HEPAC
2001 · 2:142–149 © Springer-Verlag 2001

Original papers

J. Rovira[1] · R. Tremosa[1] · A. Gilabert[2] · M. Torralba[2]
[1] Grup de Recerca en Economia de la Politica Social, Universitat de Barcelona, Spain
[2] Servei Català de la Salut, Unitat de Planificació Farmacèutica, Generalitat de Catalunya, Spain

# The role of prices in drug expenditure analysis

## An application of price indexes for two therapeutic groups in the Catalan Health Service (1991–1999)

**Abstract**

The objective of this article is to develop and apply several types of price indexes to the analysis of pharmaceutical expenditure to improve the way traditional indexes adjust for innovation in drug supply. The Laspeyres and Paasche indexes in the fixed and linked modalities were used. Price is defined as average expenditure at consumer price per daily defined dose (DDD). The empirical application is restricted to two therapeutic groups, antipsychotics and antidepressants, and to the pharmaceutical expenditure of the Catalan Health Service in the period 1991–1999. The indexes can be computed from the information currently recorded in the administrative procedures of health care insurers, or from sample information provided by regular market surveys. The proposed method allows for controlling the effect of several factors on average pharmaceutical price changes, specifically, the introduction of new drugs that show some degree of therapeutic innovation.

**Keywords**

Pharmaceutical expenditure · Prices · Laspeyres indexes · Paasche indexes

The increase in pharmaceutical expenditure is one of the main concerns of health managers, given both its relative importance in total expenditure and the difficulty in controlling its growth. Expenditure on personnel or equipment is easier to control, as the availability of resources for making that expenditure is subject to administrative procedures that require prior authorization. The use of a drug depends on a long list of decisions (registration, price fixing, inclusion in public financing, inclusion in formularies of specific institutions, consideration in clinical guidelines, etc.). However, once those decisions have been made, supply is very elastic, in other words the laboratories will supply at a given price, the maximum authorized price for example, practically any quantity that doctors decide to prescribe.

The increase and, in general, the variation in pharmaceutical expenditure on a product are a result of the simultaneous variation in two factors: the quantity of units sold and the price of that product. When the expenditure relates to a heterogeneous group of products, as when the total pharmaceutical expenditure or that of a therapeutic group are being considered, the variation is the variation in units sold multiplied by the variation in the average price of those units. As regards average price, its variation may result from: (a) a change in the price of existing drugs, (b) a shift in consumption towards presentations or products of a different price.

The first factor, a change in the price of the products, is not that relevant in Spain and, thus, cannot explain the increase in pharmaceutical expenditure in recent years. It should be borne in mind that all drugs financed by the Spanish National Health System are subject to a price control system. This means that the price of the drug at the time of its launch, and any subsequent change, must be authorized by the health authorities. Revision of the price of a single drug hardly every happens. Changes are usually applied generally to the whole market. General increases in authorized prices have been infrequent and, in any case, small, and have not even kept pace with inflation. In some cases, general price reductions have even occurred.

This pricing policy has led the pharmaceutical industry to develop certain strategies to maintain or increase their income and profitability. First, encouraging consumption, to increase the number of units sold. Second, to by-pass the control of authorized prices, the manufacturers opted for the introduction and promotion of new products,

Joan Rovira
The World Bank, HDNHE, 1818 H Street NW,
Washington DC 20433, USA,
e-mail: jrovira@worldbank.org

HEPAC
2001 · 2:142–149 © Springer-Verlag 2001

J. Rovira · R. Tremosa · A. Gilabert
M. Torralba

## El papel de los precios en el análisis del gasto en medicamentos. Una aplicación de índices de precios para dos grupos terapéuticos en la sanidad catalana (1991–1999)

### Resumen

El objetivo de este trabajo es desarrollar índices de precios de medicamentos que permitan separar el efecto de distintos factores, especialmente la comercialización de nuevos medicamentos que suponen distintos grados de innovación terapéutica, sobre los incrementos de precios y sobre el gasto. Se han utilizado los índices de Laspeyres y de Paasche en sus versiones fija y encadenada, tomando como precio el gasto medio a PVP (Precio de Venta al Público) por DDD (Dosis Diaria Definida). La aplicación empírica se circunscribe a dos grupos terapéuticos, antipsicóticos y antidepresivos, y al ámbito de la prestación farmacéutica del Servei Català de la Salut en el periodo 1991–1999. Esta metodología puede ser aplicada de forma rutinaria y automática a cualquier grupo terapéutico o a la totalidad de los mismos, utilizando la información que recogen habitualmente las administraciones sanitarias en el proceso de facturación de los medicamentos o la información muestral sobre consumo y gasto de algunos estudios de mercado.

