to values that do not reflect the real structure of consumption does not allow measuring the real dynamics of consumer prices. To solve this problem, German statisticians Etienne Laspeyres and Hermann Paasche in 1870 proposed indices named after them. The Laspeyres and Paasche indices are special cases of the Lowe indices and, like the Lowe indices, are not limited to price indices, but are widely used in various fields of statistics to measure evolution of price, production, turnover, GDP, and so on. Their difference from Lowe's indices is to specify the period of fixation of the vector, the impact of which must be neutralized (quantitative or price). Namely, in the Laspeyres index, the vector that is neutralized is fixed at the level of the previous period, and in the Paasche index - at the level of the current period.

The study of these indices allowed us to formulate a number of properties that are expected to demonstrate an ideal price index, namely: associativity, proportionality; invariance of the index in the case of proportional change of quantities; increase in the index for rising current prices; decrease of the index with the growth of the base price; the limits of the aggregate index, and the deviation between the Laspeyres and Paasche indices.

The deviation between the Laspeyres and Paasche indices is due to the negative covariance between them, which is known to indicate a systematic excess of the value of one variable over the value of another. That is, in the case of anticorrelation between price vectors and quantity vectors, the Laspeyres index somewhat overestimates inflation, while the Paasche index somewhat underestimates inflation. That is, for the same elementary indices, the value of the Laspeyres index will always exceed the value of the Paasche index while the Paasche index, on the other hand, does not systematically take into account the structure of consumption that existed in the previous (base) period.

The search for an ideal formula, free from the shortcomings of the Laspeyres and Paasche indices, gave impetus to the development of an axiomatic approach.

**The axiomatic approach** was formulated as independent by the British economist Alfred Marshall (1887), the American economist Korea Moylan Walsh (1921), the Irish economist Francis Edgeworth (1925) and the American economist Irwin Fischer (1930). Marshall proposed a modification of the Lowe index formula with a simple arithmetic mean of the two comparable periods, developed then in Edgeworth's work, which is why the corresponding index is named after two economists. A variant of this

index, but with the geometric mean of the two periods compared, was proposed by Walsh.

The Marshall-Edgeworth and Walsh indices demonstrate the property of reversibility. However, they do not have the ability to circularity, although their deviation from the target value for this property is smaller than in the case of the Laspeyres and Paasche indices. The values of the Marshall-Edgeworth and Walsh indices are located between the values of the Laspeyres and Paasche indices, i.e. with the help of these indices it is possible to reduce the systematic errors in measuring inflation, characteristic of the Laspeyres and Paasche indices. In the development of the ideas of Marshall-Edgeworth and Walsh, Fischer proposed an index that is the geometric mean of the Laspeyres and Paasche indices.

To select the formula of the index-candidate an axiomatic approach offers twenty tests to check its ability to demonstrate both the properties formulated in the economic approach and additional ones. All tests are grouped into six groups: 1) general; 2) for homogeneity; 3) monotony; 4) symmetry; 5) the limits of the aggregate index; 6) tests of the index of dual quantities.

Among the proposed indices, the only one that demonstrates all twenty formulated properties is the Fisher's index, which is why it is called the superlative index.

Within the axiomatic approach, the concept of the index as a weighted geometric mean of price level ratios was also developed, in which it is proposed to use a symmetric mean cost share (relative weights) for the two periods as weights. In this approach, fourteen properties that the candidate indexes must satisfy are formulated, and two formulas are proposed. Finnish statistician and economist Leo Waldemar Törnqvist (1936) proposed to use the *arithmetic* mean of the relative weights of two periods, and Walsh (in the development of his previous index) - the *geometric* mean of the relative weights of two periods. These indices are based on two important hypotheses. The first hypothesis assumes the separation of the weighting system in the calculation of the index. That is, if, for example, the price of only one commodity has changed between two comparative periods, the costs incurred by the consumer for other commodities will not affect the aggregate index. The second hypothesis assumes the invariance of the index in relation to the dynamics of prices for goods that for some reason did not gain weight. That is, if the price of only one commodity has changed between two comparison periods, but the weight of this commodity is zero, the aggregate index will be equal to one (or 100 percent).

Of the two presented indices, the Törnqvist index is quite symmetrical and fully meets the stated requirements, which is why, like the Fisher index, it was included in the group of superlative indices. The Törnqvist index is a further significant contribution to the formation of the ideal CPI concept, namely in the separation of the weighing system, which significantly increased the possibility of various operations *in case of*

*missing or incomplete primary data, as well as embedding other formulas for sub-indexes within the aggregate index.*

The results of calculations obtained using the Fisher and Törnqvist indices are quite similar in value. In some classifications, the Walsh index is also included in the group of superlative indices. The property of superlative indices is their ability to take into account both prices and quantities during defined periods. *Superlative indices are symmetric and provide a close approximation for theoretical price indices. The results these indices give are close in value.*

In general, the superlative index is defined in index number theory as equal to its own theoretical prototype (ideal index), defined for a particular functional form of its reference quantitative vector. Hence, it is an index that is "... a flexible functional form that can provide a second-order approximation to other twice-differentiable functions around the same point" (Diewert, 1976; Export and import price index manual, 2009).

The **stochastic approach** is based on the hypothesis that individual indices oscillate around a trend of the distribution of these indices. This idea was first proposed by the Italian economist Gian Rinaldo Carli in 1764, was deeply studied in the works of British economist William Stanley Jevons (1863), and finally substantiated by Edgeworth.

