PART ONE
PRICE INDICES,
HOW AND WHY THEY ARE CALCULATED

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Imagine a year when agricultural production increased by 10%. It is a case here of an increase in value, because adding together physical quantities of breadmaking wheat with fodder wheat or fruit of various classes, varieties and origins, is no more relevant than putting tonnes of cereals together with hectolitres of wine, stems of flowers and heads of cattle, when measuring producers' activity or customer satisfaction.

However, a rise in value can reflect an increase in quantities or an improvement in quality, just as it can reflect an increase in prices that bears no relation to the goods. If, at the same time, prices have risen by 4%, the volume of wealth created by agriculture has gone up, not by 10%, but by about 6%. It is therefore necessary to distinguish between what results from the changes in real terms and what constitutes a variation in prices.

1.1. – Measurement of price variations

Changes in the price of a commercial item are measured by comparing its successive values. If it is an object manufactured according to a strictly defined standard, sold at the same point of sale under similar conditions, the matter is straightforward.

It becomes more complicated when the item disappears from the shelf and has to be replaced by another one and their prices have to be linked up. In other words, if a standard ballpoint pen sold for 2.50€ is replaced by another selling for 2.70€, the effect of the change in standard has to be separated from the straightforward increase in price in the 20 cents' difference.

It is complicated even further when a group of products is involved (ballpoint pens, cars, wine, tomatoes) whose value changes due to the joint effect of variations in price and composition, even more so when a branch of the economy is involved.

In order to clarify the method of calculating agricultural price indices, it was necessary to call *item* the level of aggregation where the elementary indices are calculated. The index of an item is deduced from the information provided by one or more *sets* of prices and several items constitute a *group*. A variable number of levels of groups results in the general index.

Calculation of a price index is broken down in the following way :

- *Monitoring the successive values of a panel of identical products.* By setting aside the basket value, the effect of variations in its contents, this sequence reflects a pure price-effect.

- *Dividing these current values by that of a base year,* which brings the indices of the various items back to a common unit, the items can then be compared among themselves and incorporated into the same group[1].

- Calculating indices of groups and a general index by means of elementary indices weighted by the value covered by each of them.

Particular care is taken when making up the sample of sets. Each of them covers a number of transactions relating to homogeneous items, as far as possible. This prevents a variation in structure impacting on a level, which might be interpreted as a price variation. Any set missing in a given month is estimated by applying the average variation found in other sets of the same item.

1. in fact, it changes them into a magnitude with no measurement. The listing of prices of a product consists of a component at a level associated with its market value (a kilogram of sheep's carcass costs more than a kilogram of tomatoes) and a component associated with the price change. Dividing by the reference value isolates the *variation* component.

Price volume distribution

A wine-growing region produces two appellation controlée [*carrying a guarantee of origin*] wines. For the sake of simplicity, the quality of each wine remains consistent over time. 8,000 litres of the first wine are produced and sold at 1€ per litre ; 2,000 litres of the second wine are produced and sold at 5€ per litre. The following year, hail destroys half of the second wine whose prices increase by 10% whilst the first wine, escaping damage, supplies stable quantities at prices that are 5% higher. Between the first and second year, the average regional price has gone from :

$$\frac{(1\times 8\,000)+(5\times 2\,000)}{8\,000+2\,000}=1{,}8\in \ \textit{per litre}$$

to

$$\frac{(1{,}05\times 8\,000)+(5{,}5\times 1\,000)}{8\,000+1\,000}=1{,}54\in \ \textit{per litre}$$

i.e. a drop of 14.4% due to an increase of 5% and 10% in the unit prices. By working this way, the variation in the average value of a litre of wine, regardless of quality, can be measured. However, the variation is not due specifically to prices. Let us suppose that each of the two prices is unchanged in relation to the first year, the quantities being the same as in the example above. A similar calculation would give

$$\frac{(1\times 8\,000)+(5\times 1\,000)}{8\,000+1\,000}=1{,}44\in \ \textit{per litre}$$

The decrease in the average price (from 1.80€/l to 1.54€/l or 1.44€/l), whilst each appellation has seen its price increase or stay the same, indicates that the share of the more expensive wine has fallen. This structure effect cannot be compared to the (pure) variation in price, which needs to be evaluated.

To carry out this evaluation, the most common method used consists of fixing the share of each wine. By neutralising changes in quantities in this way, one avoids calculating the average price and a real price index is calculated, as it happens the Laspeyres index. This is the type of index used for the IPPAP. The numerical example above gives the following calculation :

$$\frac{(1{,}05\times 8\,000)+(5{,}5\times 2\,000)}{8\,000+2\,000}=1{,}94\in \ \textit{per litre}$$

The increase from 1.80€ to 1.94€ per litre is equivalent to an increase of 7.8% in the price index, the average of the 5% and 10% increases in the two appellations, weighted by the value of each wine produced in the first year.

