Problems of inflation measurement

Today there is a broad measure of agreement in principle among economic theoreticians and practitioners alike that safeguarding price stability should be the primary objective of monetary policy. Precisely for that reason, the accurate measurement of general price trends is a particularly important requirement for monetary and economic policy. This requirement confronts statistical offices with a series of difficult problems, which are partly methodological and partly practical. In the United States, an intensive public debate has been conducted for quite some time now on the difficulties associated with measuring inflation and on proposed solutions. In Europe, too, this subject has again started to attract greater interest, particularly since the central banks have come relatively close to the objective of price stability, or even largely attained it. The following article discusses important aspects of intertemporal price level comparisons, not least in the light of the forthcoming entry of eleven states into stage three of economic and monetary union in Europe, which will place additional demands on price statisticians.

Nowadays, monetary stability is given high priority in most countries, while other objectives of central bank policy, which had previously played a role in many cases, have receded into the background. Thus monetary policy is now based on the perception that enduring price level stability makes a major

Price stability as the objective of monetary policy

contribution to fostering social harmony and prosperity, whereas inflationary processes, as well as deflationary spirals (which have occured rarely in history), entail substantial costs to the overall economy. With monetary policy strategies being geared increasingly towards the objective of stable prices, the official inflation rates recorded today in many countries are at an historically low level. The lower the rate of price increases, however, the greater is the impact of problems of statistical measurement. Hitherto no comprehensive studies have been available in Europe, however, so that often – this applies to Germany, too – more or less well-founded assumptions regarding the extent of the measurement bias must be relied on. This article addresses some of the key issues in this context and, at the same time, seeks to provide a stimulus for an in-depth coverage of this subject, which is also significant for the overall monetary strategy to be pursued by the European System of Central Banks.

Methods and associated difficulties of calculating price indices

Price increases at the consumer level as a measure of monetary stability

The statistical offices publish a large number of price indices that can be used as indicators for the domestic price and cost climate and, more especially, as a measure of the change in the purchasing power of the currency. Thus statistical information on the outcome of the price formation process in the economy is generally available for all major production and distribution levels in different aggregations and periodicities. In most countries, the degree of monetary stability is primarily as-

sessed on the basis of a price index measuring households' consumption. Although such an index directly captures only a certain proportion of overall price trends, the approach appears meaningful in that the satisfaction of private needs is considered to be the predominant purpose of all economic activity. In Germany, the reference point is usually the percentage change in the consumer price index in comparison to the previous year. For the analysis of overall price trends, however, further price indices are needed, which, since their composition is often similar to that of the consumer price index, meet with comparable difficulties.

No "ideal" index ...

Economic theory has elaborated fairly clear-cut concepts on how the purchasing power of money should be measured. An "ideal" index should reflect the change in the amount needed to maintain a given standard of living. However, the attempt to statistically implement this highly demanding concept founders in the face of a number of problems, especially the necessary definition of individual orders of preferences and their aggregation. Above and beyond the theoretical implications, public statisticians must in practice also weigh the cost of their work against the benefit it yields. Another point to be borne in mind is that the users of price statistics are very keen to have the statistics available with little time lag and to receive continuous reports at short intervals. Therefore statistical offices employ simplifying methods for calculating the rate of inflation.

Above all, these methods are based on the assumption that – over a more or less extend-

... but simplifying methods used for calculating the rate of inflation

ed period – consumers' habits do not change. Hence price increases are not measured on the basis of the expenditure needed to maintain a constant standard of living but by means of the cost of an unchanging selection of representative products and services known as a "basket of goods". The quantities of the selected goods and services which are included in the price index are kept at a constant level (see Annex). In an economy in which solely prices change, this method would provide an accurate picture; but in a dynamic environment consumers' habits also change as a rule, even if they only do so gradually. Therefore discrepancies between official price indices and an "ideal" index are inevitable. These discrepancies, however, must not be allowed to become too great if a price index is to have any relevance to economic policy.

Overstatement of price increases by the price index in the United States and other countries

Studies carried out on the United States and other countries have come to the conclusion that price indices based on the conventional method of calculation tend to overstate the rate of inflation.[1] As early as in 1965, in its report prepared at the request of the Federal Finance Court, the Deutsche Bundesbank, too, came to the conclusion that the consumer price index of that time was not free of distortions and therefore did not reflect the rate of inflation with total accuracy.[2]

Four "sources of bias" in price statistics

In the studies on the accuracy of inflation measurement, four major possible sources of bias[3] are normally distinguished:

– Households often react to a change in relative prices by shifting their consump-

tion towards goods that have become comparatively less expensive. A price index with a fixed weighting pattern overstates inflation in so far as those goods that have become relatively more expensive are given too much weight. Much the same is true if a basket of goods becomes obsolete because real incomes increase (or decrease).

