# PRICE ANALYSIS AND A SYSTEM OF PRICE STATISTICS

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For some considerable time the interest in price statistics has mainly been focused on their use as "intermediate goods". The requirements of a system of price index numbers which have to be established in this connection are largely in the field of statistical coordination (integration of statistics on quantities, values and prices).

Recently the inflation problem has given rise to an increased interest in price statistics as "final goods". A meaningful analysis of inflation will devote attention to the relation between input prices and output prices. In this article several versions of an analysis of prices of final demand categories based on an ordinary Leontief input-output scheme are presented and the needs for price statistics are discussed. In fact a self-contained system of price statistics emerges from the price analysis.

There is a difference in the nature of the price index numbers required in compiling input-output tables in constant prices (Paasche) and that in the case of price analysis (Laspeyres). However the need for price observation runs largely parallel because in both cases the same detailed information on price developments will probably be used.

Price analysis gives the possibility of a step-by-step approach in building up a system of price index numbers.

## 1. INTRODUCTION

Information on prices and changes in prices forms an important part of the description of the economic process. Until recently the idea that this information must be regarded as a coherent whole had not been worked out organizationally and statistically in the Netherlands.

In an organizational respect a start is now being made with this. The compilation of price statistics is now being centralized in one division of the Netherlands Central Bureau of Statistics. This division has the following tasks:

—furnishing information on prices and price changes;

—developing a system of price index numbers that will form the point of departure for the above;

—analysing the relation between price developments and the relation between the development of costs of production and that of product prices.

An essential element of the definition of the tasks is further the coordination of these activities with the compilation of the other economic statistics, for price statistics describe an aspect of the economic process which is not detached from those aspects that are described by means of statistics on values and quantities.

The idea which is thus acquiring organizational substance is the following. For a systematic description of the economic process, systematic information on price developments is of great importance. This system is directed on the one hand towards the provision of information on price developments in themselves (price statistics as final products) and on the other towards information on the economic process in general (price statistics as intermediate goods). As regards the latter, it is a matter of the integration of statistics concerning quantities, values and prices. These two considerations form separate elements of the purpose for which a system of price index numbers should be developed.

## 1.1. *Price Statistics as Final Goods*

Data on price developments form in themselves important indicators for the economic policy of the authorities and private bodies. For instance, in the Netherlands the price index number of household consumption plays an important part in wage negotiations and in fixing the rates of income tax and thus in the Government's incomes policy. In addition this number, like other price index numbers, is used in indexation clauses of private contracts. These are only a few instances from a large variety of uses; the universal importance of information on price developments in themselves can perhaps be most clearly illustrated by referring to the fact that among the objectives of Government economic policy the pursuit of stable price development enjoys high priority.

However, the provision of information on behalf of *inter alia* price and incomes policy comprises more than the publication of a number of separate price index numbers. Thus in recent times great interest has developed in data on the influence of changes in the prices of raw materials on changes in the price of end-products. Such data too should be included in the information to be furnished on price developments.

Other examples are:

—determining the influence of changes in the rates of indirect taxes on the price index number of household consumption. The price index number corrected for this influence is used in the Netherlands for revision of the (progressive) income tax rates and for determining the "price compensation" in contracts of employment (the additional wage increase that will be paid if prices have risen by more than a certain agreed percentage);

—determining the influence of changes in rates of remuneration of the factors of production on the prices of end-products. There is great need for such information when following a price and incomes policy.

Thus the provision of information on price development includes furnishing data on the relation between price developments themselves and that between price and cost developments. The compilation of these data may be termed "price analysis". Notably with regard to this price analysis certain systematic requirements will have to be made of the compilation of price statistics.

## 1.2. *Price Statistics as Intermediate Goods*

The (potential) use of price statistics in the compilation of data at constant or current prices is of particular importance in the development of a system of price index numbers. There is a need here for both price index numbers by kind of commodity and price index numbers by industry.

The requirements that have to be established in this connection of a system of price index numbers are largely in the field of statistical coordination. In part general aspects of this coordination are concerned; in addition a few specific points play a part.

The general aspects of the statistical coordination relate above all to the classification into industries and commodity groups used in the price statistics. The

integration of statistics relating to quantities, values and prices is possible only insofar as these statistics start from the same commodity nomenclature and the same classification of industries and the same grouping of establishments into that classification.

The specific aspects of statistical coordination relate in this connection to, among other things, the harmonious development of economic statistics in general. Thus in a certain phase of the build-up of price statistics the place that the prices of commercial activities occupy in the system of price index figures will be connected with the state of affairs regarding the other statistics on trade. In addition coordination problems of a more technical statistical nature are involved, such as the choice of valuations (consumers' prices, producers' prices etc.) and weights (index number problems, alternative weights for different applications, etc.).

A point of departure for the development of a system of price index numbers on behalf of the integration of statistics regarding values, quantities and prices is formed by the system of statistical description of the economic process. This may be subdivided into:

—description of the production process;
—description of the process of distribution and spending of personal incomes;
—description of the process of the formation and distribution of wealth.

Within the statistical description of the production process input-output tables occupy a central position. These are above all tables of the "industry × commodity" type and of the "commodity × industry" type. For the analysis of the production process "industry × industry" and "commodity × commodity" tables are primarily important.

From what was said with regard to statistical coordination, it now emerges that the system of price index numbers will have to fit in with this in two ways. The price index numbers by industry relating to production (valued at producers' prices, where appropriate specified by use) and those on imports (valued at c.i.f. prices, if necessary including import taxes, specified by competing industries, where appropriate by use) will have to tie in with the "industry × industry" table. For the index numbers by commodity group the same reasoning applies with regard to fitting in with the "commodity × commodity" table, concerning both domestically produced and imported goods.

In addition, for indicators concerning a number of quantities from the input-output tables it is important to have index numbers of consumers' prices by industry and by final expenditure category.

The tie-in with input-output tables is important not only for the development of a system of price index numbers but likewise for the remaining economic statistics describing the production process.