At the same time, the value of production has gone from

(1 x 8 000) + (5 x 2 000) = 18 000 €

to

(1,05 x 8 000) + (5,5 x 1 000) = 13 900 €,

i.e. a drop of 22.8%. One can also say that the value index is equal to 100 – 22.8 = 77.2 (this is an "elementary" index, a simple ratio of the two amounts).

The wine of this region therefore has the index of 100 + 7.8 = 107.8 as a price and the index of 77.2 as a value. The change in "volume" is defined as being the part of the change in value, which cannot be explained by the change in prices. More precisely, one says :

$$\textit{Volume index}=\frac{\textit{Value index}}{\textit{Price index}}$$

However, the index of volumes is not the Laspeyres type but the Paasche type (see below). In fact, it can be expressed as the change in average price by fixing the quantities not at their level in the initial period, but at the level in the final period (8,000 and 1,000 instead of 8,000 and 2,000 for a Laspeyres index)

With our numerical example, the index of volume is :

$$\frac{77{,}2}{107{,}8}\times 100=71{,}6\ \textit{ie a drop of}\ 28{,}4\%$$

The 22.8% decrease in value is therefore the result of a drop of 28.4% in volume, moderated by a 7.8% increase in prices. Let's examine this variation in volume more closely. It is mainly due to a reduction in (physical) quantities that have fallen from 10,000 to 9,000 litres, i.e. 10%. However, this only explains part of the drop in volume. The other reason is that the structure of production, between the two wines, has changed since less of the more expensive wine is produced. This type of structure effect is compared to the "quality effect" (in our example, this is not linked to a change in the quality, in terms of taste, of each of the two wines, which is assumed to have remained the same over time). In order to measure this quality effect, the index of volume must be placed in relation to the (elementary) index of quantities :

$$\frac{71{,}6}{90}\times 100=79{,}6\ \textit{ie a drop of}\ \ 20{,}4\%$$

To sum up, the change in value (-22.8%) can be broken down in the following way :

- Price +7.8%
- Volume -28.4%

of which physical quantities -10.0%
Quality effect -20.4%

The Laspeyres formula reflects this definition by expressing the index as the relationship[2] of the current value of production[3] with that of a base period (0), the structure of both (q_0) corresponding to the latter.

$$L_t = \frac{\sum p_t q_0}{\sum p_0 q_0}$$

This definition assumes complete market coverage. In practice, the nomenclature of items covers all production[4], whilst within an item, a partial observation is generally used as the basis,

- *indicators* used by all the trade,
- *price leader*,
- *expert's opinion*,
- average based on a representative sample,
- variation in index based on contributions in present sets

The formula below expresses the movement of elementary indices (i_t) to those of groups then to a general index, keeping to a suitable method for each item which can stray from the strict orthodoxy.

$$L_t = \sum i_t \frac{p_0 q_0}{\sum p_0 q_0}$$

The group index is obtained from the arithmetic mean of the elementary indices, weighted by values for the base period, these being the sum of the corresponding prices multiplied by associated quantities. When, for economic reasons, the base year strays too far from a normal year and the use of raw data may falsify the results throughout the base, they can be replaced by an average, for example an average of three consecutive years centred around the base year.

The index is independent of the nomenclature chosen, particularly the identification of items at the level from which the move is made from prices to indices. This aspect of the question needs to be stressed. A nomenclature must be, in part, arbitrary: a result of the choices made according to the principles of national auditing, which do not necessarily reflect the reality of different markets. The neutrality of the method of calculation in terms of the aggregation nomenclature is therefore a valuable quality.

The annual indices of items are obtained by quotient of the annual basket value and that of the base year or, more or less the same, by the arithmetic mean of the monthly indices, weighted by the quantities supplied in the corresponding months of the base year[5]. The monthly and annual indices of groups are calculated from the average of indices of items or groups on a lower level, weighted by the value of deliveries in the base year, which come from a breakdown of the national auditing results.

1.2. – The different types of index

The Laspeyres index[6] where the weight allotted to each price increase is locked into the economic data of the reference year, is the formula most often used for reasons associated with the robustness of the method and the availability of data, but it is not the only solution. Its main fault lies in the distortion between the structure of production and that of prices when one strays from the reference year.

2. multiplied by 100 for reasons of clarity.

3. sum, during successive periods of calculation (t), for all merchandise traded, of the unit price (p) multiplied by the corresponding quantities (q).