– New methods of distribution often result in cheaper shopping facilities. In this case, a price index that is based on a fixed selection of reporting units tends to overstate price increases.

– Substantial problems for price statisticians result both from the frequent model changes in the case of many industrial goods and from the regular product innovations. Statistical offices do try to take account of differences in quality when exchanging the goods selected for monitoring prices, since money spent on improved quality is not to be recorded as a rise in prices. However, experience has shown that this is achieved only to a limited extent.

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1 See above all the study by M. Boskin, E. Dulberger, J. Gordon, Z. Griliches and D. Jorgenson (Advisory Commission To Study The Consumer Price Index), Toward A More Accurate Measure Of The Cost Of Living, Washington, 1996. — **2** See Deutsche Bundesbank, The extent of depreciation of money since 1950, and the prospective trend of the value of money, Report prepared by the Deutsche Bundesbank on 21 July 1965 at the request of the Federal Finance Court, Monthly Report, March 1968, p. 3–19. — **3** The distinctions are not strictly clear-cut; despite certain overlaps, however, they have proved their worth in practice.

– Statisticians also face great difficulties in respect of new goods, the prices of which tend to decline in comparison with established products once they have been introduced into the market. Even if their significance increases rapidly, they are normally taken into account for price monitoring only after a time lag of several years, so that their initial specific price trend is not included in the measured inflation rate. For this reason, too, the recorded inflation rate typically overstates the "true" increase in prices.

Additional statistical consequences of overstating the rate of price increases

An overstatement of the rate of price increases by the officially calculated rate of inflation has a number of consequences beyond the field of price statistics, for subindices taken from price statistics are used not least for deflating components of GDP on both the output and expenditure sides. Accordingly, an overstatement of price increases results both in an underestimation of overall real economic growth and in the incomplete statistical recording of the real growth of other key economic policy variables such as households' disposable income and labour productivity.

The German consumer price index

Basket of goods and weighting pattern

A consumer price index has been calculated for western Germany since 1969 in the form of a Laspeyres index with fixed quantities of goods, which are adhered to over a number of years (see Annex). The Federal Statistical Office normally rebases the consumer price index on a new year and a new basket of goods every five years. For this purpose the price statisticians calculate a new weighting pattern that is considered to have been representative of households' consumption pattern in the base year. The Federal Statistical Office hereby draws on the results of its regularly undertaken sample surveys and on the random sampling of the income situation and of consumption habits carried out every five years among selected households, which keep a minute record of their expenditure on private consumption.

A weighting pattern is normally already four years old when it is introduced and nine years old by the time it is replaced. This means that the average age of a weighting pattern used for current inflation measurement is 6½ years. Accordingly, this consumer price index is vulnerable to changes in consumption habits. In the long series into which the price indices are chain-linked every five years, the average age of weights is only 2½ years, so that the risk of bias is not as great.

Age of weighting pattern

For eastern Germany, a consumer price index based on the model for western Germany has been published since 1995, with the year 1991 taken as the base year. The data for deriving the weighting pattern were obtained from that year, too.[4] The problems concerning the timeliness of the weights are particularly evident in the new Länder, as the expenditure pattern there was distorted in the first few years after unification by a pent-up

Consumer price index for eastern Germany

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4 Previously, the Federal Statistical Office had calculated a consumer price index for employee households, which had been based on the second half of 1990 and the first half of 1991.

Weighting scale for the west German consumer price index

in %

	Base year		
Item	1980	1985	1991
Foodstuffs	14.5	13.4	13.2
Industrial products	36.5	32.9	36.0
Energy	9.9	10.4	8.2
Rent, including garage rent	15.4	18.4	19.9
Services and repairs	23.7	25.0	22.8