Description of the process of distribution and spending of personal income requires in the price statistics a division of the household sector into groups (income brackets, social groups, family size etc.). In the system of price index numbers this requires that provision be made for alternative weighting schemes for the price index numbers of household consumption.

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In the description of the process of formation and distribution of wealth, price statistics are concerned with the prices of assets. Insofar as these assets occur in the input-output tables it is merely a matter of further specification. One could envisage investment matrices as the point of departure for this part of the system of price index numbers. In addition there should be room in this system for prices of assets that do not occur in the input-output table, such as land and second-hand assets.

### 1.3. *Purposes of a System of Price Index Numbers*

If the purpose of the compilation of price statistics was confined to the publication of separate price index numbers, there would be little need for a system of price index numbers. Only the requirement of a reasonable degree of completeness could be made of the statistical programme.

However, when one assumes that the provision of information on price development also includes the furnishing of data on the relation between price developments, the need arises for a coherent system of price statistics. It is also a good idea to include in this the connection with cost developments, as is done in the forms of price analysis described below in this paper.

In addition, the use of price statistics "as intermediate good" makes certain requirements of the system used. Consequently, a further objective of a system of price statistics is that it must fit in with the system used for other economic statistics. The two elements of the objective of a system of price index numbers have points in common. In price analysis too the tie-in with other economic statistics plays a part, while on the other hand the use of price index numbers "as intermediate good" makes requirements of the relation between price index numbers. However, it looks as if certain less complicated forms of price analysis make relatively mild requirements of the completeness of the system of price statistics. Moreover, the gradual development of this price analysis presents possibilities for building up the system step by step.

In the use of price statistics "as intermediate good" such a flexibility is probably less clearly apparent: the compilation of an input-output table at constant prices, for example, requires a high degree of completeness of the price statistics.

This paper will be mainly concerned with the use of price statistics "as final good" as a point of departure for the development of a system of price statistics. For this purpose a version of the price analysis is presented in section 2. In section 3 attention is devoted to the requirements with regard to the price statistics connected with this analysis. Section 4 discusses variants of the analysis and explains what has been said above about the possibility of stepwise development of the system of price statistics.

## 2. A VERSION OF THE PRICE ANALYSIS

### 2.1. *Various Versions of Price Analysis*

In the introduction price analysis was defined as research into the relation between price developments and that between price and cost developments. Such

an analysis can be performed at different levels of aggregation:

—By commodity group: for instance analysis of the difference between producers'/c.i.f. prices and purchasers' prices in terms of import duties, other indirect taxes, wholesale margins, retail margins and transport margins. Such an analysis may form an incentive for coordination of price statistics, for a condition is that the classification of commodities is coordinated in the compilation of producers' c.i.f. and purchaser's prices. Moreover, this analysis may be regarded as a very important form of plausibility check in price observation when the investigation is being performed at a highly disaggregated level. This seems the most interesting use of this type of analysis: comparison of producers' price (or basic value) with purchasers' price by individual product. This form of price analysis can also indicate in which direction the future improvement of trade and transport statistics will be able to proceed.

—By industry: for instance analysis of the producers' price index of production in terms of quantities and pseudo-prices of raw and auxiliary materials, indirect taxes and subsidies, wages and social charges, depreciation allowances and operating surplus. This type of analysis can be disaggregated into separate groups of products of an industry with the aid of a recently developed method for estimating the input structure of individual groups of products.[1] In this form of analysis use can be made of price indices (including trade margins etc.) that are based on independent observation of consumers' prices of intermediate inputs (including imported raw and auxiliary materials).

—By final expenditure category: for instance, analysis of the price index of household consumption in terms of import prices, indirect taxes and subsidies, wages and social charges, depreciation allowances and operating surplus. This type of analysis can be disaggregated into separate groups of products and likewise into groups of households (income bracket), family size, social group etc.).

The last two variants may include the first one. The last variant seems the most interesting for the development of a coherent system of price index numbers.

This chapter will therefore be concerned with a version of the price analysis of final expenditure. The input-output table forms the principal instrument of analysis here. An "industry × industry" table is taken as the point of departure.

## 2.2. A Version of the Price Analysis of Final Expenditure

Now one of the possible versions of the price analysis will be worked out. The assumptions used with this version have been so chosen that it may be expected that this analysis can be performed at the Netherlands Central Bureau of Statistics within the foreseeable future. In the price analysis the development of prices of the output of an industry is explained in terms of the price development of the inputs. Here the relative changes of the quantities of the inputs consumed also play a part. However recent data on these changes especially for the intermediate and imported inputs are not available. Now first and foremost, the analysis has to

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[1]G. J. A. Mensink, "Methods of estimating the input structure for separate product groups of heterogeneous industries". Statistical Studies, no. 21, Netherlands Central Bureau of Statistics, 1974.

provide above all recent information. Therefore with regard to these problems the following assumptions have been chosen:

—price index numbers corrected for changes of the quantity of input per unit of output (pseudo price index numbers) can be determined for depreciation allowances, wages and salaries and social insurance contributions;

—for the other inputs (excluding operating surplus) pure price index numbers will suffice. This entails the implicit assumption that the quantity of input per unit of output is constant.

## 2.2.1. Further Characteristics of the Analysis

The version of the price analysis presented here is further characterized by the following points:

a. The price index-numbers are of the Laspeyres type.
b. It is assumed that price changes in inputs make their effect felt immediately and fully in the prices of the final products.
c. There are separate price index numbers available for intermediate and final production by industry.
d. Price numbers by final expenditure category based on independent observation are available.
e. By industry the input structure of intermediate production differs from that of the final production.
f. Imports are divided into product groups with separate price index numbers.
g. The other primary inputs are specified to a considerable extent. Thus wages, social charges and operating surplus by industry are regarded as a separate input category (diagonalization of rows in the matrix of the primary inputs).
h. It is assumed that it is possible to divide both trade and transport into a number of sub-industries (e.g. trade in agricultural products, trade in metal products etc.).

## 2.2.2. Formal Presentation of the Analysis

A. In the formal presentation of the analysis use is made of symbols whose meaning is given below. After each symbol the dimension of the matrix or vector in question is given in parentheses.