4. this means that the index nomenclature covers the entire branch of agriculture, which does not rule out the possibility that some areas are covered by an "other products...." item and some items are not supplied.

5. in practice, weighting coefficients only differ from each other when the seasonal structure of supplies justifies it with a pronounced profile which is more or less stable.

6. Etienne Laspeyres, German economist and statistician (1834-1913)

So that they always fit market structures, Laspeyres indices are periodically rebased[7]. This procedure corresponds to two sets of changes :

- updating the weighting coefficients so that the consequences in the general index of price variations that affect different products remain in proportion to their importance in the economy. The new coefficients incorporate variations in price and volume that have occurred since the previous base. However, price variations modifies the weighting scheme in real time as, during the same base, a variation affecting a product whose price has doubled since the base year, is mechanically twice as heavy in the index as the same variation affecting a product whose price has remained the same. Therefore, as the new weighting coefficients are introduced, the indices in the new reference year are reset to a hundred. So, rebasing when the variations of prices are transferred from the index to the weighting coefficients, only really incorporates in the latter, volume changes that have occurred since the previous base year.

- adapting to changes made in the form of trade, the system of monitoring prices and the conceptual framework of measuring economic phenomena. These changes are reflected in the nomenclature, the sample of sets and the content of prices.

By favouring structures that become older the further one strays from the base period and therefore, by keeping their old weight for products whose comparative prices have increased more quickly and whose market share has logically diminished, the Laspeyres index tends to overestimate price increases.

In the *Paasche index*[8] each price increase is reflected according to its importance in the economy during the period in question.

$$P_t = \frac{\sum p_t q_t}{\sum p_0 q_t}$$

The weighting coefficients change from one year to the next. However, production statistics are available at a later date than price statistics and it is difficult to find weighting coefficients in real time. Putting the Paasche index into practice would mean using production data from previous years as weighting coefficients, with the risk of overestimating price increases in the event of cyclic phenomena associated with price elasticity. In other words, if production follows a cycle, with periods of low production and high prices alternating with strong production and low prices, by using weighting coefficients from previous periods, the high prices are weighted by large quantities and vice versa. This explains why Paasche indices are rarely used in practice.

The *Fisher index*[9] is the geometric mean of the Paasche and Laspeyres indices and combines the advantages of both. However, it suffers in terms of the availability of data, the same drawbacks as the Paasche index.

In the *Tornqvist* index, the indices of groups are the geometric mean of the elementary indices weighted by half the sum of the weights of the base period and the current period.

Chained indices provide an interesting solution to the problems posed by updating weighting structures. The consumer price index is in France, the most familiar example of a chained index. Each year, the twelve indices are weighted by the structure of household consumption in year n-2 and tied in to the index for the month of December n-1. There is therefore a reference period for the calculation (December n-1) and a reference publication year, which changes at intervals of several years (the year is currently 1998).

7. in the European union, every five years. As production statistics are available later than price lists, several years must pass before final data are available for working out the set of weighting coefficients needed to draw up a base. Changes in base usually occur at the start of the fourth year after the new base year.

8. Hermann Paasche, German economist (1851-1925)

9. Irving Fisher, American economist (1867-1947)

1.3. – Schedule and frequency

The index is calculated and published every month. This timetable does not necessarily correspond to the schedule specific to each species. The biology, suitability for storage, social organisation of production and trade, the requirements of processing and consumer habits call for the presence or absence of quotations at different times of year and their characteristics. We should add that the schedule of prices changes with changes in the markets. There are therefore various processing models for calculating a monthly index based on species that are recorded differently over time.

Table 1. Frequency of prices

	Frequency
Cereals	Weekly
Potatoes for storage	Daily
Early	"
for potato flour	Seasonally
for processing	"
Appellation wine	Continuously
ordinary	"
Oilseeds	Weekly
Fruit	Daily
Vegetables	"
Cut flowers	"
Container-grown & bedding	"
Nursery stock	Seasonally
Seeds	"
Potato plants	Weekly
Beet	Seasonally
Lucerne	"
Pulses	Quarterly
Proteinaceous plants	Weekly
Tobacco	Seasonally
Flax	"
Hops	"
Large cattle	Weekly
Calves	"
Pigs	"
Sheep	"
Horse	"
Poultry	Monthly
Rabbit	"
Cow's milk	"
ewe's milk	Seasonally
Eggs	Monthly

Source : INSEE

The frequency with which the set is published does not necessarily correspond to that of the original source as summaries have already been made beforehand. The disappearance of physical markets that forced deals to be conducted at specific periods has smoothed out the flow of goods. The quotations are either a summary of flows during a period or periodic samples.