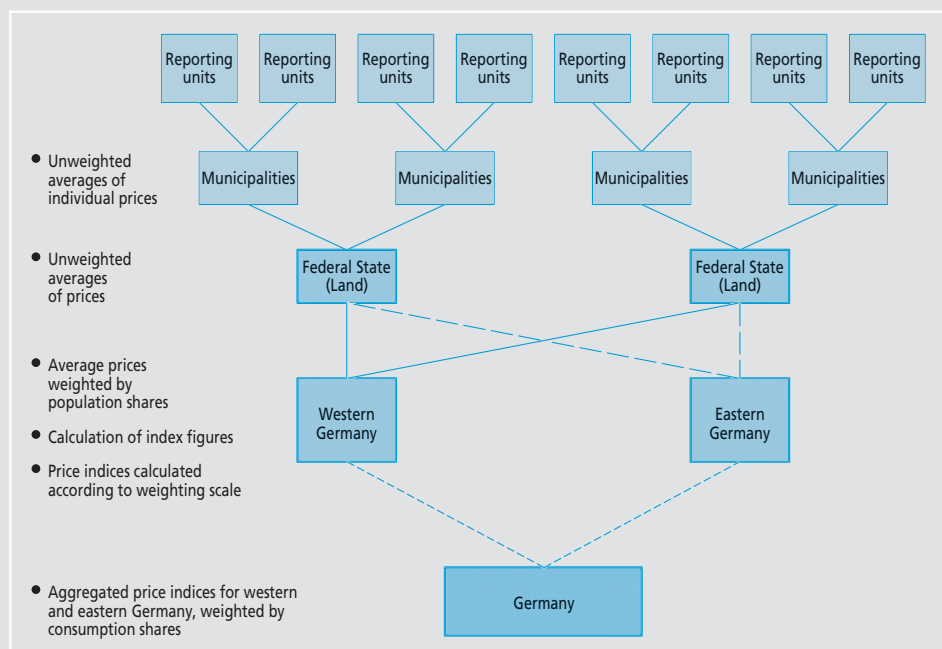Source: Federal Statistical Office.

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demand for consumer durables, especially cars and electrical appliances. Meanwhile, the consumption pattern of east German households is likely to be similar to that of west German households, even though the lower average level of incomes in the eastern part of the country continues to play a role. In the past few years, the portion of spending devoted to accommodation costs – which had previously been heavily subsidised – has increased dramatically, since rents – including incidental rent expenses – have been raised four-and-a-half fold in the context of the gradual adoption of the west German system of comparative rents from 1991 onwards. In principle, however, this perceptible rise does not result in price increases being distorted in a year-on-year comparison because according to the Laspeyres principle the quantity struc-

ture, rather than the proportions of expenditure, is recorded. Only if the rise in rents had induced consumers to move into smaller dwellings would price increases have been overstated (see Annex).

Since it was rebased to 1991, the basket of goods used for compiling the consumer price index has been broken down into about 750 categories for which prices are collected in 118 municipalities in western Germany and in 72 municipalities in eastern Germany (see chart on page 56). The statistical offices maintain a total of approximately 250,000 individual price series for the old Länder and 150,000 price series for the new Länder. The outlets selected for price monitoring must cover the entire range of distribution types; reporting units that disappear must be substituted by outlets of a similar type. First, unweighted average municipality prices are calculated for the individual items which are then used for calculating unweighted average prices for the regions (Länder). The Federal Statistical Office derives the consumer price indices for the individual Länder from these data using uniform weighting patterns in western and in eastern Germany, respectively. The data for the regions are furthermore condensed into separate price indices for western and for eastern Germany by calculating average prices, weighted by population shares, for the old and the new Länder in a first step. Finally, the price index for the whole of Germany is calculated as the average of the west and the east German indices weighted by consumption shares in the base year.

Collection and aggregation of prices

Sequence of operations in calculating the consumer price index

	Reporting units	Reporting units	Reporting units	Reporting units	Reporting units	Reporting units	Reporting units	Reporting units

- Unweighted averages of individual prices — Municipalities / Municipalities / Municipalities / Municipalities

- Unweighted averages of prices — Federal State (Land) / Federal State (Land)

- Average prices weighted by population shares
- Calculation of index figures
- Price indices calculated according to weighting scale

Western Germany / Eastern Germany

- Aggregated price indices for western and eastern Germany, weighted by consumption shares

Germany

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New goods in the consumer price index

New products, such as personal computers and microwave ovens, are normally included in the price monitoring process only when a new basket of goods is compiled. This is why, up to now, it has sometimes taken more than ten years in Germany before a new good that had established itself in the market has been included in current inflation measurement. Such time lags usually result in the statistically recorded inflation rate overstating the rate of price increases, since many new products, in the first few years after they have been introduced into the market, exhibit price trends that deviate downward from the average prices of established products. In addition, in a Laspeyres price index with a quantity weight that is fixed over several years, the increasing market significance of successful new goods is not taken fully into account,

even if they are included – in small quantities – in the price index at a very early stage. In view of these problems, the Federal Statistical Office instructed price statisticians some time ago to include new goods in the price monitoring process at their own descretion if they can be considered to be refinements of products that have been around for a longer period and if they have overtaken the traditional products in terms of their market significance. Any price differences between the traditional product and its successor must then be adjusted for the monetary value of the quality differences when linking the data.