### Palabras clave

Prestación farmacéeutica · Precios · Indices de Laspeyres · Indices de Paasche

that are strongly promoted to make consumers switch from the older ones to the newer and more expensive products. This constitutes an indirect mechanism for achieving higher sale prices. As a result , the market is characterized by a very high innovation rate (which often contributes little or no additional therapeutic value over products already existing on the market) and a marked tendency to encourage a shift in prescribing. This affects the second factor in the increased expenditure: the average price.

This shift effect is evident if we analyze the consumption of certain therapeutic drug groups, such as antihypertensives or antidepressants. In these specific cases, consumption of new drugs is steadily growing, while the consumption of older drugs is constant or even falling.

This situation in the pharmaceutical industry has already been dealt with extensively in the literature. Unlike other industrial sectors of rapid technological progress, such as computers or pesticides, where a generation of new products clearly displaces a previous obsolete generation [3]. Moreover, very often the growing number of drugs available is not accompanied by real innovation in terms of significant therapeutic advance [6]. In fact, the government regulation of pharmaceutical prices has incentivated companies in that sector to diversify their products, as a way to increase or, at least, maintain profits [2].

To summarize, the increase in the average price of drugs may be the result of a number of factors:

1. "Pure" increases in the prices of existing products.
2. Appearance and increased consumption of new products with a higher than average price. These products may involve a major or minor therapeutic innovation or may simply be products equivalent to other existing, cheaper products.
3. Shifts in consumption from low-cost products to those of a higher price, which may or may not involve any additional therapeutic benefit. These shifts take place:
   a. between different presentations – route of administration, dose, pack sizes of the same specialty;
   b. between brands of the same active substance (active principle);
   c. between different active substances, albeit therapeutically equivalent, of a chemical family (or therapeutic subgroup);
   d. between different therapeutic subgroups.

Decision makers are usually interested in determining the causes of the increases in expenditure or in average prices of drugs and the extent to which they are justified (e.g., whether it is due to an increase in patients correctly treated or whether it is a process of replacing cheap and effective existing products with newer, more expensive ones), so that they can take measures to prevent non justified increases. The first step is to identify expenditure growth factors and the relative importance of each of them.

The key question, then, is to what extent does the increased expenditure reflect an increase in therapeutic benefit or in patient well-being generally. The availability of suitable price indexes can provide the decision-maker with tools to help him answer all these questions. However, the preparation of suitable price indexes is no easy task [1, 10].

The objective of this work is to develop different types of prices indexes to apply to drug expenditure analysis, that represent an advance over traditional indexes as regards the treatment of innovation. It is not our aim to determine "the" correct index, but rather the most suitable one for each possible question or problem. More specifically, we want to develop a set of indexes that will enable us to quantify what part of the change in pharmaceutical expenditure is attributable to each of the factors responsible for that change.

To be able to identify and quantify the factors determining drug expenditure growth we need to have analytical tools and data that enable us to separate the role of each factor. Price indexes are the traditional tool for that purpose.

A price index is a measure of the central trend in price changes for a given group of products. The concept is rather simple. Its application, however, is more complex. First, from a theoretical point of view, price averages should relate to homogeneous products; second, there is no single formula for aggregating individual products (pharmaceutical specialties) or for weighting them.

These considerations are very important, especially in a market such as the drug market with the high rate of introduction of new products mentioned earlier, and where it is difficult to distinguish the additional therapeutic benefit of new commercial brands or new forms of presentation of existing products. (The question of how to account for quality changes in building price indexes is addressed in the Appendix by means of a non pharmaceutical example).

In this work the empirical application is limited to two therapeutic groups. The ultimate objective, however, is to develop a method that can be applied routinely and automatically to any group or to all of them on the basis of the information on pharmaceutical payments habitually compiled by the health authorities of the Spanish state as part of the invoicing process.

## Materials and methods

### Materials

A longitudinal descriptive study was carried out of medical prescriptions charged to the Catalan Health Service (Servei Català de la Salut, SCS). The information source was FAR 200 and FAR 413 lists from the IDMSIX program of the data processing application for monitoring the pharmaceutical payments of the SCS. This program compiles information on all prescriptions invoiced to the SCS. Two drug groups were selected for study: N06, antidepressants and N05A, antipsychotics. Annual consumption was studied for the period 1991–1999.

The degree of therapeutic innovation was determined according to the assessment published in the quasi official drug journal of the Spanish National Health Service, Therapeutic Information; specialties for which consumption had already been recorded in 1991 (at the start of the study) were assigned a special code, since although they might have been innovative at the time they were introduced, that characteristic was not relevant for analyzing innovation during the study period 1991–1999. Finally, the source for assigning the daily defined dose (DDD), was the WHO "ATC Index with DDD 1999."