Within this concept, there are two approaches: 1) unweighted stochastic approach, and 2) weighted stochastic approach.

Within the *unweighted stochastic approach*, there are two types of indices - the Carly Index and the Jevons Index. The following hypothesis was formulated for the unweighted stochastic model:

- The lower limit of the price ratios is zero, and their distribution relative to zero is not symmetric.
- Model residuals (white noise) are independent, equally distributed, and centered random variables, hence, they are usually distributed around zero.

The aim of the model is to minimize the squared error of the residuals, which is achieved using the least squares method.

However, this approach was criticized by Keynes (1930), who questioned the existence of a general level of inflation, around which all price ratios randomly fluctuate, and thus the hypothesis of white noise, that is the independence of deviations between price ratios and overall inflation. Keynes noted that deviations between price ratios and overall inflation correlate with each other, and this correlation is largely due to the relative level of spending on consumed products (Diewert, 1995).

*The weighted stochastic approach* is also represented by two indices: the weighted version of the Carly index and the weighted version of the Jevons index.

For the weighted stochastic model, the hypothesis of heteroscedasticity (autocorrelation of residuals) was formulated, according to which price fluctuations of

one commodity affect changes in the price of other commodities, as well as the assumption that weighted individual effects compensate each other, therefore there is a collinearity effect. This means that, unlike the previous model, the weighted model contains an individual trend, and inflation specific to a particular product is the sum of total inflation and individual effect.

In general, with the help of both stochastic approaches, an attempt was made to justify the calculation of the aggregate price index as a certain form of the average. The advantage of a *weighted linear estimate* is that it generally coincides with the Laspeyres index (unbiased estimate of the overall inflation rate), while the *weighted logarithmic estimate* coincides with the formula of the Törnqvist index. Both are convenient to use and to calculate confidence intervals.

However, the stochastic approach, like any other, has its weaknesses. For example, a stochastic weighted estimate assumes that the larger the share of the budget spent on a given product is, the less its relative prices are dispersed around the mean, although no empirical evidence has been obtained for it.

Promising for this method is the possibility not to track prices directly, because it is not about a set of affordable prices, it is about the simple two-stage random sample (period and costs).

**The cost-of-living index (COLI)** is directly derived from the theory of consumer behaviour and is a kind of economic approach. Within the concept of the cost of living, such indices are considered as:

- The true cost index or the index of constant utility, proposed by the Russian economist Alexander Konüs in 1924;
- The superlative cost-of-living index proposed by the American economist Walter Erwin Diewert in 1976;
- Dynamic cost-of-living index proposed by the Portuguese economist Ricardo A. M. R. Reis in 2009.

The initial hypothesis of this group of indices assumes that in the event of an increase in the price of a commodity, the consumer can replace it with another commodity: minimizing the value provided that a certain level of utility is achieved. That is, the cost-of-living index is based on consumer preferences in terms of iso-utility choice and reflects the evolution of costs in different price contexts for the same utility.

The basic formula ***of the true Konüs cost-of-living index*** correlates the function of consumer expenditure at one-year prices with the function of consumer expenditure at another year's prices, therefore it is about the cost of achieving a certain level of utility (or standard of living) in one year relative to the cost of achieving the same level in another year chosen for comparison.

The achieved level of utility reflects the quantitative needs of the consumer, so a variation of Konüs index is a formula in which the function of quantities is used

instead of the utility function. This transformation brings Konüs cost-of-living index closer to the previously considered Laspeyres and Paasche indices (depending on the period of fixation of the quantity function).

However, the result of the calculation of the Konüs-Laspeyres cost-of-living index *is less* than that obtained using the classical Laspeyres index, while the result of the calculation of the Konüs-Paasche cost-of-living index *exceeds* the result of the classical Paasche index. Hence, it confirms the view that the Laspeyres index overestimates to some extent the cost of living and, accordingly, inflation, while the Paasche index does not overestimate the cost of living and inflation. The reason for this systematic error lies in the imperfection of the assessment of the substitution effect compared to the Konüs index (Manser and McDonald, 1988).

***Dievert's perfect indices*** are an approximation of the indices of constant utility. These indices give good results for cases of homothetic consumer preferences. This is the case when the utility function has a constant elasticity of substitution. Ideal cost-of-living indices include modified Törnqvist indices and all indices derived from the quadratic utility approximation (primarily the Taylor and Fisher indices).

The advantage of ideal cost-of-living indices is their ease of use in the sense that they do not require an assessment of the parameters of the demand function, while the shortcomings of these indices are common to the shortcomings of the corresponding classical price indices, which complicates their practical use and will be reviewed further.

The problem of this group of indices is also ignoring the fact of the existence of different categories of households and different markets for the same product (points of sale and sales network). In order to eliminate this shortcoming, the cost-of-living index was further developed by introducing the so-called "democratic" and "plutocratic" weights into its formula.

"Democratic" weights are obtained by averaging the weighted percentage of expenditures for the whole population. "Plutocratic" weights are calculated by dividing total aggregate expenditures by population number and, accordingly, give more weight to high expenditure households.

Studies show that the democratic index better reflects the impact of inflation on the average household, although in practice, because in many countries the plutocratic index is used to deflate national accounts and to measure inflation, it is rarely used (Guide complémentaire, 2004).