The methods applied by the Federal Statistical Office for adjusting prices for changes in quality can be subdivided into direct and indirect methods. The most important indirect

Methods of adjustment for quality differences

method is what is known as chain-linking in overlapping periods. Here the price difference between two products which are offered for sale simultaneously is interpreted as a quality-related price difference. Many people consider this method to be superior, since it is said to leave the assessment of any differences in quality up to the market. However, a substitution of the goods selected for price monitoring is necessary if the market significance of a particular model decreases in favour of another model; in this case, though, the price-performance ratio of the new product variant must be superior to that of the old model. To that extent the method of chain-linking in overlapping periods will frequently lead to a statistical overstatement of the rate of price increases. According to the direct methods, the monetary value of the difference in quality is estimated and deducted by price statisticians. Particular problems arise in respect of products with rapidly rising quality coupled with declining prices. In these cases, the statistical offices naturally find it very hard to capture the decrease in prices of these goods accurately.

Statistical overstatement of inflation in Germany

Hence there is much to suggest that, particularly owing to the difficulties arising from the introduction of new goods and product variants, the consumer price index tends to overstate the rate of increase in prices. It is impossible precisely to quantify the statistical overstatement of inflation in Germany without a detailed study. Such a study would require a disproportionate amount of time and money, however. As is the case with the calculation of the inflation rate itself, the assessment of the "bias" occurring in inflation measure-

Selected new price representatives in the west German consumer price index
1980 Basket of goods
Ladies' quartz wrist-watch
Personal computer
Instant-picture camera
Video tape
Video recorder
1985 Basket of goods
Unleaded standard petrol
Unleaded premium petrol
Portable cassette player (Walkman)
Borrowing charge for a video film
Video camera
1991 Basket of goods
Car exhaust check
CD player
CD, pop music
CD, classical music
Steam iron
Diskettes, 3.5", 1.44 MB
Bottled beer, non-alcoholic
Kiwi
Microwave oven
Source: Federal Statistical Office.
Deutsche Bundesbank

ment must therefore be based on a series of simplifying assumptions.

Bearing in mind that qualification, a recent study carried out by the Economic Research Group of the Deutsche Bundesbank arrived at the conclusion that the average "bias" in measuring inflation in western Germany could be of the order of magnitude of ¾ percentage point per year, most of which is attributable to the difficulties arising from adjusting prices for changes in quality.[5] Similar studies carried out for the United States have found that the deviation from an "ideal" index amounts to between ½ and 1½ percentage points per year; thus, the "bias" in

Research study by the Bundesbank

5 See J. Hoffmann, Problems of inflation measurement in Germany, Discussion paper 1/98, Economic Research Group of the Deutsche Bundesbank, February 1998.

inflation measurement in Germany would be in the lower region of the US margin. Hence the Bundesbank's assessment of 1965 contained in the above-mentioned report for the Federal Finance Court is still essentially valid: "In general, it should not be considered a reduction in the value of money if the cost-of-living index ... rises by, say, 1% per annum; and an annual increase of between 1% and 2% in the index can be regarded as indicating a deterioration in the value of money only with certain reservations."[6]

Implications for monetary policy

Such an assessment of the accuracy of inflation measurement has been taken into account in formulating the Deutsche Bundesbank's monetary policy in the past. Especially owing to statistical uncertainties, the Bundesbank considers the objective of price stability to be broadly achieved if the measured inflation rate is between 0% and 2%. In the Bundesbank's annual derivation of its monetary target, this factor is reflected in a medium-term price assumption of 1½% to 2% per annum. Thus in view of recent research results, too, this means that the Bundesbank's monetary policy – judged by its statutory mandate to safeguard price stability – cannot be considered to have been too "ambitious" in the past.

Harmonised consumer price indices in Europe

The European Central Bank, which has a mandate to maintain price stability and which will shortly assume responsibility for the single monetary policy in Europe, needs a reli-

able measure of the rate of price increases in the single currency area. A consumer price index calculated on the basis of the national price indices is suitable only to a limited extent, since the national indices may differ considerably from each other in questions of detail, despite having numerous features in common. Not only monetary policy itself but also the price indices that are used as a basis for its orientation and for assessing its efficiency must therefore be provided with a new and common foundation. In doing so, priority must be given to ensuring that inflation is measured in the individual countries using comparable methods, as far as national singularities permit.