### Methods

In order to control the therapeutic novelty factor, we based ourselves not on the prices of the products per unit of sale, i.e., price per pack, but on the price per DDD of each product, meaning each route of administration of an active principle. (Using indicators such as price per pack poses the problem that in the case of a shift in sales towards higher dose packs or packs with a larger number of tablets, the value of the indicator increases, which may wrongly suggest that there has been a price increase.) According to the method used here, all expenditures at consumer price on products with the same active principle and route of administration (distinguishing, for example, between solid oral administration and oral in solution) are added together and divided by the respective number of DDD.

The prices obtained are incorporated into the index weighted by their share in the expenditure of the corresponding anatomic-therapeutic group. The product has also been defined, as an alternative, in terms of active principle (for all routes of administration) and even chemical family. The greater the aggregation criterion, the less sensitive the index is to changes in quality. The less disaggregated it is, the more it tends to presuppose that any price change is attributable to an improvement in quality.

The variables considered were expenditure at consumer price and consumption in DDD. The price variable used was expenditure per DDD, the result of dividing total expenditure at consumer price by consumption in DDD of total prescriptions for each level of aggregation considered. The aggregation levels used in the analysis were: (a) active principle by route of administration; (b) active principle; anatomic-therapeutic subgroup (c) or substitutive subgroup (which ultimately corresponds to that of chemical family).

For the calculation of price indexes we considered the Laspeyres and Paasche indexes, in two of their modalities: fixed and chained index [5]. In the fixed modality, the Laspeyres index uses consumption in the first year for the weightings, while the Paasche index uses consumption in the last year of the period. The chained modality, on the other hand, includes all products existing on a given year and changes the weighting each year according to current consumption. The fixed Laspeyres index is the most commonly used in the calculation of official price indexes such as the consumer price index (CPI).

Separate price indexes were constructed for each of the two therapeutic groups chosen, antipsychotics and antidepressants (groups N05A and N06A, respectively). It should also be noted that thanks to the data bases used, the indexes are based not on a sample of goods but on all of them. This improves the representativeness of the indexes considerably, whatever the type of index applied.

### Laspeyres indexes: fixed Laspeyres index

The formula used to calculate the Laspeyres price index ($I^L$), in its traditional version, is shown below:

$$I_t^L = \sum_{i=1}^{n} w_{i0}\left[\frac{P_{it}}{P_{i0}}\right] \quad w_{i0} = \frac{p_{i0}q_{i0}}{\sum_{i=1}^{n} p_{i0}q_{i0}}$$

where $P_{it}$ is the price of the item – active principles by routes of administration, active principles and therapeutic families or subgroups, "i" in the period "t"; $P_{io}$ is the price of the item "i" in the initial period; n is the number of items considered for each aggregation level; $q_{io}$ are the quantities of the initial period (also called base period, which in the case of the Laspeyres price index is always the first period) and $w_{io}$ are the weightings of each item in the base period (this quotient shows the weight of each item considered in relation to total expenditure for the therapeutic group for the first period).

The calculation of the fixed Laspeyres index uses fixed weightings, which are those of the base year (in our case, 1991). Thus, successive price changes calculated are always weighted by the percentage expenditure of the item in the first year of the period in question.

It should be borne in mind that the Laspeyres index implies acceptance that the distribution of consumption in the initial year is representative of the whole period, a very restrictive assumption in the case of the pharmaceutical consumption analyzed here, in which considerable inward and outward flows take

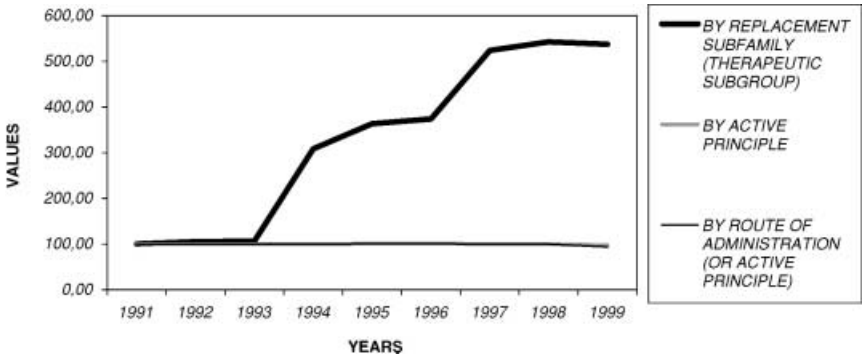


Fig. 1 ▲ **Fixed Paasche index: antipsychotics**

place, especially in active principles and routes of administration (a simple comparison between percentage expenditures for these two categories between the first and last year illustrates this point well), resulting in a considerable change in distribution of consumption between 1991 and 1999.

So in 1991 some of the items that will have considerable weight in total expenditure in 1999 do not even figure, as they had not yet been introduced. This is the case for some active principles in the antipsychotic drug group: Olanzapine increases from 0% in 1991 to 51.7% in 1999, and Risperidone from 0% to 36.1%; as for antidepressants, Paroxetine increases from 0% in 1991 to 31.5% in 1999, and Venlafaxine from 0% to 8%. The calculation assumption of the fixed Laspeyres index is certainly restrictive: not existing in the first year of the period analyzed means not being considered in any subsequent year.