The following is of importance with respect to this:

—The number of (sub)industries is $2m$ (for each industry a distinction is made between an economic sub-industry for intermediate production and one for final production);

—within imports a distinction is made between $n$ product groups;
—there are $q$ categories of indirect taxes, levies and subsidies;
—there are $2m$ categories of wages;
—there are $2m$ categories of social insurance contributions; ⎫ Viz. 1 per
—there are $2m$ categories of depreciation allowances; ⎬ sub-industry
—there are $2m$ categories of operating surplus ⎭

—there are $r$ categories of primary inputs, which at the same time are final expenditure.

| | |
|---|---|
| $p_1(m \times 1)$ | vector of price index numbers of intermediate production by industry |
| $p_2(m \times 1)$ | vector of price index numbers of final production by industry |
| $k_1[(n+q+3m) \times 1]$ | vector of (pseudo) price index numbers of primary inputs (including imports, excluding operating surplus) for intermediate production by industry |
| $k_2[(n+q+3m) \times 1]$ | ditto for final production by industry |
| $o_1(m \times 1)$ | vector of pseudo price index numbers of operating surplus for intermediate production by industry |
| $o_2(m \times 1)$ | ditto for final production by industry |
| $A_1(m \times m)$ | matrix of intermediate input coefficients for intermediate production by industry |
| $A_2(m \times m)$ | ditto for final production by industry |
| $B_{1,I}[(n+q+3m) \times m)]$ | matrix of primary input coefficients (including imports, excluding operating surplus) for intermediate production by industry |
| $B_{2,I}[(n+q+3m) \times m)]$ | ditto for final production by industry |
| $B_{1,II}(m \times m)$ | matrix of input coefficients of operating surplus for intermediate production by industry |
| $B_{2,II}(m \times m)$ | ditto for final production by industry |
| $w(m \times 1)$ | vector of weighting coefficients of final demand by industry within total final demand |
| $w_j(m \times 1)$ | ditto for final demand category $j$ |
| $l(r \times 1)$ | vector of (pseudo) price indices of primary inputs, which at the same time are final demand |
| $v(r \times 1)$ | vector of weighting coefficients of primary inputs and at the same time final demand, within total final demand |
| $v_j(r \times 1)$ | ditto for final demand category $j$ |
| $a$ | price index number of total final demand |
| $a_j$ | price index number of final demand category $j$. |

The $p$, $k$, $o$ and $l$ vectors and the $a$'s are based on data taken from the year under review. The $A$ and $B$ matrices and the $w$ and $v$ vectors are taken from the input-output table of the weighting year of the (pseudo) price index numbers. $B_{1,II}$ and $B_{2,II}$ are diagonal matrices, while in $B_{1,I}$ and $B_{2,I}$ a number of submatrices occur with a diagonal shape (e.g. wages by industry on a separate row).

B. In the analysis it is assumed that the price index numbers of production by industry and of imports are known, as are the pseudo price indices of primary inputs, but excluding those of the operating surplus. The pseudo price index numbers of operating surplus are not compiled. As a first step in the price analysis these pseudo price index numbers must be estimated.
We have

$$(2.1) \qquad p_1' = p_1'A_1 + k_1'B_{1,I} + o_1'B_{1,II}$$

which yields

(2.2)
$$o_1' = p_1'(I - A_1)B_{1,II}^{-1} - k_1'B_{1,I}B_{1,II}^{-1}$$

Further we have

(2.3)
$$p_2' = p_1'A_2 + k_2'B_{2,I} + o_2'B_{2,II}$$

which yields

(2.4)
$$o_2' = p_2'B_{2,II}^{-1} - p_1'A_2B_{2,II}^{-1} - k_2'B_{2,I}B_{2,II}^{-1}$$

C. Now all price indices and pseudo price indices are known and the proper price analysis can begin.

First the price indices of production by industry are separately "explained" for intermediate and final uses by the (pseudo) price indices of the primary inputs and imports.

a. Intermediate production.

From (2.1) we obtain:

(2.5)
$$p_1'(I - A_1) = k_1'B_{1,I} + o_1'B_{1,II}$$

which yields

(2.6)
$$p_1' = (k_1'B_{1,I} + o_1'B_{1,II})(I - A_1)^{-1}$$

b. Final production.

It follows from (2.3) and (2.6) that

(2.7)
$$p_2' = (k_1'B_{1,I} + o_1'B_{1,II})(I - A_1)^{-1}A_2 + k_2'B_{2,I} + o_2'B_{2,II}$$

Now if each element of the row vector from the right-hand term of (2.6) and (2.7) is written out in detail, one obtains a survey of the "causes" of the changes in the price index numbers of intermediate production and of final production by industry. The influence of the (pseudo) price development of each input category can be considered separately.

In this way the change of the price index number of final production by industry has been "explained". It must be borne in mind in this connection that (2.7) is concerned with the producers' prices of the final production of domestic establishments.

D. The next step is the analysis of the price index of total final expenditure. The share of total final production of the domestic establishments in this price index number may be written with the aid of (2.7) as

(2.8)
$$p_2'w = (k_1'B_{1,I} + o_1'B_{1,II})(I - A_1)^{-1}A_2w + k_2'B_{2,I}w + o_2'B_{2,II}w$$

By writing out the right-hand term of equation (2.8) in detail, one can determine the influence of the price change of each primary input category on the price index number of final production. The final production of domestic establishments is concerned here. However, imported final products must also be included in final expenditure. Further, the price of final expenditure is influenced by the development of the prices or rates of remuneration of primary inputs that are at the same time final expenditure (e.g. the wages and social insurance contributions of

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Government employees; indirect taxes paid by households etc.). The influence of these primary inputs on the price of final demand is expressed by $l'v$.