Missing items

The price of a product may be unavailable when the index comes out or the information is obtained too late or there have not been enough transactions during the month. The absence of an item may be normal, due to its seasonal nature. On the other hand, the index of the item needs to be estimated appropriately, in one of the following ways :

- by applying the variations to it seen with similar articles or items
- by carrying over the price from the previous month
- by extending the change from the previous month
- by applying the change observed the previous year or the average seasonal variation.

The index is corrected as soon as the observed piece of data is available.

Some indices have not been created[10]. This is usually due to low production figures or sectors where there were no sources of information. The group index is calculated from the weighted average of those of the other items. However, in calculating the higher level group index, the group where one of the items is missing regains its full weighting coefficient. Therefore, the average weight of the items present are implicitly allocated to the missing item.

"Variable baskets"

The abovementioned does not affect potatoes, fresh fruit and vegetables or cut flowers, which are harvested annually over a period specific to the type of product and generally do not lend themselves to being stored in their natural state in order to stagger sales. In order to try and make the index sensitive to events affecting the markets, a constant weight cannot be attributed to every product type, including during the periods when there are no products and at the start and end of the season when prices are subject to sudden variations.

The answer to this set of problems was to use a set of weighting coefficients each month that were proportional to the monthly consignments in the base year. The weight of the product in the group ($P_0Q_{m,0}$) is equal to the quantities delivered during the corresponding month in the base year ($Q_{m,0)}$, whose value has increased to the average price in the same year (P_0). The weight of each month in the average annual price and index corresponds to the quantities delivered in the same month of the base year ($Q_{m,0}$)[11].

The purpose of using variable baskets is not to trace the monthly weighting coefficients based on consignments, but to ensure that the calculation of the index is compatible with certain features of the calendar. The variable basket indices cannot be used to measure infra-annual price changes as their structure changes from one month to the next and that would lead to comparing the value of transactions relating to a group of products in a given month with those of other products the following month.

> Between May and June 2005, the fruit index increased by 7.5%. This change does not reflect an increase in prices since the price of the only three types of product available in both May and June (cherries, strawberries and apples) fell by an average of 5.7% between these two months.

Table 2 – Indices for fruit in May and June 2005

	Weightings		Indices		
	May	June	May	June	Var %
Fruit	…	…	115.9	124.6	+ 7.5
Apricot	…	35.3	…	129.0	…
Cherry	53.0	44.3	117.1	101.3	- 13.5
Strawberry	93.1	25.3	109.2	115.6	+ 5.8
Raspberry	…	6.7	…	128.2	…
Kiwi fruit	3.6	…	144.9	…	…
Peach	1.9	63.6	…	140.4	…
Apple	17.1	11.6	142.3	141.9	- 0.3
Plum	…	4.4	…	96.9	…

Source : Ministry of Agriculture, SCEES

It is a reflection of the appearance of apricots and peaches on the markets, whose prices, though in decline compared to those in June 2004 (-29% and -21% annual variation, respectively), are very high as is often the case at the start of the season and therefore cause a sudden increase in the fruit index without a real price-effect.

The difficulty in interpreting the index using a variable basket system lies in the fact that it reflects both a monthly variation and the difference in relation to the corresponding month in the base year. It operates like a system of twelve monthly indices that are unconnected and only allows comparisons in terms of annual variation. However, this peculiar statistical feature reflects what is actually happening in agricultural markets : generally, changes in the price of cherries between May and June are not discussed but it is noted that they are more or less expensive than the previous year or the five-yearly average.

10. rice, flower bulbs, some wine-growing regions, honey, wool, goat's milk …

11. Each of these quantities can be multiplied by the average price of the base year. This multiplication has no effect on the result of the calculation but the coefficients of the month in the year become identical to those of the variable basket

Variable baskets are therefore only used for groups where it is strictly necessary (fruit and vegetables, cut flowers, potatoes) and the weight of these groups in the general index is fixed to prevent variable baskets being more widely used (see appendix).

Seasonal prices

Some products are marketed at identical prices from one harvest to another. These are products grown under contract for the processing industry or whose price is found on price lists that are valid for a year (nursery stocks) or are supplied to cooperatives who pay their members in instalments in the expectation that the final price is known, i.e. at the end of the trading season or sometimes afterwards[12]. Some of these products, such as nursery stock, are in fact sold throughout the season at a set price. Others, such as sugar beet or Champagne grapes, are delivered in their entirety in the weeks following harvest.