On the other hand some items appear in 1991 with a large weighting that will end up having a very small weight in total expenditure for 1999. This is the case for some active principles in the antipsychotic drug group: Levopromazine decreases from 9.8% in 1991 to 1.0% in 1999; Thioridazine decreases from 19.7% to 1.5%; Haloperidol decreases from 23.3% to 2.1% and Sulpiride from 16.5% to 1.7%; and as regards the antidepressant drugs, Clomipramine decreases from 13.7% in 1991 to 2.1% in 1999 and Fluoxetine decreases from 54.7% to 24.9%.

For the two drug groups considered the fixed Laspeyres price index calculated, which shows little price change, is neither very relevant nor very appropriate: given the high rate of products going in and out, the market in 1999 is radically different from 1991, so it is pointless considering 1991 as the weighting base.

## Paasche indexes

### Fixed Paasche index

The formula used for calculating the Paasche price index ($I^P$), in its traditional version, is shown below:

$$I_t^P = \sum_{i=1}^{n} w_{it} \left[ \frac{P_{it}}{P_{i0}} \right] \quad w_{it} = \frac{p_{it} q_{it}}{\sum_{i=1}^{n} p_{it} q_{it}}$$

where $P_{it}$ is the price of the item "i" in the period "t"; $P_{io}$ is the price of the item "i" in the initial period; n is the number of items considered for each aggregation level; $q_{it}$ are the quantities for the final period (also called base period, which in the case of the Paasche price index is always the last period); and $w_{it}$ are the weightings of each item in the same period. This quotient shows the weight – the relative importance – of each item considered in relation to the total expenditure of the therapeutic group in the last period.

The calculation of the Paasche index also uses fixed weightings, which in this case are those of the last year. Accordingly, successive price changes are always weighted by the percentage of the item in question referred to the last year of the period considered. The fixed Paasche index, although it also involves accepting the very restrictive assumption, as with the fixed Laspeyres index, that the distribution over the period is maintained and that, accordingly, the weighting for 1 year is representative of the whole period, at least ends up pulling together all items existing in the last year considered, and is therefore more appropriate in a consumption group with a high rate of innovation.

This index, then, pulls together both the items that already existed in 1991 and those which in subsequent years have been created and incorporated into drug consumption statistics. Figures 1 and 2 show the results of calculating the Paasche index in its fixed version for both drug groups.

Calculating the Paasche price index presents one difficulty, namely, deciding what assumption to make on the prices of the products that were not marketed after the beginning of the period, for the years before their introduction. Of the two possible options, considering a price zero or projecting the entry price back to 1991, we leaned towards the second. If we want to study price *change*, the second option makes more sense than the first: in the first case a substantial price increase is assumed in the year of appearance, while in the second case it is assumed that until the product appears, there are no price increases.

**Antipsychotics.** As regards antipsychotic drugs, we can see in the Paasche index, at the level of the replacement subgroup, steep growths in the years 1994 to 1999, which can be related clearly to the introduction of new active principles (*Table 1). The appearance on the market of Risperidone (tablets) in 1994 explains the 190% growth in the price index for antipsychotics: it increases from a value of 106 to 308, the base value in 1991 being 100 (Risperidone will finally represent 32% of total expenditure in this therapeutic group in 1999). On the other hand in 1997 the introduction of Olanzapine (tablets) will explain the 40% growth in the Paasche index for the same antipsychotics, from 373 in 1996 to 523 in 1997 (Olanzapine will finally represent 51% of total expenditure in this therapeutic group in 1999, being the main active principal of antipsychotic drugs). As we said at the beginning, drug prices are regulated or controlled by the Administration: this explains why, once they have been launched, their price is maintained or even falls, and we have very few active principles that show a clear price increase over the years. It is at the moment of introduction, when a new active principle enters the market, that the ratio between its total expenditure and quantity

