ON THE MEASUREMENT OF INFLATION IN THE NETHERLANDS

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This paper summarizes some salient points of a monograph entitled „Inflatie in Nederland van 1952 tot 1975" (*Inflation in The Netherlands*) by B. M. Balk, G. J. van Driel and C. van Ravenzwaaij.

Summary
In this investigation the problem of the measurement of inflation is discussed. The data consist of monthly prices of 235 commodities observed during the years 1952 to 1975 inclusive. It is postulated that the price movement consists of two components, an inflationary and a specific one. It is argued that the data do not contradict this hypothesis.

Then an index of inflation is constructed as an unweighted average of 141 series of price indices. A short term analysis of this index reveals seven waves of inflation.

1. Introduction

It is customary to use the word "inflation" as a description of the situation in which the "general price level" shows an upward trend and the inverse concept - the "purchasing power of money" - a downward one. The adjective "general" is however emphasized. During a period of inflation not all prices do increase. In fact it is possible that the prices of some commodities decrease, while nevertheless the period is considered an inflationary one.

The term inflation is used rather loosely, so that an objective measure of the general price level or its change becomes desirable. This problem has been a point of discussion - and a source of controversy - between economists for decennia and still is one today. During the seventies - a period of strong uninterrupted inflation the measurement problem acquired a practical dimension. As a protection against the undesirable consequences of inflation the use of the technique of indexing has become widespread. But which price index is to be used for this purpose? The problem is relatively simple if the contract price of a commodity has to be indexed, while a price index for that commodity is available. Much more difficult is the choice of a price index to be used for the indexing of wages, or taxes or social benefits. And which price index is to be used to index nominal monetary debts or to compare the annual financial statements of a given enterprise?

If an obvious choice out of the available price statistics does not exist, one is forced to fall back on some general index, like the official consumer price index. This index is practically the only authorative measure of the devaluation of the purchasing power of money, based on direct observation of prices and calculated and published regularly. However, this method is not generally considered to be a sound one. It is countered that, although everybody is affected by inflation, different persons and enterprises are affected differently, so that the use of a general figure for all categories and all individuals is incorrect and will lead to undesirable consequences. Within this view "inflation" and "level of prices" have a meaning only in the context of a given basket of commodities and services. This train of thought is, for instance, to be found in the Sandilands report - a paper originating from the English accountancy world [2]. In paragraph 28 it is stated literally:

> "A general index of price changes or of the purchasing power of money is of little practical use and the concept of "general price changes" and its converse, "the general purchasing power of money" are unquantifiable."

Of course, we do not wish to deny that different persons and categories might be exposed to quite different an increase in price. It is absolutely true that in the short run prices of individual commodities can diverge appreciably so that the choice of weights greatly influences the value of the price index of the aggregate. We are of the opinion, however, that these price increases to which various individuals are exposed are not the same thing as inflation. This confusion perhaps finds its cause in the generally accepted terminology and in the vague description of the term inflation with which we started this introduction.

The increase of the price of a commodity or a precisely defined basket of commodities is a manifest - i.e. a directly observable - phenomenon, specific for that commodity or for that basket. We follow the Sandilands report, where it contends that everybody experiences his own price increase.

However, we see inflation as a general phenomenon, not specific for a certain commodity or basket and not directly measurable. We suppose the price increase of a given commodity to consist of two components, namely a general component which is the same for every commodity and a specific component. Now the isolation of the general component out of a great number of price series becomes one way to quantify inflation. If we interpret inflation in this way, the sentence just quoted from the Sandilands report seems rather apodictic.

Our hypothesis was tested against the evidence of the development of the observed prices in "Inflation in The Netherlands" [1]. Subsequently a common inflation component was isolated and quantified. To this end the movement of the prices of a great number of goods and services was analysed over the period from 1952 through 1975. The time series of the partial price index numbers of 235 commodities over the 288 months of this period were carefully constructed by the Dutch Central Bureau of Statistics, so that we could base the analysis on some 70 thousand index numbers. Of these 235 series, 141 are consumer price indices. These series illustrate the movement of the prices the consumer has to pay for goods and services. The remaining 94 series are price indices of producer commodities. These series illustrate the movement of the prices the producer fetches in the domestic market.

For our purposes this material suffers from the serious disadvantage that the 235 commodities cannot be seen as a random drawing out of the population of all commodities that are traded in the country at a given moment of time. On the contrary, the selection has been very systematic. The prices of these commodities have been observed in order to construct the official consumer price index and the official wholesale price index.

We feel that these official price index numbers are not suited to measure inflation because they are based on a "panier de provision". Therefore, we shall have to arrive at a general measure of inflation in another way. Whatever the way this will be done, the drawback of the selectivity of the sample cannot be circumvented. In this light concepts like "the standard error of an average" have little meaning. For this reason we have omitted the calculation of this kind of measures of uncertainty. They are easily misinterpreted.

We shall propose certain unweighted averages of available series of price index numbers as a measure of general inflation. These averages are to be preferred for representing the inflation component above weighted averages because, as a rule, there is the danger that the influence of the specific components after the averaging is greater in the case of the weighted than the unweighted averaging procedure. We have called the unweighted average of the 141 consumer goods the "consumer index" and the unweighted average of the 94 producer goods the "producer index". A clear distinction must be made between these two series on the one hand and their weighted alternatives: the official consumer price index and the official wholesale price index respectively.