Table 3. Season, commercial and statistical calendar

	Harvest	Marketing	Final price
Small-grain cereals	July-Aug	July-June, but 60% in July and August	September n+1
Maize and sorghum	October	October to September but 65% in October-November	September n+1
Potatoes for processing	Sept		
Potato for potato flour	Sept		
Champagne (grape)	Sept	grapes delivered at harvest	
Nursery stock		continuous	price in September
Lucerne		April	April or May n+1
Cereal seeds	July-Aug		
Fodder seeds		September-August	
Potato plants		September-April	
Beet	October	October-November	
Tobacco	Sept		
Hops	October	October-September	June n+1
Ewe's milk		September-August	

Source : INSEE

It would have been logical to calculate the index only during the actual marketing period. However, the distribution of these products throughout the nomenclature (logically, hops, Champagne, nursery stock and sugar beet cannot be put in the same category) would have ended up in the widespread use of variable baskets. To ensure that the index is consistent, it was agreed that a marketing situation spread out over twelve months at a constant price should be simulated. The index calculated for beet is identical from October to September and has a constant weight in its group. When the product is actually sold over twelve months, the annual price is the average of the monthly prices covering the two seasons. If deliveries are limited to a short period, the annual average is calculated over this period. The annual index for sugar beet is that of October whilst the index for nursery stock is the average of the indices for twelve months relating to two seasons.

As seasonal prices are not known with any certainty until the end of the season, provisional prices are recorded and corrected later. Sometimes at the start of the season the price from the previous season continues to be used.

Wine poses a particular problem as it is a processed product, the agricultural product being the grape, delivered in a very short period after the harvest. Apart from Champagne, which is dealt with by traders, grapes are not traded in any way when they leave the vineyard, even when the wine is made by a cooperative. The prices of different appellations are used to calculate the index of the farm-gate prices of agricultural products and the manufacturing retail price index. When interprofessional organisations distinguish between different harvests in statistical reports, they switch to the new vintage when the quantities involved exceed those of the previous one. This usually happens in the first months of the following year.

Seasonal adjustment of agricultural price indices

Interpreting the change in prices calls for several precautions when they follow a regular seasonal pattern. Due to the ordering of births and feeding conditions, the price of cow's milk reaches a maximum in winter, falls in summer and then recovers in autumn. Monitoring a monthly decrease or increase can therefore lead to explaining a change that is reproduced every year to a comparable extent without showing the characteristics specific to the current year. Indices of corresponding items and groups, adjusted for seasonal variations, are therefore calculated. The monthly seasonal coefficient (relationship between the monthly level and the annual average level) is obtained using econometric means

12. see problems regarding the cereals index, below

and the raw index is divided by this coefficient, thus isolating variations due solely to the economic climate. The seasonal profile is gradually distorted by changes in methods of cultivation and marketing.

However, most agricultural prices do not have a pronounced seasonal pattern. Apart from those paid for by seasonal prices, plant products are not particularly seasonal. As variable basket indices are not comparable from one month to the next, they are not seasonally adjusted. On the other hand, livestock prices follow seasonal patterns that are generally quite marked and are seasonally adjusted.

1.4. – Agricultural price indices in the European Union

Calculated in the oldest member states even before the European Economic Community was formed, the agricultural price indices were revised and coordinated by the Community as part of the Common Agricultural Policy. Work on harmonising the methodology was begun in the 1970s in the *Agricultural Prices* working group led by Eurostat to whom the prices owe their present appearance. Each new member state draws up an index of farm-gate prices and an index of purchase prices of the means of production according to a common methodology. These national indices are connected according to the European nomenclature. They are used to calculate European indices and are employed in the drawing up of agricultural economic audits. The European indices are Laspeyres indices that are rebased every five years, in the years ending in zero and five. The weighting structure is locked into that of sales of agricultural products which is recorded in the agricultural economic audits. The European indices have come out every quarter since 2005. However, France, like a great many countries, will continue to calculate and publish monthly indices and will send the quarterly averages to Eurostat (calculated using the same principle and the same weighting coefficients as the annual indices).

The member states have adopted the standardised methodology in spite of the obstacles presented by particular local features. As the EEC, then the European Union, has expanded, the disparity between standards of production, marketing and social involvement in price monitoring has deepened, aggravated by budgetary difficulties and different statistical traditions. The entry of countries from the former Eastern Europe is introducing economies whose political organisation has been closed to any price monitoring for many years.

° ° °

These considerations regarding the calculation of indices have enabled us to measure the link between the calculation model, the nature of prices and the conditions under which they are monitored. We still have to describe the problems associated with the monitoring of agricultural prices, which has been profoundly affected in recent decades by changes in marketing methods.