Harmonised price statistics as a precondition for a successful monetary policy in Europe

For this reason, the Statistical Office of the European Communities (Eurostat), supported by the national statistical offices and the central banks, has been endeavouring for quite some time to harmonise consumer price statistics. The publication in February 1996 of "partially harmonised consumer price indices" as from the reporting month January 1994 was a first result of these efforts.[7] These "interim" indices were derived from the national consumer price indices, with only those items being taken into account which were broadly comparable in all the countries considered. Some items were disregarded, notably expenditure on owner-occupied homes and on various services, the position of which

European interim index since 1996

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6 Deutsche Bundesbank, The extent of depreciation of money since 1950, and the prospective trend of the value of money, Report prepared by the Deutsche Bundesbank on 21 July 1965 at the request of the Federal Finance Court, Monthly Report, March 1968, p. 12.
7 See G. Elbel, Der "Interimsindex" – ein Zwischenschritt auf dem Weg zum europäischen Verbraucherpreisindex, Wirtschaft und Statistik 3/1996, p. 187–192.
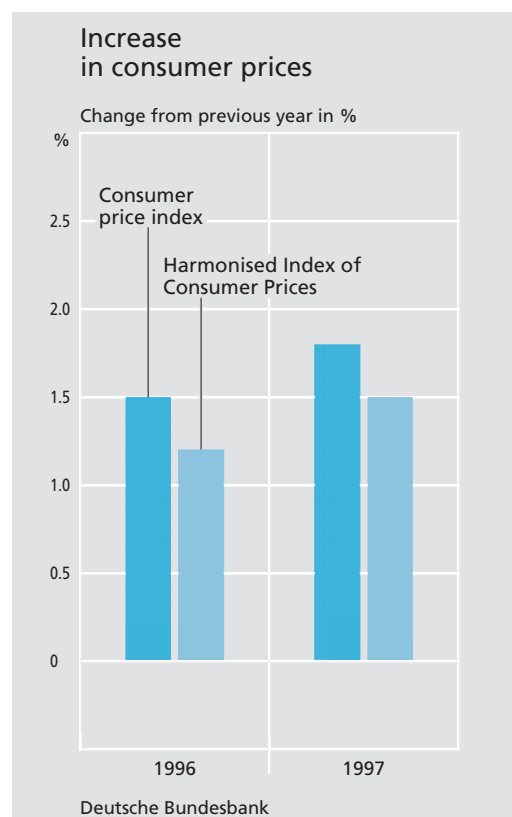
differs fundamentally among the individual countries. Taking 1996 as a reference year, the interim index covered less than 83 % of the expenditure that is included in the German consumer price index.

Harmonised consumer price indices since 1997

Since March 1997, what is known as Harmonised Indices of Consumer Prices (HICP) have been made available for the member states of the European Union as well as for Iceland and Norway.[8] The national HICPs are used for calculating the European Consumer Price Index (ECPI), the Consumer Price Index for the European Economic Area (CPI-EEA), and the Consumer Price Index of the European Monetary Union (CPI-EMU). In spite of the name change, the HICPs are likewise partially harmonised price indices; however, in the meantime some progress has been made by extending the coverage of private consumption and, especially, by harmonising the methods applied.

Taking 1996 as a reference year, the German HICP now captures 87 % of the expenditure on which the consumer price index is based. In addition, certain minimum requirements must be met with regard to the timeliness of the weighting scale, the inclusion of new products in the basket of goods, and the methods applied for quality adjustments. Different methods will continue to be admissible, at least for the time being. These include the methods used for updating the weighting scales and for aggregating individual prices at the micro-level (see Annex). Some practices which are commonly used in compiling consumer price indices and which have a particularly negative impact on the

Increase in consumer prices

Change from previous year in %

Consumer price index

Harmonised Index of Consumer Prices

Deutsche Bundesbank

comparability or quality of the results, however, are expressly prohibited; if, for example, a particular current price cannot be collected, it must not be assumed that this price would be the same as the one collected last time. In the case of quality changes, an "automatic linkage", which strictly interprets any difference in prices between two given points in time as a change in quality, is likewise prohibited.