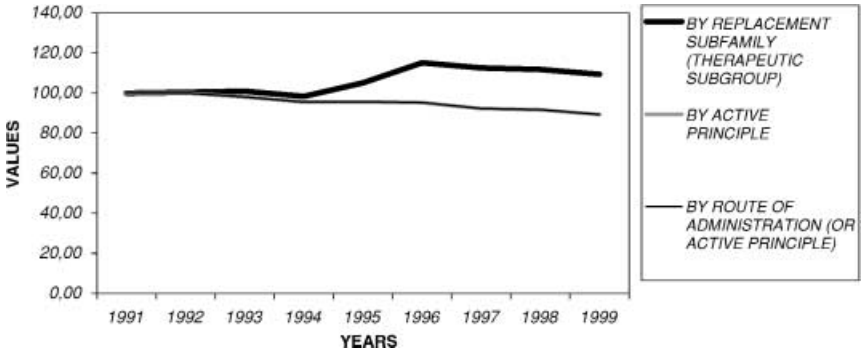


Fig. 2 ▲ **Fixed Paasche index: antidepressants**

(DDD) leaps upwards. And it is this quotient between expenditure and quantity that gives a higher price than that of the other existing active principles, which brings about the spectacular growth in the general level of prices of the therapeutic group. Consequently, stimulated by the introduction of these two active principles (Olanzapine and Risperidone), which between them represent nearly 90% of pharmaceutical expenditure of the whole antipsychotic drug group in 1999, the fixed Paasche index increases from a value of 100 in 1991 to 537 in 1999, a combined growth of over 500% in just 8 years. Figure 1 shows the Paasche index of the antipsychotic group at the levels of replacement subgroup, active principle and active principle by route of administration. It can be seen that it is only at the first aggregation level that we observe the large growth in price index: when a new active principle or route of administration enters the market, its value is 100; and given that the majority of prices are maintained or tend to fall once they are on the market, the price index does not pick up the effect of the entry of the new product on the average price of the item for the other two lower aggregation levels, as it projected the entry price back to 1991.

**Antidepressants.** As regards antidepressants, the introduction of new active principles does not cause increases in the Paasche price index (with one exception). As a whole, this fixed index for antidepressants increases from a value of 100 in 1991 to 109 in 1999 (*Table 2). In 1992 the appearance of Paroxetine hardly alters the general Paasche index of the group. In 1994 there appears a new route of administration of an existing active principle: Fluoxetine starts being supplied in solution, despite the fact that it has been available in tablet form since 1991; given the price at which it enters the market (which also falls over the years), this innovation does not cause a substantial growth in the index for antidepressants either. Finally, it is the introduction of Venlafaxine in 1995 that causes a small growth in the price index in the next 2 years: although its price falls in the end, the price level at which it enters the market pushes the index up by nearly 10%.

### Chained Paasche index

To overcome the limitations of price indexes with fixed weighting we use chained indexes. These are used, for example, in cases where the items considered move in and out at high rate. The formula for this index is the one used by the Bureau of Labor Statistics (BLS) to calculate the Medical Care Price Index (MCPI). It is also the one used by the National Bureau of Economic Research (NBER), in its more recent publications, to calculate the price indexes of some pharmaceutical products.

The formula used for the Paasche index ($I^P$) in them is as follows:

$$I_t^P = \sum_{i=1}^{n_{t-1}} w_{i,t-1} \left[ \frac{P_{it}}{P_{i,t-1}} \right] I_{t-1}^P$$

$$w_{i,t-1} = \frac{p_{ib} q_{ib}}{\sum_{i=1}^{n_{t-1}} p_{ib} q_{ib}}$$

where $P_{it}$ is the price of the item "i" in the period "t"; $P_{i,t-1}$ is the price of the item "i" in the period prior to "t" (t-1); n is the number of items considered for each aggregation level; $q_{ib}$ are the quantities of the item "i" in the base period "b", and this "b" may be equal to the initial period, the previous period (t-1) or any other period; $w_{i,\,t-1}$ indicates the weightings of each item in the previous period, t-1; and finally, $I^P_{t-1}$ is the value of the chained Paasche index also corresponding to the previous period.

Tables 3 and 4 (*) show the result of these calculations, figures 3 and 4 represent the trends in those indexes for the three aggregation levels considered. For antipsychotics (*Table 3), the chained index increases from a value of 100 in 1991 to 139 in 1999. The evolution of this index shows the same leaps as those recorded in Table 1, although in a smaller proportion: the entry of Risperidone in 1994 and Olanzapine in 1997 are responsible for the subsequent jumps in the price index. It can be seen that in this chained calculation modality, unlike the fixed, the price indexes at the level of active principle and route of administration also reflect the impact of the introduction of therapeutic novelty: the index value for