***The dynamic cost-of-living index*** measures the so-called dynamic inflation by extending the concept of the *constant* utility index to the idea *of a time-varying* utility function. In this model, uncertainty and expectations play a leading role, in contrast to the model with constant utility. This method is based, in particular, on the a priori

stochastic evolution of product prices (for example, price logarithms correspond to first-order autoregressive processes, VAR models, etc.).

This approach has the advantage of comprehensively modelling forms of intertemporal substitutions in consumer preferences, but longer than monthly substitutions. Interesting results are provided by long-term panel surveys, which show significant changes in preferences depending on age, social status and living conditions, as well as the transfer of budget savings between generations: from older generations to younger (help of middle-aged parents to student children) and, conversely, from adult children to elderly parents (when children who have reached a certain social status and income level, in turn, provide financial assistance to parents). According to Reyes, this dynamic inflation rate takes into account the fact that the consumer lives a large number of elementary periods and throughout his life will optimally (from his point of view) distribute their own consumption (Reis, 2009).

In summary, we can say that the ideal concept is a scientific hypothesis about the possibility of measuring inflation in the consumer sector of the economy using the chosen formula, which must meet a number of established requirements. The implementation of the presented theoretical concept is possible under the condition of its certain approximation. Such approximation is the expression of declared but difficult to observe phenomena through other, more accessible (close in value) or simpler ones, which is common practice in economic research. The process of approximation of the ideal CPI occurs through finding the conditional concept of the CPI.

## 4. Conditional CPI concept

The conditional concept of the CPI is the transitional link that allows further empirical testing of the theoretical (ideal) concept, and determines the methodological principles of the index. Expression of the ideal concept through the conditional concept reflects the real conditions for the economic agents of each country and the primary information accessibility. Adjustments are made to the basic components of the CPI, such as:

- aggregate representative consumer;
- actual final consumption of households;
- geographical coverage of the index;
- consumer needs units;
- comparison period;
- where, when and how the price of consumer products (goods and services) should be recorded;
- the aggregate index formula and the sub-indices formula.

Precision of the concept of aggregate representative consumer is taking into account different geographical and consumer categories of the population: residents-nonresidents and urban-rural population. According to the ideal concept, the price index should cover the entire population of the country, which consists of such categories as residents and non-residents, as well as urban and rural population. But in practice, there are a number of reasons that complicate this task, both due to the limited budget of statistical observations and due to limited access to certain data sources, thus leading to a significant deviation from the ideal concept.

Given the existing budgetary and organizational constraints, the factors of choice between urban and rural populations are:

- the purpose for which the price index is expected to be used;
- population of each category;
- contribution of consumption (transactions) of each category in the total amount of consumption;
- geographical accessibility for statistical observations;
- evolution of consumption structure and the ability to obtain data to build the weight structure of the index for each category.

The first parameter that outlines *the conditional limits of the* aggregate representative consumer is the choice between:

1) a resident, regardless of whether he carries out his consumption within the country or also abroad;

and, at the same time,

2) a resident and a non-resident, but under the condition of their consumption exclusively within the territorial boundaries of the country.

The need for such a choice is due to two different approaches to determining the national product in national accounting. The first approach is designed to calculate gross national product (GNP), and the second - to calculate gross domestic product (GDP). However, it should be noted that both approaches in their unchanged form are quite difficult to implement in consumer price statistics. In the first approach (GNP method) it is almost impossible to obtain information on consumption and prices of products of residents living outside the country. In addition, the consumption of residents abroad reflects the inflationary processes of the economy of their current stay. The second approach (GDP method) also makes it difficult to monitor on an ongoing basis the consumption patterns of non-residents living within the country: such households are volatile and statistical monitoring often requires appropriate legislation. Non-residents may also have an income level that deviates significantly from the average income level of residents, which introduces a systematic error in the weight structure. In addition, the share of non-resident households in the

total number of households in the country is usually very small, so the consumption inherent to them may not be considered as typical for a given economic area.

The choice between these methods is a very important issue in today's conditions when a large number of people temporarily left Ukraine because of the war. Classically, residents who consume within the territorial boundaries of the country are the only appropriate conditional definition of the aggregate representative consumer. But should the CPI of Poland, for example, take into account the consumption of millions displaced Ukrainians? And does the current CPI of Ukraine take into account the real structure of household consumption, when households are largely truncated because of population migration?

The second parameter of the formation of the *conditional boundaries of the* aggregate representative consumer is the representation of urban and/or rural population in its structure. In favour of the rural population there is the fact that in the case of using the index to analyze poverty, the registration of prices in rural areas is more informative than in cities. In addition, in the vast majority of countries, the rural population significantly outnumbers the urban population. At the same time, the volume of money transactions for the purchase of goods and services in rural areas is smaller compared to urban agglomerations, hence for the price index the total weight of urban consumption is more significant than in rural areas, while the cost of registering prices in rural areas due to territorial dispersion, and often limited availability, is significantly higher.

The decisive factor in choosing the coverage of the population for the CPI is the ability to obtain and timely update the weights to build an aggregate index. Changes in the structure of urban consumption happen faster than in rural areas, both due to greater availability of new goods and services in the city and due to a more dynamic and less traditional way of life. And because scales for rural households are rarely available for measurement, the ultimate preference is often given to the urban population. The last factor is especially important in times of war when rural zone accessibility is restricted for statisticians.