Particular problems arise in respect of categories of goods that are financed to different extents in the individual European countries through direct payments by households

Particular problems in respect of expenditure on medical services and education

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8 See G. Elbel, Zur Einführung Harmonisierter Verbraucherpreisindizes in Europa, Wirtschaft und Statistik 3/1997, p. 187–191; Commission of the European Communities, Report on harmonization of consumer price indices in the European Union, Brussels 1998.

or indirectly through taxes and social security contributions. This especially concerns expenditure on health care and on education services. Usually, consumer price statistics are based solely on direct expenditure on goods and services. For example, the rising cost of hospital in-patient treatment is usually reflected in Germany in higher contribution rates to the statutory health insurance funds. The consumer price index, however, indicates a price increase in the health sector only if the health care expenditure of privately insured families increases, or if families insured under the state scheme have to pay higher supplementary charges (such as prescription fees or higher personal contributions to the cost of dentures). This means that in countries where private health insurance is more common, a higher proportion of the total expenditure on medical services is included in the consumer price index.

In order to maintain comparability in inflation measurement, only the prices of over-the-counter pharmaceutical products have so far been uniformly included in the HICPs; most of the health sector as well as the bulk of services in the education sector continue to be disregarded. In principle, however – just like many other goods and services that are partly financed through taxes or social security contributions and are therefore obtained by households at prices which do not cover the true costs – those goods of the health and education sectors that have so far been excluded from the HICP should likewise be included in the calculation, provided that they are purchased by households individually against the payment of a price. The aim is to

include all goods in the index which are assigned to private consumption in the national accounts in line with the expenditure concept. Admittedly, this definition means that the goods in the health and the education sectors are recorded in the HICPs of the individual countries rather disparately, so that the results are not comparable in this respect; however, its advantage is that, in all countries, the HICPs measure the change in the purchasing power of money used by households for consumption purposes. Discussion on this subject, however, is still going on.

Efforts to harmonise inflation measurement encounter special difficulties also in respect of recording the cost of housing. For households living in rented accommodation, data on rents and incidental rent expenses, as well as redecorating costs that have to be borne by the tenant, are collected. In the case of owner-occupied dwellings, not only expenditure on maintenance and repairs but also mortgage rates have been taken into account in some countries; one of the disadvantages of doing so, however, is that the interest rates themselves include expectations as to future trends in prices; consequently, the price index ceases to be merely a measurement of current price increases. In other countries, among them Germany, the expenditure on comparable rented accommodation is included as a proxy for owner-occupied dwellings in the national consumer price index. This introduces a kind of opportunity cost component whereas, for the rest, the price index is based exclusively on prices actually paid. The total cost of housing aggregated in

Inflation measurement in respect of owner-occupied dwellings

60

this way is then updated with the aid of the continually collected data on rents.

Up to now, owner-occupied dwellings – apart from the incidental expenses – have not been included in the HICPs. Thus housing costs, which in most cases have increased at an above-average rate in the past few years, have been included in the inflation rate only in part. A price index that does not include owner-occupied dwellings therefore under-states the overall rate of price increases. Fur-thermore, the marked differences in the pro-portion of home ownership means that the inflation rates recorded in the individual countries are not comparable.

Consequently, further steps need to be taken for a harmonisation of price statistics in Eur-ope. Extending the range of coverage to in-clude the above-mentioned problematic items is extremely difficult, however, and will take quite some time, in spite of the intensive discussions now being held in the statistical bodies. Furthermore, it must be ensured that the common methodological requirements are strictly adhered to. Only then can monet-ary policy makers be confident that the har-monised indices reflect the true movement of prices. All in all, however, the methodological difficulties cannot be completely overcome.

Further harmonisation in Europe

The Annex to this article appears on the following pages.

Annex

Methods of aggregation applied in the German consumer price index and in the Harmonised Index of Consumer Prices

Aggregation at the macro-level

The German consumer price index is calculated as a Laspeyres index. In this calculation, a notional sum of expenditure of the present (consumed quantities x_i^b of the good i in the base period b valued at the prices of the present p_i^t) is contrasted with a sum spent on a basket of goods in the base period (consumed quantities in the base period x_i^b valued at the prices of the base period p_i^b):

$$(1)\ P_L^{t,b} = \frac{\sum_i p_i^t x_i^b}{\sum_i p_i^b x_i^b}$$

The quantity structure is derived indirectly from a representative structure of expenditure. In this way, a modified Laspeyres price index is obtained in which the changes in the prices of the individual goods are weighted by expenditure shares in the base period a_i^b:

$$(2)\ P_L^{t,b} = \frac{\sum_i p_i^t x_i^b}{\sum_i p_i^b x_i^b} = \frac{\sum_i \frac{p_i^t}{p_i^b} p_i^b x_i^b}{\sum_i p_i^b x_i^b} = \sum_i a_i^b \frac{p_i^t}{p_i^b}\ where\ a_i^b = \frac{p_i^b x_i^b}{\sum_l p_l^b x_l^b}$$