(2.9)    The price index number of total final demand is now found from
$$a = p_2'w + l'v$$

E. By replacing $a$, $w$ and $v$ in equations (2.8) and (2.9) by $a_j$, $w_j$ and $v_j$, one gets an "explanation" of the price development by separate final demand category (e.g. the consumption of family households):

(2.10)    $p_2'w_j = (k_1'B_{1,I} + o_1'B_{1,II})(I - A_1)^{-1}A_2w_j + k_2'B_{2,I}w_j + o_2'B_{2,II}w_j$

(2.11)    $$a_j = p_2'w_j + l'v_j$$

Now it has been assumed that price differentiation can exist among the final uses by industry. This makes it possible for the "observed" price index number by final demand category to differ from what is "explained" in (2.11). This is because equation (2.10) utilizes an average price index number of the final supplies by industry. The difference between the "observed" and the "explained" price index number may have two causes. In the first place it may be the consequence of the fact that the baskets of products supplied for the various final uses are not homogeneous among themselves. In that case the assumption of the same input structure for all final supplies by industry is too stringent. A second cause may be the fact that the same product yields a different price in different markets (e.g. export market versus domestic market).

When one adds up the differences between the "observed" and the "explained" price index number for all final demand categories, after weighting with the share in the final demand in the weighting year, one finds that they compensate for one another. At least this is so if the weighted average of the observed price index numbers by final expenditure category is equal to the price index number of total final expenditure: a matter of consistency of price index numbers.

## 3. DISCUSSION OF THE NEED FOR PRICE STATISTICS

This section will investigate what information should be collected on prices in order to perform the version of the price analysis presented in the previous section.

The second part of the section will investigate whether the price information required for the price analysis can be used in the compilation of an input-output table at constant prices and what additional information is still required for that.

### 3.1. *Price Statistics Required in the Price Analysis*

With a view to exactitude of terminology this paper speaks of price index-numbers (of goods and services) and pseudo price index numbers (of value-added components).

The price index numbers needed for the version of the price analysis in the previous section are of the Laspeyres type. These price indices must form a consistent system. This means *inter alia* that the weighting year for all price index

numbers used should be the same and that weighting coefficients should be derived from the same basket of goods and services. Thus the price index numbers of the final expenditure categories should be consistent with those of the outputs of industries and with those of imports by kind of commodity.

### 3.1.1. Price Index Numbers of the Output by Industry

In the price analysis three price index numbers are used:
—the price index number of total output;
—the price index number of intermediate output;
—the price index number of final output.

Apart from cases of pure price discrimination these price index numbers can be calculated from one series of price observations per product. This is only a matter of alternative weighting schemes for the total, the intermediate and the final basket of goods and services. Insofar as pure price discrimination occurs to a sufficiently large extent, this should be observed and incorporated in the separate price index numbers. The above is concerned with price index numbers corresponding to the "basic value"[2] (see 3.1.4.a).

### 3.1.2. Price Index Numbers by Final Expenditure Category

These price index numbers can be compiled quite independently of those in the preceding section. The observation often occurs at other places. Purchasers' prices are usually then observed.

### 3.1.3. Price Index Numbers of the Products Imported by Establishments

In our version of the analysis it was assumed that imports were divided into product groups. For each of these product groups a price index number must now be compiled. This makes stringent requirements of the observation of the import prices. The usual unit value index numbers taken from the statistics of foreign trade are often unusable for this.

### 3.1.4. Pseudo Price Index Numbers of the Primary Inputs of Establishments

*a. Indirect taxes, levies and price-reducing subsidies.* In the analysis indirect taxes are divided into categories. For each category a separate pseudo price index must be compiled.

Indirect taxes may be divided into commodity taxes and other indirect taxes. In observation of the price of the output the influence of the latter taxes is included in any case. In principle the commodity taxes and subsidies can be recorded in the input-output table in two ways:
—with the producer of the taxed product;
—with the consumer of the taxed product.

The second variant is to be preferred, since the rates may differ for different uses of the production by industry.

Commodity taxes can be levied on quantity or value of the products. As it has been assumed in our version of the analysis that no changes occur in the quantity

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[2]See United Nations, *A System of National Accounts*, Series F, No. 2, Rev. 3 (1968).

of product consumed per unit of output (at constant prices), in the first case the development of the rate can be taken as the pseudo price index number.

If, on the other hand, a tax is levied on value, the burden of the tax varies with the prices of the products on which the tax is levied. The product of the developments of the above prices and of the rate can then be used as the pseudo price index number.

For non-commodity taxes the rate will generally be chosen as the basis for the pseudo price index, for practical reasons.

On certain imported products a levy is imposed. Since the rate of the levies and subsidies differs by product, it is desirable to have a pseudo price index number by industry.

*b. Wages and salaries.* It is desirable to have a pseudo price index number of wages and salaries by industry. On the one hand, there are differences between the industries in the development of the wage bill per man-year. On the other hand, there is a difference in the extent to which wage increases are passed on in the prices of the products, since there are considerable differences in the development of the output per man-year (at constant prices). Now it is not necessary to know the development of the wage bill per man-year and that of the output per man-year separately. As a pseudo price index number one can take the quotient of the wage bill in the year under review and the output of the year under review at prices of the weighting year.

If the development of the average wage per man-year and that of the output per man-year are known, the change of the pseudo price index number can be further analysed. If at the same time one has data on the wage drift,[3] this trend can even be resolved into three components, viz.:

—change in standard wage;
—wage drift;
—change in real output per man-year.

*c. Employers' contributions to social insurance.* Here too it is desirable to have a separate pseudo price index number per industry. Social insurance contributions are in general a percentage of wages. What has been said under b. about wages and salaries thus also applies here. The pseudo price index of social insurance contributions is therefore influenced by the development of the wage bill per man-year, of the output per man-year and of the rate.

Here too one can take as the pseudo price index the quotient of the total contributions per industry in the year under review and the output in the year under review in prices of the base year if the separate components of this pseudo price index number are not known.

*d. Depreciation allowances.* By industry a separate pseudo price index of depreciation allowances is necessary. The reason is that:

—the nature and the composition of the stock of capital goods in use may differ.

—the real depreciation per unit of output may develop quite differently per industry in connection with differences in the change in capital productivity.