Thus, in the conditional CPI concept, the definition of the aggregate representative consumer is much narrower than in the ideal concept, and in the vast majority of cases it covers *urban households that consume within a specific economic jurisdiction (country).*

The definition *of the actual final consumption of households in the conditional index* directly follows from the definition of the aggregate representative consumer as consumption within a certain territory. In addition, it is also determined by the time factor and the chosen method of estimating consumption costs, namely – the choice between methods: purchase, use, and payment.

In the case *of purchase*, it means the *moment of purchase of* goods or services, regardless of when they are actually used or consumed. The moment of purchase of goods is the moment of transfer from the seller to the buyer of ownership of the goods or services. In the case *of use*, it is the *period during which the product is consumed or used many times.* Payment means *the period of time of actual payment for a product,* which may differ from the period of purchase or use.

The choice of method depends, on the one hand, on the structure of consumption, and, on the other hand, on the development of banking services and payment system in trade and services. The first means that the share in the structure of consumption of fast moving, semi-durable and durable consumer goods and services varies from one country to another. In poorer countries, the share of fast moving consumer goods is much higher than in developed countries, while the latter are characterized by significant volumes of durable consumer goods and services. On the other hand, in developed countries there is a widespread practice of seasonal sales and discounts, when goods are sold cheaper than usual, and the consumer tends to buy on this occasion bigger quantity of goods than she currently needs to consume or use them future periods. Economically advanced countries also have a developed and extensive banking system and offer financial services in the form of bank checks, credit purchases, online payments and remittances, which are often prevalent in trade as opposed to cash. E-commerce became especially widespread during the COVID-19 pandemic. The preference for non-cash payments was also given by the banking system of Ukraine in the first months of the war, which allowed reducing the outflow of large money from the bank accounts of consumers. E-commerce in Ukraine is facilitated also by the well-developed shipping business, which is flexible according to the need of the customers, even during wartime.

A new trend in the behaviour of Western consumers, which is getting more widespread, is also the purchase of goods on individual orders in accordance with the proposed samples. This is a deliberate deferred consumption (sometimes up to 2 months) of the ordered goods, which are not mass-produced, but only on individual orders. The goods bought in this way are of course more expensive, but are more relevant in terms of compliance with modern fashion trends and personal preferences. This approach also suits both the producer and the seller, because it allows not to invest in mass production of products that often do not find their consumer, settle in warehouses and eventually gets destroyed or deposited in landfills of poor countries, which entails losses for the owner, and environmental pollution.

This means that in countries with a less modern system of financial services, less e-commerce and a more traditional style of consumption, the time lag between the moment of payment, purchase and consumption can be either insignificant or non-existent, and accordingly, the three methods of determining the actual household final

consumption considered to produce similar results. For this reason, according to the CPI Manual, the vast majority of countries use the purchasing method to determine consumer spending (Consumer price index manual, 2020). However, the rapid evolution of trade methods requires a revision of this approach, and many statistical services make some adjustments to determine the actual final consumption. This adjustment allows the direct use of big data on real-time transactions made by the population to purchase and pay for consumer goods and services, which reduces the restrictions on obtaining primary data imposed by the war conditions.

By general agreement, there are *units of homogeneous needs and units of heterogeneous needs*. Units of homogeneous needs cannot be replaced. Units of heterogeneous needs are interchangeable with a substitution elasticity equal to one. Units of needs are defined at the level of the elementary market, which corresponds to the market of a particular type of product or service for a particular area. Outside the specified elementary market, the units of needs cannot be replaced. Together with the "purchase" method, this satisfies the requirement of an ideal concept such as tracking prices at the place of purchase of goods and services, not at the place of residence of the consumer. The type of product or service corresponds to a variety of products. In the case of goods or services purchased over the Internet, only their parameters are taken into account to determine their basic market.

The specification of the elementary comparison periods depends on such factors as *cyclical consumption* and *price volatility* for a particular product. It is necessary to distinguish between the period of comparison and the frequency of registration of prices.

The production and corresponding renewal of stocks of goods in sales outlets largely depend on how often the consumer needs to purchase them. For example, fresh food can be renewed in stores on daily basis, two or three times a week, weekly or decadal, which, in turn, may be accompanied by changes in price and range.

Price volatility also depends on the type of product and the system of its commercialization. For example, ticket prices for the same flight of the same airline can fluctuate significantly each time a consumer makes an online request. The greater the volatility in the price level of a particular product, the more frequent is the need for its registration, which is especially relevant in wartime, when the established periodicity of price registration can be radically revised.

The months of the year were chosen as the conditional CPI concept as the comparison periods. The month corresponds to the smallest standard business cycle, which covers production-sales-consumption of most products. During the year, each current month (month of observation) is compared directly with December of the previous year. Every two of such months *are considered to be well comparable.* The argument in favour of December is the existence of a pronounced annual

(calendar) periodicity of changes in price levels. December is the final month of the year and at the same time a transition between two consecutive years. January marks not only the beginning of the year, but also the beginning of economic recovery, which is systematically accompanied by new orders and rising consumer prices. All other periods *are considered hardly comparable.* In the event of an emergency situation not at the beginning of the calendar year, but later, the question arises of the comparability of the periods that actually characterize such a situation and the periods before its occurrence.