Price indices are used not only to describe how prices have changed since the base period but above all as a measure of the average change in prices between the two points in time t-1 and t, neither of which corresponds to the base period, since inflation is usually recorded as a percentage change in a price index against the previous year and not against the base year. Hence, a quotient of two Laspeyres indices is calculated for current inflation measurement:

$$(3)\ \frac{P_L^{t,b}}{P_L^{t-1,b}} = \frac{\frac{\sum_i p_i^t x_i^b}{\sum_i p_i^b x_i^b}}{\frac{\sum_i p_i^{t-1} x_i^b}{\sum_i p_i^b x_i^b}} = \frac{\sum_i p_i^t x_i^b}{\sum_i p_i^{t-1} x_i^b}$$

Thus the current rate of price increases is measured on the basis of a basket of goods from the past, which may have become obsolete by the time of measurement owing to a shift in consumption patterns.

Such a quotient of two Laspeyres indices, too, can be presented as an average of price changes weighted by expenditure shares:

$$(4)\ \frac{P_L^{t,b}}{P_L^{t-1,b}} = \frac{\sum_i p_i^t x_i^b}{\sum_i p_i^{t-1} x_i^b} = \frac{\sum_i \frac{p_i^t}{P_i^{t-1}} p_i^{t-1} x_i^b}{\sum_i p_i^{t-1} x_i^b} = \sum_i a_i^{t-1} \frac{p_i^t}{p_i^{t-1}}$$

Here the implicit value weights are notional expenditure shares with prices from the period (t-1) and quantities from the base period (b):

$$(5)\ a_i^{t-1} = \frac{p_i^{t-1} x_i^b}{\sum_l p_l^{t-1} x_l^b}$$

Starting from the base period, the value weights are updated with the aid of the relative price changes:

$$(6)\ \frac{a_i^{t-1}}{a_i^b} = \frac{\frac{p_i^{t-1} x_i^b}{\sum_l p_l^{t-1} x_l^b}}{\frac{p_i^b x_i^b}{\sum_l p_l^b x_l^b}} = \frac{\frac{p_i^{t-1}}{p_i^b}}{\frac{\sum_l p_l^{t-1} x_l^b}{\sum_l p_l^b x_l^b}}$$

Hence goods whose prices increase disproportionately are given a greater value weight in current inflation measurement owing to the fixed quantities, whereas goods with relatively decreasing prices are given a smaller value weight. Only if consumption

patterns do not change in quantitative terms can the value weights which have been updated with the aid of relative prices provide an exact weighting in current inflation measurement.

Chain-linking of price indices

In the German consumer price index, the index series are typically chain-linked at five-year intervals coinciding with rebasing to a new base year. The index figures of the old base year are divided by the index level of the new base year, so that in the linking period the figure 100 is obtained both for the old time series and for the new one. In the long series, such a chain-linking of Laspeyres price indices broadly ensures a weighting that is up to date. However, in this case inflation is measured on the basis of different baskets of goods.

For the HICP, the possibility of updating the weighting scale annually is envisaged.[9] For this reason, in a first step the month of December, rather than an annual average, is selected as the reference period for calculating the index, and the price indices are chain-linked annually. Since in most cases an up-to-date weighting scale is available only with a time lag, in some countries the current index level is calculated on the basis of a weighting scale that is two years old and is exchanged each December. The chain-linked indices are related to the annual average of 1996. Accordingly, the rate of price increases in a given month m – expressed as the year-on-year rate – is calculated as a quotient of two indices with differing weighting scales:

$$(7) \quad \frac{P_L^{t,b,m}}{P_L^{t-1,b,m}} = \frac{\dfrac{\sum_i p_i^{t,m} x_i^{t-2}}{\sum_i p_i^{t-1,12} x_i^{t-2}} \dfrac{\sum_i p_i^{t-1,12} x_i^{t-3}}{\sum_i p_i^{t-2,12} x_i^{t-3}} \dfrac{\sum_i p_i^{t-2,12} x_i^{t-4}}{\sum_i p_i^{t-3,12} x_i^{t-4}} \cdots \dfrac{\sum_i p_i^{b;12} x_i^{b}}{\sum_i p_i^{b} x_i^{b}}}{\dfrac{\sum_i p_i^{t-1,m} x_i^{t-3}}{\sum_i p_i^{t-2,12} x_i^{t-3}} \dfrac{\sum_i p_i^{t-2,12} x_i^{t-4}}{\sum_i p_i^{t-3,12} x_i^{t-4}} \cdots \dfrac{\sum_i p_i^{b;12} x_i^{b}}{\sum_i p_i^{b} x_i^{b}}}$$

$$= \frac{\dfrac{\sum_i p_i^{t,m} x_i^{t-2}}{\sum_i p_i^{t-1,12} x_i^{t-2}}}{\dfrac{\sum_i p_i^{t-1,m} x_i^{t-3}}{\sum_i p_i^{t-1,12} x_i^{t-3}}}$$