[3]Wage drift is the quotient of the change in the wage bill per man-year and the change in the standard wage.

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The first factor causes differences between the pure price index numbers by industry. The last factor influences the pseudo price index numbers.

The influence of depreciation allowances on the change of prices can therefore be resolved into a pure price component and a component concerning capital productivity.

*e. Operating surplus.* The pseudo price indices of operating surplus need not be compiled. They are determined in the analysis.

### 3.1.5. Price Index Numbers of the Final Products Imported

By product group a price index number is required. Further, what has been said in 3.1.3. about the products imported by firms applies.

### 3.1.6. Pseudo Price Index Numbers of the Primary Inputs which are at the same time Final Demand

*a. Indirect taxes, levies and price-reducing subsidies.* We are concerned here with the indirect taxes weighing directly on consumption by final expenditure category. See further 3.1.4.a.

*b. Wages and salaries paid by the Government.* In the version of the price analysis presented one pseudo price index number will suffice if Government consumption is not divided functionally.

*c. Social insurance contributions paid by the Government.* The pseudo price index number is equal to the index of the value of social insurance contributions per man-year (see point b.).

*d. Government depreciation.* In our version of the price analysis one pseudo price index number will suffice here.

### 3.2. *Price Analysis versus Input-Output Table at Constant Prices*

This section is concerned with the extent to which the need for price statistics arising from the price analysis presented must be adjudged a relatively large one. For this purpose a comparison should be made with the existing need for price statistics within the framework of the integration of statistics on values, quantities and prices.

A complete and detailed inventory of required price statistics "as intermediate goods" would go beyond the scope of this paper. We shall therefore confine ourselves to a broad comparison of the price statistics needed for price analysis with those that are required in the compilation of input-output tables at constant prices. Moreover, this comparison will not be performed in full, but will be limited to the following two points:

a. to what extent does the collection of price statistics required for performance of the version of price analysis presented contain data that are not required in the compilation of input-output tables at constant prices?

b. are there price statistics which at first sight seem to be essential to the compilation of those tables, but which can be omitted from the given version of the price analysis?

The addition "at first sight" in the second point calls for some explanation. One can compile input-output tables at constant prices in various ways. Firstly there are variations with regard to the definitions. Then the degree of refinement

of the statistical technique used may vary. This paper does not deal at length with these matters.

Nevertheless, pronouncements are made on price statistics that are necessary for the compilation of the above tables. These pronouncements are therefore of a provisional nature and must be regarded against the background of the objective of these tables, viz. that they should furnish information on the development of the production structure. This means among other things that they should reflect the development of the input coefficients at constant prices.

Input coefficients at constant prices may change in the course of time through various causes:

I. As a consequence of changes in the composition of the basket of final products, changes in the input coefficients can occur insofar as several products are produced in each industry.

II. Even if one assumes the composition of final demand to be constant, changes in the input structure may occur. Causes may be technological development (saving on the amount of input per unit of output) and substitution between various kinds of inputs. The latter is not confined to primary inputs; the phenomenon also occurs with intermediate inputs.

A spectacular example of this is the replacement of oil by natural gas that recently took place in the Netherlands.

Now in the version of the price analysis presented above a constant input structure at constant prices was assumed for intermediate and imported inputs. For the components of gross value·added at factor cost, on the other hand, the development of productivity was taken into account.

The choice of these assumptions is connected with the aim of the price analysis, viz. to furnish recent information. On the one hand this means that the change of Laspeyres price index numbers must be analysed because in most cases it is not feasible to compile for instance Paasche price index numbers for very recent periods. The changes in the input structure mentioned under I above should therefore be left out of consideration.

On the other hand, the changes in the output structure mentioned under II should be taken into account. However, recent data are hardly available on this, especially for intermediate and imported inputs. In fact the compilation of these data requires the availability of a complete input-output table for the period under review. The changes mentioned under II are of relatively minor importance to intermediate and imported inputs and thus to indirect taxes. Exceptions can be made in special cases (for instance, the above-mentioned energy substitution and specific cases of import substitution), for which additional calculations can be performed. The opposite applies to the components of gross value added. For these recent data can also be compiled regarding the development of productivity. Hence, for the first category of inputs a constant input structure at constant prices has been assumed and for the other inputs it has not.

However, when making input-output tables at constant prices the issue at stake is the development in the volume of all elements in the table. If information on homogeneous quantities is not available, one has to fall back on deflation of an input-output table at current prices.

Consequently, for making an input-output table at constant prices, one should in the absence of adequate information on quantitative developments have available a complete input-output table of the year under review.

This means that between the time at which the price analysis can be performed and the time at which the input-output table is made one to two years will lapse. This also means that the price material to be compiled will be used in the first example for the price analysis. Then, if required, the material can be refined for the compilation of an input-output table at constant prices.

It will now be attempted to answer the questions given at the beginning of this section under a. and b. for each part of the input-output table.

### 3.2.1. Output by Industry

In our version of price analysis three price index numbers for each row were required, viz. for the intermediate, the final and the total output per industry. Furthermore, price differentiation was considered possible between the final uses of the output per industry. However, the price indices in question do not need to be known separately.

For making input-output tables at constant prices this information is necessary, since otherwise the development in the quantity of sales by final expenditure category is incorrectly estimated.

Further, in the price analysis the absence of price differentiation between the intermediate uses of the output per industry was assumed.

If this assumption is not correct, this has consequences for the reliability of the results of the analysis. But it is not out of the question that certain results are reasonably reliable.

The contributions of all separate inputs to the price index number of the total final expenditure are correctly estimated when the operating surplus is not specified by industry.

If, however, one suspects that a very great degree of price differentiation exists, it seems useful to make the analysis more complex by examining the input structure of the output for each intermediate use.

For the compilation of an input-output table at constant prices one will in the event of price differentiation between intermediate uses almost always want to have price indices for each separate use, in view of the purpose with which such tables are compiled.