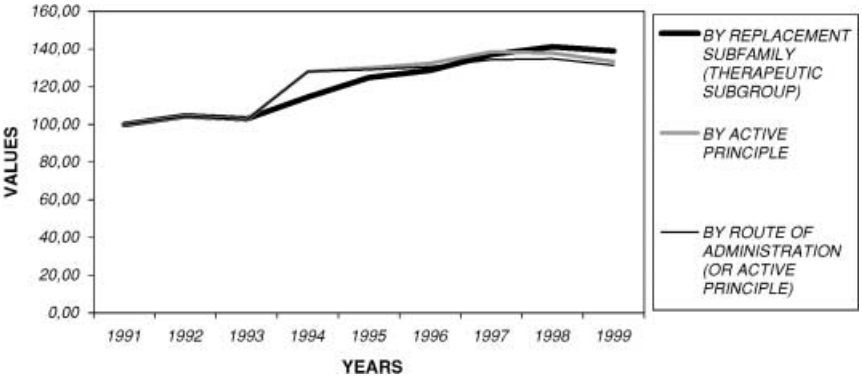


Fig. 3 ▲ **Linked Paasche index: antipsychotics**

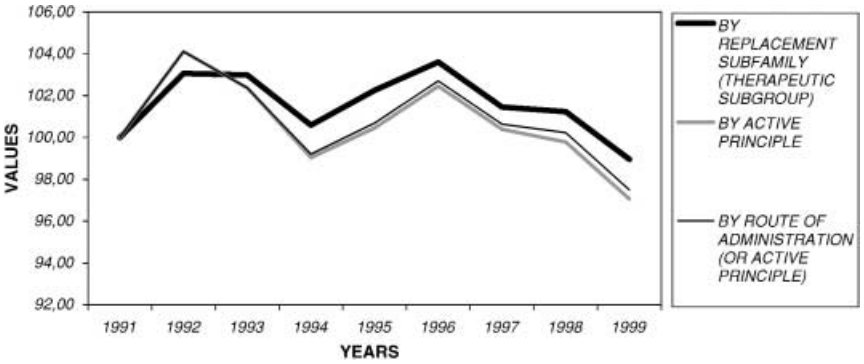


Fig. 4 ▲ **Linked Paasche index: antidepressants**

1 year is affected (corrected) by its value in the previous year. And as regards antidepressants, we can see a slight fall in the chained price index, of barely 1% between 1991 and 1999, after slight increases.

## Accounting for therapeutic innovation in price indexes

In this section we attempt to analyze price trends eliminating the possible effects of innovation. To do so price indexes are calculated eliminating, first, products introduced over the period which involve some therapeutic contribution, and second, new products which do not involve any relevant therapeutic contribution over existing products.

Tables 5-8 (*) show the results of considering two categories or levels of innovation, B (reasonable therapeutic innovation) and C (practically no therapeutic innovation), in accordance with the criteria and subsequent cataloguing by the Ministry of Health [9] (http://www.msc.es/farmacia/ infmedic/documentos). Figures 5 and 6 represent the consideration of those levels for the aggregation level of chemical family.

It is in the antipsychotic group that we see the most notable difference between the price index with total products and those that are left after eliminating the three active principles considered of level B. In Table 5 we see that when those principles (Olanzapine, Risperidone and parenteral Zuclopenthixol) are eliminated the increase in prices in this therapeutic group is considerably reduced: with all products, between 1991 and 1999, the index grew from 100 to 139, and without those products, only from 100 to 109. The products responsible for a large part of the growth in the (total) price index were, therefore, the active principles which involved a notable therapeutic innovation (in particular Olanzapine and Risperidone). When the active principles of levels B and C (Sertindol pastilles, Zuclopenthixol pastilles, solution and parenteral depot) are eliminated, the price index increases somewhat less than in the previous case. Table 7 shows an increase in value from 100 in 1991 to 111 in 1999; so level C products have a slight deflationary effect.

In the case of antidepressants, there is a slight difference between the index for products as a whole and the index resulting after eliminating the products classed as reasonable therapeutic innovation (i.e., Moclobemide, the only level B product). The price index, which before fell from 100 in 1991 to 98.9 in 1999, now falls to 96.9: this minimal difference is because in 1999 Moclobemide, launched in 1992, has a weight of less than 1% of total expenditure for its therapeutic group. On the other hand, it is when the level C active principles (Citalopram, Mirtazapine, Nefazodone, Reboxetine, Paroxetine, Sertraline y Venlafaxine) are eliminated that the price index falls considerably. It can be seen from Table 8 that, after falling from a value of 100 in 1991 to 98.9 in 1999, the price index now falls to 89.4.

As the prices of drugs, once introduced in the market, are controlled by the government and because of the way in which the industry (with the administration's approval) has responded to that control, traditional price indexes, such as the fixed Lapeyres index, do not provide valid and relevant information. These indexes show small increases or no increase at all, a totally different picture from the one drawn from the trends in average price per prescription, which habitually records a notable, sustained growth, particularly in our case for antipsychotics (nearly 700%). By using a fixed Paasche index, on the other hand, the growth of prices of antipsychotic products shows an increase from a value of 100 in 1991 to 537 in 1999: stimulated by the introduction of two active principles, Risperidone in 1994 and Olanzapine in 1997 (which between them cornered nearly 90% of pharmaceutical expenditure for the whole antipsychotic therapeutic group in 1999), the overall growth of the therapeutic group is over 500% in just 8 years. Finally, using the Paasche index in its chained version, it increases by nearly 40%, and the periods of price increase coincide with the years in which the above therapeutic novelties were introduced.