Hence the basket of goods of two different years are included in the inflation rate. This means that, even for short-term inflation measurement, the advantage of an "uncontaminated" comparison of prices is lost; in return, a shift in the consumption pattern can be taken into account in the process of inflation measurement at an early stage. However, weighting scales that are two years old are not necessarily more suitable for the purpose of current inflation measurement than weights that are three or four years old.

Regional aggregation

For the west German and the east German consumer price indices, price indices for the individual Länder are first calculated using a uniform weighting scale whose average, weighted by population shares, is used to obtain the total indices for the two separate areas. The consumer price index for the whole of Germany is then obtained by calculating the average of the two sub-indices for Germany weighted by consumption shares.

For the total ECPI, a weighted arithmetical mean of the HICPs (with country-specific weighting scales) is calculated:

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9 The Federal Statistical Office has so far not exercised this possibility.

$$(8) \quad P_{EVPI}^{tb} = \sum_k c_k^b P_{HVPI,k}^{t,h} = \sum_k \sum_i c_k^b a_{i,k}^b \frac{p_i^t}{p_i^b}$$

In this calculation, the national shares c_k^b in total consumer spending during the base period, converted using purchasing power parities, are selected as weights. Hence the weights for the individual categories of goods within the ECPI correspond to the average of the national expenditure shares weighted by consumption shares adjusted for purchasing power variations.

Aggregation at the micro-level

The aggregation of prices at the micro-level poses problems similar to the aggregation across different categories of goods. For practical reasons, the statistical offices calculate sub-indices only for a limited number of goods; however, they do not do so for different variants of one particular good. For each sub-index a large number of prices are collected, however, in order to eliminate any random price movements. Ideally, these individual prices p_{ij} for the variants j of a good i would have to be weighted in a way similar to that applied for the average prices at a higher level of aggregation. In general, information on the quantities sold, categorised by outlet and an exact product specification, is available for this type of weighting – if at all – to only a very limited extent. In many countries, including Germany, the sub-indices are therefore calculated as an unweighted quotient of average prices from the reporting and the base periods:

$$(9) \quad \frac{p_i^t}{p_i^b} = \frac{\sum_j \frac{p_{ij}^t}{n}}{\sum_j \frac{p_{ij}^b}{n}}$$

The drawback of this method of calculation is that in most cases the average prices thus calculated represent a mixture of prices for goods of varying quality. Such a quotient, however, can also be represented as an average – weighted by prices – of changes in prices for individual products in particular outlets:

$$(10) \quad \frac{p_i^t}{p_i^b} = \frac{\sum_j \frac{p_{ij}^t}{p_{ij}^b} \frac{p_{ij}^b}{n}}{\sum_j \frac{p_{ij}^b}{n}} = \sum_j g_{ij}^b \frac{p_{ij}^t}{p_{ij}^b} \quad \text{where } g_{ij}^b = \frac{p_{ij}^b}{\sum_l p_{il}^b}$$

Thus goods or outlets that are more expensive are given a greater weight. This is unproblematical for inflation measurement only if the relative prices at the individual outlets do not change.

In addition to this method, a further approach to aggregating prices at the micro-level is permissible for calculating the HICP and is applied in some countries – but not in Germany. This method is used for calculating the changes in prices of individual, precisely specified models. From these changes, an index figure for the position of the basket of goods is obtained via a geometric median:

$$(11) \quad \frac{p_i^t}{p_i^b} = \prod_j \left(\frac{p_{ij}^t}{p_{ij}^b} \right)^{\frac{1}{n}}$$

A mathematical equivalent to this method is the calculation of average prices via a geometric median which are then used for forming index figures:

$$(12) \quad \frac{p_i^t}{p_i^b} = \frac{\prod_j (p_{ij}^t)^{\frac{1}{n}}}{\prod_j (p_{ij}^b)^{\frac{1}{n}}}$$

One frequently perceived advantage of using the geometric median for aggregating at the micro-level is that it implies a certain measure of substitution between different product variants and outlets.