The properties of transitivity and reversibility are well demonstrated by elementary, that is unweighted, indices. However, as we know, the CPI should take into account not only the changes in the level of prices of consumed products, but also the structure of final consumption, so the aggregate CPI cannot be calculated as a simple average value from elementary indices, but only as a weighted average. For each well-comparable period, the system of consumer expenditure weights of units of needs is based on the consumer expenditures of households registered for the previous year as a whole. At the same time, in the conditions of high instability of the structure of household consumption during the war, caused primarily by the migration of many households from dangerous regions and the formation of the so-called "truncated" households, the system of weights needs to be significantly updated.

Thus, according to the conditional concept, the CPI is an indicator of the monthly average change in the level of prices paid by urban consumers for the market basket of goods and services (Konny et al., 2019), which, however, must be substantially clarified in the light of the extreme conditions of war.

The choice of formula for the conditional CPI concept depends on a number of factors and is related to the chosen approach and practicality. Conceptualization of a common approach to a possible assessment of consumption inflation, namely *a choice between CPI and COLI*, depends on statistical tradition: American (USA and Canada) and European. The American school considers COLI as an ideal target metrics, while the European school prefers the CPI. Accordingly, in the American school the conditional concept of the index is substantiated within the limits of COLI, and in the European school - within the CPI. Hence, this is the justification of a particular formula of the aggregate index and, if necessary, sub-indices.

Among those considered within the ideal concept, the basic formulas for the aggregate index are: Laspeyres, Paasche, Marshall-Edgeworth and Walsh, Fischer, Törnqvist. In terms of the ideal concept and in accordance with the requirements formulated within the economic, axiomatic and stochastic approaches, the best properties are shown by the Törnqvist index (Table 1) (Chauvet-Peyrard, 2014).

**Table 1.** Estimation of theoretical properties of indices for aggregate CPI estimation

*(3 points - the best score, 2 points - the average score, 1 point - the worst score,* x *- is not considered within the specified method)*

| Approaches | Aggregate index formulas | | | | | |
|---|---|---|---|---|---|---|
| | Laspeyres | Paashe | Walsh | Jevons | Fisher | Törnqvist |
| Economic | 1 | 1 | 2 | 1 | 2 | 3 |
| Axiomatic | 1 | 1 | 2 | 2 | 3 | 3 |
| Stochastic | 1 | 1 | 1 | 2 | x | 3 |

Fisher's index is also effective from the point of view of the axiomatic approach and somewhat worse from the point of view of the economic approach. The Walsh and Jevons indices also meet the requirements of the axiomatic approach quite well, although the Walsh index has better properties from the economic point of view and the Jevons index from the point of view of the stochastic approach. It is interesting to note that the Laspeyres and Paasche indices have the lowest score for all three approaches. According to the results of the generalization presented above, if we proceed solely from the theoretical properties of all these indices, preference should certainly be given to the Törnqvist and Fisher indices. However, numerous empirical studies indicate the existence of a number of limitations in their practical application. In fact, only the Laspeyres index and to some extent Jevons are possible for practical application (Table 2).

**Table 2.** Evaluation of practical properties of indices for aggregate CPI evaluation

*(3 points - the best score, 2 points - the average score, 1 point - the worst score,* x *- not possible for practical use)*

| Aggregate index formulas | | | | | |
|---|---|---|---|---|---|
| Laspeyres | Paashe | Walsh | Jevons | Fisher | Törnqvist |
| 3 points | x | x | 1 point | x | x |

It should be considered, however, that even the Laspeyres index in its theoretical form cannot be directly used in statistical practice, but requires some modifications. Practical use of index formulas is influenced by such factor as a*ccessibility and timeliness of inflow of primary data necessary for CPI compilation on a regular basis*. Since, according to all the above-mentioned formulas, the aggregate CPI is an averaged value of various kind, its calculation requires primarily two types of primary data: the structure of consumption of goods and services and registration of price levels. The availability of these data is a decisive factor in developing a conditional CPI concept. Unlike all the considered indices, the formula of the Laspeyres index assumes the use of data that can (with some conditions) be obtained at the time of the operational calculation of the index by official statistics.

Thus, in practice, the processing of data on household expenditures surveys takes a long time, so there is a lag between the period of the survey of unit costs and their first use to compile the index. This, of course, makes it impossible to use the Laspeyres formula for real-time CPI compilation. Therefore, the share of costs obtained for the previous period can be used to weight price changes provided by the transformation of the classic Laspeyres formula into the formula proposed by Jung in 1812 [Consumer price index manual, 2004], in which the period of the weight structure of the index is independent of the comparison periods. The Laspeyres index advantage is also in the fact that the formula allows for an easy solution to the task of inclusion to the common system of calculation of other formulas for the lowest levels of aggregation. It is not possible to obtain a weight structure at these levels, so the formulas of Carly, Jevons and Dutot are the basis for elementary sub-indexes. The Carly index is the arithmetic average of individual indices, while the Jevons index is the ratio of the geometric average of individual price levels, and the Dutot index is the ratio of the arithmetic average of individual price levels.