This phenomenon is not observed with antidepressants. In terms of average price the increase is 84% between 1991 and 1999, although calculating the fixed Paasche index for antidepressants shows an increase from a value of 100 in 1991 to 109 in 1999. In this case, too, it is the introduction of new products (Paroxetine 1992; Fluoxetine sachets 1994; Venlafaxine 1995) that pushes this index

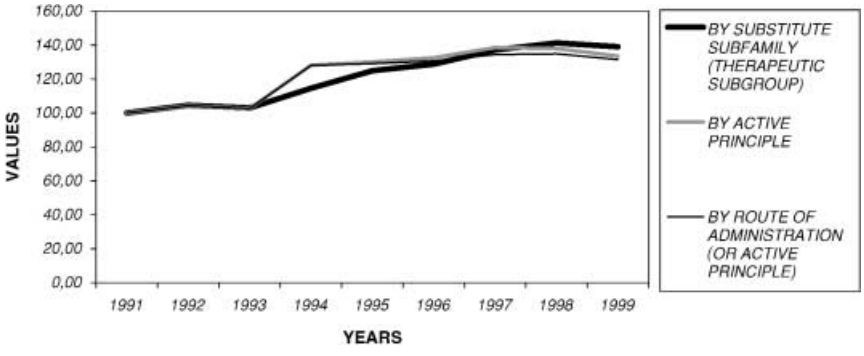


Fig. 5 ▲ **Antipsychotics, linked Paasche index, and innovation level**

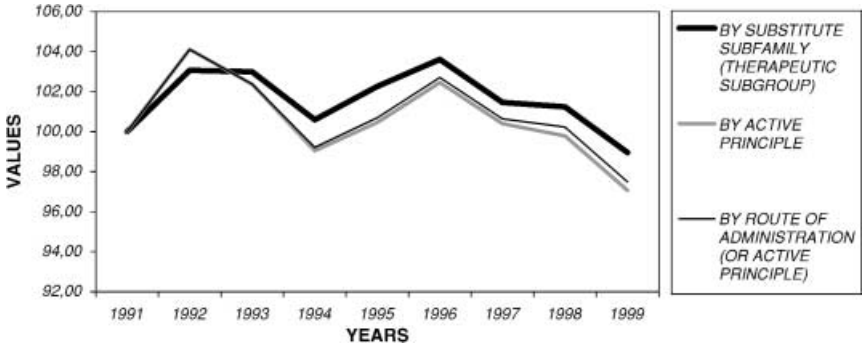


Fig. 6 ▲ **Antidepressants, linked Paasche index, and innovation level**

upwards, albeit to a far lesser extent). Finally, using the Paasche index in its chained version, the index in question shows a slight price fall of 1% between 1991 and 1999.

An attempt was also made to relate the increase observed in the fixed Paasche indexes to the level of innovation represented by the different therapeutic innovations considered. In the case of antipsychotics there is a notable correlation between the growth in prices and the active principles involving reasonable innovation: by eliminating the three active principles of level B only (Olanzapine, Risperidone and parenteral Zuclopenthixol) the growth in prices in this therapeutic group between 1991 and 1999 is reduced from 40% to 10%. In the case of antidepressants, however, there is practically no difference between the price indexes for the actives principles as a whole and the remainder once the principle classed as a reasonable innovation (Moclobemide) is excluded; it is when the level C active principles (Paroxetine, Sertraline and Venlafaxine) are excluded that the price index for this group falls nearly 8 percentage points between 1991 and 1999.

The above results demonstrate that the choice of price index is an essential question in the analysis of trends in prices and pharmaceutical expenditure. The choice of a particular index implies certain specific assumptions regarding the representativeness of the products chosen and the homogeneity of consumption over time. Basing the price index on products existing at the beginning of the period (fixed Laspeyres) improves homogeneity at the expense of representativeness, while taking the weightings of the last period considered (fixed Paasche) destroys homogeneity but achieves greater representativeness.

Given the trends experienced between 1991 and 1999 in the composition of the therapeutic groups considered (with some active principles, especially among the antipsychotics, that did not exist in 1991, but which represent a very high percentage of total expenditure in 1999), it makes more sense to try to base on the Paasche price index any conclusions about the evolution of the prices. However, using this index poses in its turn several problems. For instance, there is no clear criterion for treating the prices of products that did not exist at the beginning of the period: if they are given a zero value, price growth will be overestimated. If they are assigned the price of the first period in which they appear, an underestimation is likely to occur. Another practical problem is that using the Paasche index routinely and continuously over time means that the weightings will vary each year, and so the index should be recalculated annually for the whole period. The results of any analysis could change if repeated in a subsequent period.

Obviously, this is not ideal if the index is to be used as a basis for administrative decisions, negotiations, etc.

## Conclusions

The optimum solution to the selection of a valid and reliable price index, at least in the context of our study, seems to point towards the application of chained Laspeyres indexes, which in the case of pharmaceuticals does not pose the information problems that would arise with other goods, since data on consumption are usually available, making it easy to calculate weightings year by year.