Summarizing, it may be said that in the case of price differentiation between various uses of the production of each industry, the compilation of an input-output table at constant prices requires more information on prices than our version of price analysis. However, the dividing line is a vague one, since the reliability of the detailed results of the price analysis decreases as a result of price differentiation between intermediate uses, and supplementary information seems useful here too. Moreover, no absolute requirements of reliability can be made of the input-output tables at constant prices either.

### 3.2.2. Imports

In our version of the price analysis one price index was needed per product group. The number of industries and thus in principle the number of product

groups, as a result of the division of each industry into two sub-industries, was greater than in the case of the input-output table at constant prices.

However, from the viewpoint of price observation there is no difference, since the price indices in both cases are compiled from the same price material.

### 3.2.3. The Other Primary Inputs

In the discussion in 3.1.4. of the price information required for the price analysis, it was stated that for most primary input categories the quotient of the value of the input in the year under review and the output in the year under review in prices of the weighting year could be taken as the pseudo price index for each economic category.

In the price analysis pseudo price indices were compiled for certain primary input categories (wages, social insurance contributions, depreciation allowances) by industry. There were two reasons for this. On the one hand, differences in the development of the rates of remuneration of these inputs in the separate industries were expected. On the other hand there were differences in the development of the amount of input per unit of output.

Now the latter reason ceases to apply in the compilation of input-output tables. However, the former one still applies in full, so that it also seems desirable to have available by industry separate indicators for the development of the rates of remuneration of these primary input categories.

Now it was also said in 3.1.4. that for a good insight into the background of the change of the corrected price index numbers referred to above it was useful to know separately the price development and the quantitative development of the primary inputs. In that case no more price information is needed for making an input-output table at constant prices than in the price analysis.

On account of the division of each industry into two sub-industries, in this case too the required number of pseudo price indices is in principle greater in the price analysis than in the compilation of an input-output table at constant prices. In practice there will be little difference, since for practical reasons there will in general be little point in compiling separate pseudo price index numbers for the inputs of the two sub-industry classes.

With regard to indirect taxes, there is no difference in the need for data between the price analysis and the compilation of input-output tables at constant prices.

### 3.2.4. Conclusions

On the strength of what has been stated in subsections 3.2.1. to 3.2.3., the following conclusions can now be drawn with regard to the questions asked at the beginning of this section:

a. In a number of cases the number of price indices required for making an input-output table at constant prices proved to be less than in the version of price analysis presented. This difference was found not to exist for the size of the price observation.

b. In various cases the need for price material in making an input-output table at constant prices was greater than for the price analysis.

Finally, it can be concluded that the need for information on price developments when compiling input-output tables at constant prices runs largely parallel to that in our version of the price analysis and may perhaps be considered to be somewhat greater, if anything.

### 3.3. *The Nature of the Price Index Numbers*

It was stated in section 3.2. that from the viewpoint of the price analysis there is a preference for price index numbers of the Laspeyres type. This preference was connected with the fact that this analysis should furnish recent data.

The question now arises whether this preference for Laspeyres price index numbers also applies to the making of input-output tables at constant prices.

In the Dutch situation an input-output table at constant prices will probably be built up from very detailed statistical material. This is necessary because when compiling an input-output table at constant prices allowance should be made for price differentiation as a result of differences in baskets between various uses of the output of each industry. The price indices to be used in deflation should then be built up from detailed data on values and prices. In that case, however, it is also possible to calculate values at constant prices already at this detailed level. At this highly disaggregated level the difference between Laspeyres and Paasche is not very relevant in practice.

There will possibly be a slight preference for a Laspeyres definition of constant prices. This is easier to interpret than a Paasche definition. If one wants input-output tables of the Laspeyres type, the price index numbers to be derived from the tables in current prices are of the Paasche type.

In the case of price indices as final products there is in general a preference for price indices of the Laspeyres type. Considerations regarding the interpretation also play a part in this, similarly to the situation with input-output tables at constant prices.

The price analysis ties in with this. Needless to say, price analysis makes stringent demands in terms of the frequency of reweighting of the price index numbers.

### 4. POSSIBILITIES OF A STEP-BY-STEP APPROACH

This section will investigate how the version of the price analysis presented in section 2 and the related system of (pseudo) price index numbers can be built up in phases. It will also examine whether and in what direction the price analysis can be further expanded. There seems little significance in phasing the build-up in the case of the input-output table at constant prices, having regard to the objective for which these tables are compiled.

The version of price analysis which we presented in 2.2. makes requirements with regard to the extent and nature of the statistics which cannot yet be complied with in the Netherlands.

It is therefore desirable to arrive at a phasing in the build-up of the analysis. This phasing is also important for gaining experience. By making trial calculations with the aid of simpler models problems may be discovered that will also arise with

more complicated variants. This experience is in addition a guide in the development of the system of price index numbers. Moreover, it offers the chance of investigating what influence simplifying assumptions have on the results.

## 4.2. The "Simple" Version of Price Analysis

One of the simplest versions of price analysis of final demand is that in which each type of primary cost is regarded as one input category with one pseudo price index. The analysis of the price index number by final expenditure category then proceeds as follows: the contribution of the primary inputs (excluding operating surplus) is estimated as the product of the cumulated input coefficient and the pseudo price index of the primary input in question (e.g. the quotient of the development of the wage bill and that of the gross domestic product in constant prices). The contribution of the operating surplus is then found from the difference between this price index figure and the contributions of the other primary inputs.

There are a number of serious drawbacks to this method, which is occasionally used, notably in the analysis of the price index number of household consumption:

a. For each primary input category only one (pseudo) price index number is used. Since between industries there are often considerable differences of the pseudo price index number of the inputs, this simplification will severely distort the results if such an analysis is performed for separate final demand categories. It should be borne in mind that it is for instance quite feasible that industries producing mainly consumer goods have a pseudo price index number of wages with quite a different development from that of economic categories chiefly producing investment goods.

b. The difference between the part "explained" by contributions of the other primary inputs and the "observed" price index number per final expenditure category is regarded as the contribution of the operating surplus. However, this difference consists of a number of components:

1. contribution of the operating surplus; .
2. distortion through price differentiation as a consequence of a difference in composition of the output of each industry for different uses;
3. difference through pure price discrimination;
4. statistical discrepancies, including:

—differences because changes in the (pseudo) price of the primary inputs do not always make their effect felt immediately and fully in the price of the products;

—differences as a consequence of the assumptions made in an input-output analysis not being entirely correct (insofar as not yet mentioned above);

—differences through inaccuracy in price observation, in the estimation of the input-output-table etc.,

—differences through possible inconsistencies in the system of price index numbers.