***Practical implementation of the conditional CPI concept***

Practical implementation is the application of a random variable arising from previous assumptions, by organizing statistical observation. The practical implementation of the conditional concept includes numerous stages that generally correspond to those given in international recommendations and methodological materials of the State Statistics Service of Ukraine (Methodological provisions. State Statistics Service of Ukraine. 2020):

In the context of the transformation of the ideal concept (through the stage of the conditional concept) to its practical implementation, it is important to take into account the impossibility of direct use in statistical practice not only the ideal but also the conditional concept. That is, even the conditional CPI concept needs some adaptation in order to be able to collect data and calculate the index on a regular basis, while ensuring the continuity of the time series. This is mainly due to the fact that consumer needs, on the one hand, and the market supply of goods and services, on the other hand, are not fixed in time. Changes in the economic conditions of life, the impact of the technical progress and fashion push the consumers to seek new degrees of usefulness, which naturally entails the emergence of new and disappearance of obsolete, morally and technologically, products. In turn, the manufacturers are in constant pursuit of models and developments of new competitive goods and services that they could offer to the consumers and thus encourage them to regularly review their preferences in favour of more expensive goods and services. This circle is thus an upward spiral, in which the renewal of supply is accompanied by changes in product quality and rising consumer prices.

To this is added the phenomenon of seasonality of goods, which periodically partially or completely disappear from the market, and appearing next season, have, as a rule, new characteristics and higher prices. All this requires a corresponding adjustment of the conditional index formula.

There are numerous techniques for taking into account the disappearance of old and the emergence of new products and, accordingly, taking into account changes in product quality. An important point in terms of the adaptation of the conditional concept is that their application requires the separation of calculations for the respective product groups using a whole arsenal of models and formulas. As an example, we can cite the approach of *option pricing and production cost*, as well as *hedonic regression*, which are widely used in the practice by leading national services [Chauvet-Peyrard, 2014]. In the case of the option pricing and production cost approach, the difference in price can be taken into account due to the difference in the total price of options that complete the finished product, i.e. the price is formed as the sum of base cost and added options cost. A striking example of the option method is the price of cars, which can vary significantly within one model, depending on the options chosen by the buyer.

In turn, the hedonic approach assumes the existence of an implicit market for all possible product characteristics, and the product itself can be likened to a certain vector of characteristics, i.e. it is believed that there is a real product for any possible combination of characteristics under conditions of perfect competition. It is assumed that the consumer maximizes his own utility in the face of budget constraints, so that the marginal utility provided by each characteristic should be equal to its marginal cost. Hedonic regression of quality adjustment is often used in the case of monitoring the prices of high-tech goods and services. The products for which this approach is considered appropriate are those that are sold in highly competitive and dynamic markets and, accordingly, change rapidly, but at the same time, they are not difficult to track on a regular basis. These include products such as computers, computer software and IT tools, as well as Internet services and more.

The attempt to improve the quality of the aggregate index through the use of numerous additional adjustments based on inclusions in the basic formula gives a compilation of the practical concept of the index. This, in turn, significantly distances practical concept from the conditional concept, which is a potential source of systematic criticism. Is it possible to resolve this contradiction? And how can this be taken into account when constructing a consumer price index in the current extreme situation?

As the experience of recent years shows, great prospects in this sense exist in the development of fundamentally new sources of information and in new technologies for primary data registration, processing and storage.

***New sources of information and prospects***

Today, in statistical practice, such sources of primary data are traditionally used to build the CPI, such as:

1. Household budget survey;
2. Price collection survey: price registration is carried out by price collectors from different outlets and often with use of electronic devices.
3. Data of websites where relevant goods or services are sold: data are registered either by statisticians manually or with the help of robots (web scraping) and special mobile applications. Some institutions provide statistical services with their own Application Programming Interface (API) for direct access to pricing information. Collecting data with the API is often simpler and clearer than long-term support for web scraping code.
4. Administrative data: files of administrative records on prices and levels of consumption of certain, primarily social services and goods.

All of these sources have both strengths and weaknesses. The main problem is the growing distance of the conditional concept from its ideal prototype. First, because the CPI aims to measure the constant quality of price change, over time, when a particular product disappears from sale, it is necessary to choose a substitute product, and any change in quality between the original and the substitute product must be evaluated and eliminated to display the so-called "net" price change. Second, new products entering the market must be accounted for in a timely manner with an appropriate economic weight for which data are not available. Third, the CPI is based on samples that may contain systematic error. Finally, traditional data sources often provide only supply prices and not actual consumption prices, as they do not reflect the practice of discounts, which is very common and takes various forms in the retail system.

Alternative sources that different countries have been developing recently are:

1. Third-party data are data collected by a third party that contains prices for goods or services obtained from several sources. The third party is the so-called aggregator, which standardizes the elements and structure of data obtained from various commercial institutions. Such datasets are usually obtained by official statistics on a paid basis, or, in some cases, free of charge.
2. Corporate data (that is that owned by corporations or companies) is a set of data obtained directly from the headquarters of a company that collects data in its own outlets or collects it on sales websites. Because such datasets are usually created for internal use, it is the owner who determines the architecture of this data. The information provided to statistical agencies is that the company is willing to provide, i.e. may vary in structure, so statisticians should negotiate with data owners on the optimal level of detail to ensure the confidentiality of personal records. Adapting the obtained corporate data to statistical needs is one of the key challenges when using such sources.

The most promising source of information on the evolution of consumer prices in corporate data is direct *cash data of sales outlets (data of cash registers)*. Cash register data refer to transactions that reflect both the price paid for each unit of goods and the number of units of goods purchased. These data are automatically registered and collected by retailers when the buyer goes through the cash register and pays for the goods purchased by him.