Moreover, to enable us to separate the different factors responsible for the increase in average prices and, in the last instance, expenditure on drugs, it would be helpful to develop for each therapeutic group a set of indexes with the following aggregation levels: (a) pharmaceutical specialty, (b) active principle by route of administration, (c) active principle, (d) chemical family. In future, improvements in quality should be identified and assigned monetary values on a product by product basis, so as to determine what proportion of the price increases are attributable to those improvements or whether they are pure price increases. This information would enable us to diagnose the causes behind trends in expenditure and to create a rational basis for future policies.

**Acknowledgements.** This work was awarded a research prize by the "Sociedad Española de Farmacéuticos de Atención Primaria." The authors are grateful for the initiative and support of Josep Lluís Segú in the preparation and development of the project.

## Appendix: price indexes and quality variations

The treatment of changes in the quality of products over time is a problem common to all price indexes. The more usual price indexes, such as the CPI, are Laspeyres indexes which reflect trends in the prices of a basket of goods representative of consumption in the initial base period. If the basket is not changed, it gradually loses its representativeness over time and, as a result, so does the index. But updating the basket by introducing new products and removing those products no longer consumed poses its own problems.

In theory, price indexes should reflect trends of a set of goods that provides the consumer with a particular utility. Let us suppose that instant coffee replaces traditional coffee in the family shopping basket. The price of normal coffee is 500 Ptas/kg and the price of instant coffee is 1000 Ptas. Let us suppose, furthermore, that those prices have remained unchanged for the whole of the period in question. If at any given moment the price of the former is simply replaced by the price of the latter, one is implicitly accepting that the two goods are homogeneous (i.e., the same product) and that their price has doubled.

Obviously, the products are not homogeneous and consumers may prefer the advantages of instant coffee, so the price difference should be attributed to the improved quality and should not be reflected in the price index. In economic terms, the individual is obtaining increased utility from the new basket in which traditional coffee has been replaced by instant. Consequently, a new basket should be created which includes instant coffee.

The argument could be further complicated if we suppose that making a cup of coffee requires 10 g of traditional coffee and only 5 g of instant. In that case it could be argued that the relevant unit of product is not price per kilogram but the cost of the coffee necessary to make one cup. Under these suppositions, the price of coffee would have remained constant (20 Ptas per cup). In fact it could be argued that the price had fallen, as part of the new price corresponds to an improvement in quality of the product.

Unfortunately, in other cases the situation is more confusing. Let us suppose now that coffee beans at 500 Ptas/kg are replaced by ground coffee at 1000 Pta/kg. Although ground coffee may imply an improvement in quality, it would be hard to accept that such an improvement could justify such a large price increase. This would be even more doubtful if the conditions within the coffee market were not those of a competitive market. Part of the increase could be a pure price increase due, for example, to changes in supply and demand. If we substitute the new product in the consumption basket and start the index with a new base, we will have undervalued the real price increase.

There are, of course, theoretical methods for differentiating the pure price increase part from the part attributable to quality changes. For example, one could estimate the cost of grinding the coffee or consumers' willingness to pay more for this feature of the product. However, the adjustment methods are not easy and will no doubt be subject to criticism.

*Tables 1 to 8 are available at URL: http://link.springer.de/link/service/journals/10198/supp/2001/071/071.htm

## References


1. Boskin MJ, et al (1998) Consumer prices, the consumer price index and the cost of living. J Econ Perspect 12:3–26
2. Borrell J-R (1999) Pharmaceutical price regulation. A study of the impact of the rate-of-return regulation in the U.K. Pharmacoeconomics 3:291–303
3. Cockburn IM, Anis AH (1998) Hedonic analysis of arthritis drugs. National Bureau of Economic Research working paper 6574
4. Fernandez-Cornejo J, Jans S (1995) Quality adjusted price and quantity indices for pesticides. Am J Agricultural Econ 77:645–659
5. Frank RG, Berndt ER, Busch SH (1998) Price indexes for the treatment of depression. National Bureau of Economic Research working paper 6417
6. García MA, et al (2000) Adopción de los nuevos medicamentos por los médicos prescriptores. El medico innovador. Rev Atención Primaria 25:58–66
7. Gerdtham U, et al (1997) Price indices of drugs and the switching to new drugs. Pharmaeconomics 1:71–80
8. Griliches Z, Cockburn I (1994) Generic and new goods in pharmaceutical price indexes. Am Econ Rev 5:1213–1232
9. Ministerio de Sanidad y Consumo (1992) Información Terapéutica del Sistema Nacional de Salud, 16:222
10. Ruiz-Castillo J, Ley E, e Izquierdo M (1999) La mesura de la inflació a Espanya. Colleció d'Estudis Econòmics. Caixa d'Estalvis i Pensions de Barcelona "la Caixa", no 17