## 4.2. The "Improved Simple" Version of Price Analysis

This version is characterized by the following points:
a. The output of each industry is assumed to be largely homogeneous. Only the consequences of price differentiation between the various final uses of output by industry are investigated. There is one price index number of the output per industry.
b. The primary inputs are highly detailed. Wages, social charges, depreciation allowances and operating surplus are regarded per industry as separate input categories (diagonalization of rows from the input-output table). The compilation of pseudo price indices of all these separate input categories is considered possible.
c. The industries "trade" and "transport" are not disaggregated.

In fact this version differs only with regard to point b. from the "simple" version. This point b. meets the two serious drawbacks mentioned in the preceding section. As a pseudo-price index number is used for each primary input category for each industry, the results of the analysis are more reliable.

Further, it becomes possible to estimate the pseudo price index of the operating surplus by industry[4] and to establish its contribution to the price index by final demand category. In this way the contribution of the operating surplus of each industry is estimated as it would have been if there were no price differentiation and no statistical discrepancies.

In addition, the price index number calculated as the sum of the contributions of all primary inputs to the price development of consumption can be compared with the price index number of consumption compiled with the aid of directly observed prices. The difference to be derived from this comprises components 2 to 4 mentioned under b, in preceding section.

## 4.3. Intermediate Steps

### A. Trade and Transport

In the "simple" versions of price analysis there is one industry "trade" and one industry "transport". In the analysis these two industries are treated like all other industries. In the Dutch input-output table transport margins are also included in trade margins. The relevant output of transport has been recorded as intermediate input of trade. The direct observation of the prices of commercial services presents quite some problems. However, there is a possibility of arriving indirectly at an estimate of the price index. If one has available a Laspeyres index of the producers' prices of final demand and a Laspeyres index of purchasers' prices based on the same basket, excluding the indirect taxes weighing directly upon consumption, the price index of trade margins (including transport margins) can be derived from the difference in these two indices, for the use of Laspeyres indices for the purchasers' prices implies a constant "basket" of commercial services incorporated in the purchased goods.

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[4]In a simpler way as in equations (2.2) and (2.4) (subsection 2.2.2. B), because now: $p_1 = p_2$; $A_1 = A_2$; $B_{1,I} = B_{2,I}$; $B_{1,II} = B_{2,II}$ which yields $o_1 = o_2$.

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The use of one average price index of the commercial services presents problems when one wishes to proceed to analyse purchasers' prices by product group, since commercial and transport services are heterogeneous products. It is not inconceivable that the price development and the input structure of trade and transport in certain categories of commodities differ greatly from those in others. A division of commercial and transport services in price analysis into different categories, such as those proposed in the price analysis version of section 2, would improve the situation. However, this demands rather a lot of information.

Now it is possible to derive the price indices of subgroups of trade (including the corresponding transport) by comparing producers' price indices and purchasers' price indices for separate final product groups (corresponding to the subgroups of trade) in the same way as suggested above for the total final demand.

As an intermediate form of the simple versions of price analysis and the version presented in section 2, the following is now possible.

Suppose that the price indices of subgroups of commercial services (including the corresponding transport) have been derived in the manner described above, but that the composition of the inputs of these subgroups separately is not known. In that case one is obliged to operate in the input-output table with one row and one column for trade.

Price analysis then gives in the first place an explanation of the producers' price index of production by industry by the (pseudo) price development of the primary inputs of the same and other industries. The price index of commercial services is accordingly explained by the development of the primary costs of trade and those of other industries.

In addition the contribution of price development of the output of the industry "trade" (including transport) to the purchasers' prices of separate final product groups can now be established.

## B. Price Differentiation and Input Structure

The "simple" versions of price analysis use one price index number for the output of each industry. Thus no allowance is made for price differentiation that could exist as a result of a different composition of the basket of products supplied according to use. At the same time no price discrimination is observed.

As the price material becomes better and more differentiated, one can try to refine the analysis. For this one should also know the input structure of the output by use. In the price analysis version of section 2 it has been assumed that it is possible to compile for intermediate and final uses separate price index numbers of output by industry by means of an alternative weighting scheme of the observed prices by product. For this one should have available data on the position of the basket of products supplied to intermediate or final uses.

Incidentally, these data are also required for estimating the input structure of the output for intermediate and final uses. With the aid of the method stated in section 1[5] one can estimate the input structure for separate product groups within the output. Now by weighting these input structures by product group together for different uses one gets an estimate of the input structure by use. In this process

[5]See note, p. 45.

each product group gets as weight the share of that group in the total supply to that use in the base year.

Insofar as pure price discrimination between intermediate and final uses of output by industry occurs to a large extent, this should be observed and incorporated in the separate price index numbers.

The above refinements in the analysis will make the results more reliable. This applies in particular to the estimates of the pseudo price indices of the operating surplus for each separate industry and to the pseudo price index of the operating surplus of all industries together. For when the possibility of price differentiation between the intermediate and the final uses of output by industry is excluded, as in the "simple" versions of price analysis, while it is in fact present, an incorrect estimate is obtained of the contribution of the development of the operating surplus of all industries together to the price index of the final output per industry and, as a result, to the price index of total final demand.

This can be demonstrated as follows: a change in the price of intermediate supplies has no effect on the level of the operating surplus which is earned by all industries together, for an increase in the price of an intermediate supply means that the operating surplus increases in the case of the supplying industry, while as regards the receiving industry the operating surplus decreases by the same amount. Thus on balance the contribution of the total operating surplus does not change as a result.

It follows from this that the total operating surplus of the industries depends only on the level of the prices of the final output. In the "simple" versions one takes the price index number of the total output per industry as the price index number of the final output.