Cash register data have long been used in marketing research. But in recent years, leading statistical agencies have also initiated first pilot and later regular collection of cash data for statistical purposes, namely to build the CPI. Among the pioneers in this field are the national statistical agencies of the Netherlands (the first CPI publication calculated using cash data was published in 2002), Norway (2005), Switzerland (2008), Sweden (2012) and Belgium (2015), Denmark (2013), Iceland (2016), Luxembourg, Italy (2018), France (2020) and the United States (2021). A significant methodological contribution to the cash data adaptation for statistical purposes was made by Eurostat (2017).

Due to certain difficulties, the use of cash register data to build national CPI is currently limited to certain items of goods sold in supermarket and hypermarket chains. The use of cash data implies the presence on each product of a global item number (Global Trade Item Number - GTIN), which is a 14-digit international product number. Thanks to the GTIN, it is possible to scan and computer data on each product throughout the commercialization chain. These codes are an internationally recognized system and are supported by the international organization GS1.

The main motive that prompted the development of cash data as a new resource of statistical information was the need to restructure official statistics in accordance with the requirements of the big data era (because cash data are a kind of big data). In addition, it is also obvious that it is expedient to use this type of corporate data for statistical purposes in conditions of limited access to traditional sources of information, which is especially relevant in the context of Russian military aggression in Ukraine.

From a financial point of view, this resource is to some extent "free" for statistics, as the production of cash data is outside the statistical process, even if their processing for statistical use requires significant investment.

Also, the obvious advantage for statisticians is the comprehensive nature of cash data, real-time data flow and the availability of previously unavailable information, namely the number of units consumed and the corresponding household expenditures, which certainly opens up many opportunities for price statistics (Leclair, 2019).

A fundamental component of the price index number theory and, accordingly, the ideal CPI concept is the availability of real-time information on household expenditures. Until recently, such information was not available, so theoretically perfect formulas, such as superlative indices, could not be used in statistical practice.

Access to cash data allows not only to improve the CPI estimates, but also to bring the aggregate index formula closer to its ideal concept (Konny et al., 2019).

The comprehensive nature of cash data allows for more accurate statistics and the possibility of creating more detailed versions of consumer price indices, for example, by specific segments of consumption. Experimental studies have shown that cash data can also be used successfully for spatial price comparisons (Léonard et al., 2019).

We should also take into account the current trend towards branching out and consolidating the network of sales outlets of various sizes in both urban and rural areas. In many cities, the so-called "neighbourhood" trade is becoming more widespread, offering goods in small supermarkets in urban areas, but not on the outskirts of cities. On the other hand, modern residents of small settlements, traditionally not covered by the CPI survey, are increasingly buying consumer goods in large supermarkets located in their region, which are becoming the norm in rural areas. The possibility of directly obtaining cash data from supermarkets allows at the same time to better cover the urban population and include data on rural consumption, thereby significantly increasing the level of representativeness of the CPI, both nationally and regionally. This, in turn, brings the practical concept of the aggregate consumer closer to its ideal vision.

Cash data allow us also to quickly identify new products that need to be added to the CPI basket, or products that are obsolete and that should be removed in order to update and match the basket to the actual structure of household consumption. The same applies to the timely recording of changes in the structure of household consumption caused by mass migratory flows of the population during the war.

Thanks to detailed cash data, it is also possible to choose index formulas that can take into account the lowest level of substitution aggregation carried out by the consumer due to rising prices during the two observation periods (Leclair, 2019).

In general, *cash data better control the concept of price to be measured by the CPI than traditional methods,* as the prices reflected on price tags may differ from the prices actually paid by the consumer through various promotions.

It should also be kept in mind that the detection and replacement of products that appear and disappear during the year is an operation that requires significant human resources. The continuous nature of cash data allows one to automatically search for the previous price of the required product in the data accumulated over previous periods, which is also highly relevant in extreme conditions, when supply and price levels are very volatile.

Today, there are two common approaches to the use of cash data: sampling data collection and exhaustive data collection.

The sampling data collection is the most common among countries that already use cash data to build the CPI. Cash data provide an opportunity to form a qualitative basis for the sample, namely - the list and parameters of all goods sold in sales outlets, with the weight of each of these items in the turnover of sales outlets, which allows random selection of products, on the one hand, and on the other hand, to control the sample bias.

The exhaustive data collection has been developed and implemented in Danish statistical practice since 2013. The use of the exhaustive data collection was primarily aimed at reducing differences in the approaches used by statisticians for different sales outlets and consumer goods within the Danish CPI. That is, it is possible to apply a generalized approach and an index formula to a significant number of goods and services, which significantly reduces the compilation nature of the practical CPI formula mentioned above. Today, this approach is still used for uniformly defined groups of goods. According to the proposed methodology, the price index is calculated as the ratio of the turnover index and the weighted quantity index, i.e. it is the Geary-Khamis method applied to time series. At the same time, the quantitative scales for homogeneous goods are updated monthly during the current year, based on the prices and quantities of sales registered by sales outlets, which is highly relevant in wartime. The advantage of this method is that it does not cause bias in chain indices, because at the end of each year such price indices coincide with transitive indices (Chessa, 2016).

The challenge of working with large cash data is their incomparably greater volume than traditional data. For example, in France it is 1.7 billion monthly records received in real time [Leclair, 2019]. The procedures for their transmission through communication channels, processing, storage and protection differ significantly from those provided for traditional statistical data sets. According to the international experience gained in recent years, a prerequisite for the successful involvement of cash data in the CPI calculation covers a number of issues (Leclair, 2019), namely:

- evaluation and analysis of new sources of information;
- legal support of the right of statistical access to them;
- form of data access (free / paid), budget and frequency;
- data reliability;
- methodological support;
- and technological capability of national statistical services to gather, treat and storage cash data.