If these two price indices do in fact differ, as is the case with price differentiation, one also finds with the "simple" version a different contribution of the total operating surplus of the industries to the price index of the final output per industry and thus a different pseudo price index number of the total operating surplus of all industries together. But in that case the estimates of the pseudo price index numbers of operating surplus by industry cannot all be correct either.

This is why the analysis presented in section 2 started from price differentiation between intermediate and final output.

But a simpler analysis is possible. Without dividing the industries into two subindustries producing intermediate and final output separately the "improved simple" analysis can yield some good results. If the price index of final output is applied to the total output of each industry, the contribution of total operating surplus of all industries to the price change of total final demand is correctly estimated.

## 4.4. *The Version of Price Analysis presented in Section 2*

Now that the analysis has been rendered more complex by dividing trade and transport into sub-industries and admitting a certain degree of price differentiation, we have come to the version of the price analysis presented in section 2. Further to this, the price analysis by product group and by industry can be developed (see 2.1.).

At the same time it appeared from section 3 that sufficient information is now available to make a start with the compilation of an input-output table at constant prices.

## 4.5. *Expansion and Refinement of the Analysis*

A. A possible expansion of the analysis may be sought in the more thorough analysis of the price differentiation phenomenon. It has already been suggested in 2.3. in which direction this could go.

In the first place one can think of estimating the input structure of output by industry for different final uses. Parallel to this, price index numbers by industry and by final demand category must be compiled. This is a matter of alternative weighting schemes for the already available prices by product group. A good insight into the basket of products supplied for each separate use is needed.

Further, one can refine the analysis by making allowances for price differentiation between the intermediate uses of the output by industry. For this price index numbers ought to be compiled, while estimates should also be made of the input structure of the output of separate intermediate uses.

The analysis can be still further expanded by investigating price discrimination more closely. If it is suspected that there are considerable differences in the price of the same product also between the various intermediate (or final) uses, one could try to observe this.

B. Expansion of the analysis can also be sought in another direction. In section 2.2. it was stated as an assumption regarding the version of price analysis presented there that changes in the (pseudo) price of the primary inputs make their effect felt immediately and fully in the prices of the products.

In reality these changes will make themselves felt in the (pseudo) price index numbers of the primary inputs with a certain delay. In the process differences may occur between the various input categories (for instance: an increase in import prices may be more quickly reflected in output prices than a wage increase, or conversely). Further, the delay may be less in the case of a direct connection than in that of an indirect connection (for instance: an increase in the pseudo price index of wages in agriculture may be reflected first in the price index of agricultural products and only afterwards in the price index of the products of the food industry).

Now one can try to estimate the size of the delays referred to above by means of regression analysis. Thus in a regression equation the prices of output by industry in period $t$ could be explained by the contributions of the primary inputs in the periods $t$, $t-1$, $t-2$ etc. In doing so the "weights" of the various periods are estimated as regression coefficients.

A number of variants of such a regression analysis are possible. For instance, one could think of a time series analysis by separate commodity group (defined for each industry of origin) or a time series analysis of the price index number of total final demand (or perhaps parts of it). Also conceivable is a cross-section analysis of the various commodity groups for one specific year, in which as a result the extent of the delay for the price index number of the total final demand is estimated.

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With both a time series analysis and a cross-section analysis there is the danger that the number of explanatory variables will be large in proportion to the number of observations. As a result, the number of degrees of freedom will in many cases be too small for estimating significant regression coefficients. This situation can be improved by reducing the number of explanatory variables. On the one hand one could think of reducing the number of primary input categories between which a distinction is made, and on the other of setting a maximum to the extent of the delay.

## 5. CONCLUDING REMARKS

The interest in price statistics has for some considerable time been mainly concentrated on their use "as intermediate goods", for policy was primarily interested in cyclical fluctuations of economic activity and in growth. Recently the problems of inflation have given rise to increased interest in price statistics "as final goods". In that framework there is a need for more than a collection of separate price index numbers. Thus Hill rightly assumes that an integrated system of price statistics is required for systematic analysis of the inflation process.[6]

Various forms of inflation analysis are conceivable, but every meaningful analysis will probably devote attention to the relation between input prices and output prices. The price analysis discussed in the preceding sections is directed towards this relation. A distinction has been made between various forms of this price analysis in which attention was largely devoted to analysis of the price development of final expenditure. It came to the fore in this that analysis of the relation between input prices and output prices, like that between producers' prices (basic value) and purchasers' prices, makes requirements with regard to the relation between the relevant price statistics. This relation between price statistics is very similar to that between the statistics forming the basis of the input-output table at constant prices. In fact a self-contained system of price statistics emerges from the price analysis.

Incidentally, for the use of price statistics "as intermediate goods" too a system of price index numbers fitting in with the system of the statistics relating to values and quantities is important. However, there is a considerable degree of agreement between this system and that of the price analysis.

From the discussion of the need for pure statistics it appears that the nature of the required price index-numbers in compiling input-output tables in constant prices (Paasche) will differ from that in the case of price analysis (Laspeyres). However no large difference will exist for the nature and size of the price observation, because in both cases the same detailed information on price developments will probably be used.

Consequently, when building up a system of price statistics there is scarcely any reason to see the use of these statistics "as final good" as competing with that "as intermediate good". Nevertheless, there was reason to devote special attention to the former use. In the first place this was justified by the possibilities of a

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[6]Cf. T. P. Hill, "A system of integrated price and volume measures (indices)", Statistical Studies and Surveys, 1972, No. 3, Statistical Office of the European Communities, p. 11.

step-by-step approach to the build-up of a system of price statistics that are indicated by the price analysis. In addition, perhaps more enthusiasm may be expected for development of a system of this kind in the interests of the systematic presentation of price statistics than if this were to be built up on behalf of entirely different statistics.

This certainly does not mean that in the development of a system of price statistics integration with other statistics does not continue to be an important point of view. Come to that, price analysis itself cannot be developed without this integration, as emerges from the character of pseudo price index figures described.