## 5. Conclusion

The current challenges in the field of price statistics are both new and ancient, i.e. related to the conceptual framework of the CPI. The natural transition from the theoretical concept of the index to its conditional concept and then to its practical implementation has led to a significant deviation of the aggregate formula from the theoretical foundations. This contradiction can be resolved by revising the paradigm of sources of statistical information for the compilation of the CPI. The use of big data, especially direct cash data, has the potential to reduce the cost of statistical surveys,

expand the sample size and improve its design while reducing the burden on respondents, obtaining more reliable data on transaction prices and comprehensively improving the price index by including real-time information on household expenditures (Konny et al., 2019).

The revision of the paradigm of primary data sources allows for a significant reduction in the methodological and organizational limitations imposed by the extreme conditions of Russia's military aggression against Ukraine. In the conditions caused by the war, this kind of information allows regular estimates of the consumer price index for a large number of goods without the loss of quality, and control the structure of consumption both in general and by region, and opens prospects for reducing discrepancies between conventional concept of the CPI, its ideal concepts and their practical application.

## References

Balk, B. M., (2004). Direct and chained indices: a review of two paradigms. URL: https://www.researchgate.net/publication/228443023_Direct_and_chained_indices_a_review_of_two_paradigms.

Balk, B. M., (2018). Mixed-form indices: a study of their properties. URL: https://ec.europa.eu/eurostat/cros/system/files/euronaissue1-2018-article3.pdf.

Chauvet-Peyrard, A., (2013). Les indices de prix. De la théorie à la pratique. URL: https://dokumen.tips/documents/cours-les-indices-de-prix-de-la-theorie-a-la-pratique-acp-version-publique-2013.html.

Chessa, A. G., (2016). A new methodology for processing scanner data in the Dutch CPI. URL: https://ec.europa.eu/eurostat/cros/system/files/euronaissue1-2016-art2.pdf.

Consumer price index manual. Concepts and Methods – 2020. International Labour Office. International Monetary Fund. Organisation for Economic Co-operation and Development. European Union. United Nations. World Bank.

Diewert, W. E., (1995). On the Stochastic Approach to Index Numbers. Document of discussion, no DP 95-31, University of British Columbia.

Diewert, W. E., Hill, R. J., (2010). Chapter 12 Alternative approaches to index number theory. Price and productivity measurement: Volume 6 – Index Number Theory. URL: http://www.indexmeasures.ca/Vol6_10,09,26.pdf.

Diewert, W. E., (1995). Axiomatic and economic approaches to elementary price indexes. *NBER Working Paper*, No. w5104.

Diewert, W. E., (1976). Exact and superlative index numbers. *Journal of Econometrics,* 1976, vol. 4, issue 2, pp. 115–145.

Export and import price index manual: theory and practice, (2009). International Monetary Fund, Washington, D.C.

Guide complémentaire du Manuel de l'indice des prix à la consummation, OIT, (2004). URL: http://www.imf.org/external/data.htm#guide.

Hill, T. P., (2010). Lowe indices. *Price and productivity measurement*, Vol. 6, pp. 197–216.

Hulten, Ch. R., (2008). Divisia index. The New Palgrave Dictionary of Economics, 2nd ed.

Konny, C. G., Williams, B. K., Friedman, D. M., (2019). Big Data in the U.S. Consumer Price Index: Experiences & Plans. URL: https://www.nber.org/books-and-chapters/big-data-twenty-first-century-economic-statistics/big-data-us-consumer-price-index-experiences-and-plans.

Leclair, M. et al., (2019). Utiliser les données de caisses pour le calcul de l'indice des prix à la consummation. *Courrier des statistiques*, 3, pp. 61–75.

Léonard, I., Sillard, P. & Varlet, G., (2019). Écarts spatiaux de prix dans l'alimentaire avec les données de caisse, Economie et Statistique/*Economics and Statitistics*, 509, pp. 73–87.

Manser, M. E., McDonald, R. J, (1988). An Analysis of Substitution Bias in Measuring Inflation, 1959-85, *Econometrica*, Vol. 56(4), pp. 909–930.

Reis, R., (2009). A dynamic measure of inflation. NBER. URL: https://www.nber.org/papers/w11746.

Sillard, P., (2017). Indices de prix à la consommation. Insee, Document de travail, N°F1706.

State Statistics Service of Ukraine, (2016). Metodolohichni polozhennia shchodo orhanizatsii statystychnoho sposterezhennia za zminamy tsin (taryfiv) na spozhyvchi tovary (posluhy) I rozrakhunkiv indeksiv spozhyvchykh tsin [Methodological guidance on organization of statistical observation of change in prices (tariffs) on consumer goods (services) and calculation of consumer prices indices]. URL: http://ukrstat.gov.ua/norm_doc/2021/310/310.pdf [in Ukrainian].

Stoevska, V., (2018). Official consumer price indices – historical perspective, ILO Department of Statistics. URL: https://unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.22/2018/ILO.pdf.

The World Bank Consumer price index manual, (2004). Theory and practice, Geneva, International Labour Office.

Von Auer, L., (2004). Economic monotonicity of price index formulas. Otto-*von*-Guericke-Universität Magdeburg. URL: http://www.ipeer.ca/papers/Auer,Nov.04,RevisedCommentSSHRC46.pdf.