2. The description of the price movements of individual commodities

Exponential growth

Apart from a few exceptions the price movement of the 235 commodities shows a rising trend over the whole period of 24 years. Several methods are available to characterize the price development of a single commodity by means of one single number. We decided to fit an exponential trend to the observed series of price index numbers using the method of least squares; thus:

$$\log z_{it} = a_i t + b_i + u_{it} \tag{1}$$

The symbol z_{it} stands for the observed index number of commodity i in the month t; whereas u_{it} is the corresponding random error. The regression calculations being performed on a monthly basis, the regression coefficient a_i can be interpreted as the growth rate of the trend on a monthly basis. However, throughout this text, the term growth rate will systematically be used meaning a percentage describing the increase or decrease of a trend or an index number during a period of one year. To this end the regression coefficient from (1) is transformed into a growth rate on an annual basis by means of the formula:

$$g_i = 100 \left\{ \exp\,(12a_i) - 1 \right\}$$

Describing the time path of a price index by just one parameter is of course an extreme simplification. It is to be expected that - especially when viewed over a longer period of time - there will be some series that fluctuate wildly; the calculated growth rates will then be very inaccurate. Furthermore there will be some series with a growth rate which is not constant in time. Here the fitting of an exponential approximation is an unfortunate choice. Nevertheless we restricted ourselves to a one-parameter description of the time series and investigated how this approximation fitted the actual price movements of the 235 commodities.

A conventional criterion to judge the quality of the fit of a linear trend to a series of observational results is the correlation coefficient. In our case the variance of the independent variable - i.e. time - is the same for all series, as the length of the period is the same. In such a situation the variance of the residuals is perhaps a measure of fit that is more easily understood. For instance, a standard deviation (symbol s) of magnitude .10 indicates that the observed index number deviates more than 10 percent of the calculated trend value, on the average only once per three observations. Fitting a trend over 24 years of the 235 commodities 110 series showed an s-value smaller than .10, of 117 series the s-values were between .10 and .20 and of 8 series the s-values were greater than .20. Another result was that s-value and growth rate are independent.

On the basis of these results we can put that at most half of the series show an exponential growth that is relatively undisturbed. On the other hand, the number of very poor fits is only small.

It is interesting to observe that as a consequence of the exponential growth of the individual price index numbers the time path of a composite price index number will show super-exponential growth. This means that for such composite index numbers the growth rate is not a constant in time, but increasing as soon as individual growth rates do differ.

As an example suppose $z_{1t} = 100\{\exp(0.1t)\}$ and $z_{2t} = 100\{\exp(0.2t)\}$ and let m_t be defined as $m_t = \frac{1}{2}(z_{1t} + z_{2t})$. In the following table are listed some growth rates of m_t for a few values of t.

t	z_{1t}	z_{2t}	m_t	*growth rate*
0	100	100	100	16.3%
1	110.5	122.1	116.3	
5	164.9	271.8	218.4	17.7%
6	182.2	332.0	257.1	

This property of composite index numbers is not generally known. As far as we know super-exponential growth does not exist in the physical sciences.

Growth rates computed over a period of 24 years

The frequency distribution of the 235 growth rates on the basis of the full

24-year period is shown in table 1. It is practically symmetric and unimodal. The average exceeds 3 percent and the variation is appreciable. If one distinguishes between consumer goods and producer goods a difference in level becomes apparent: the average growth rate of consumer prices is about 1 percent higher than that of producer prices.

TABLE 1. Frequency distributions of growth rates over a period of 24 years

Growth rate	*Consumer goods*	*Producer goods*	*All commodities*
–3	–	1	1
–2	1	–	1
–1	–	2	2
0	5	5	10
1	9	14	23
2	23	25	48
3	35	28	63
4	27	12	39
5	22	6	28
6	11	–	11
7	3	1	4
8 and over	5	–	5
Total	141	94	235
Average	3.6	2.5	3.1
Variation	1.9	1.5	1.8

If compounded over 24 years a difference in growth rate of 1 percent has considerable consequences. The observed unweighted average index number of the consumer goods - i.e. the consumer index - reached the value of 268 at the end of the period, while that of the producer goods - i.e. the producer index - only rose to 211 (the basis of both series is 1951 = 100). Part of the difference in development can be attributed to technical factors like the different way the changes in the VAT levels are incorporated in consumer and producer price statistics. The Korea hausse too has been a factor of importance, for in the base year 1951 producer prices were pushed up more than consumer prices. Nevertheless a complete explanation of the difference in growth rates cannot be obtained in this manner. This remains unsatisfactory even if one takes into account the relatively small number of observations and verifies that the modal class of both distributions is the same.

Growth rates computed over periodes of 6 years

The procedure to calculate growth rates described in the beginning of this section can be used to calculate growth rates for any part of the time series. A priori one cannot predict whether fitting a trend to a part of the series will lead to a better fit or to a worse one. On the one hand it is quite possible that a time series has an exponential character during parts of the period but does not obey the exponential law over the entire period of 24 years. On the other hand, the exponential model may be quite appropriate considering the 24-year period as a whole, while severe disturbances are apparent during some parts of this time span. We shall study this aspect first, before considering the partial growth rates in more detail.

Dividing every time series of 24 years into four parts of 6 years, four times 235 growth rates as well as the same number of s-values can be calculated. These s-values are tabulated in table 2.

TABLE 2. Frequency distributions of s-values resulting for periods of 6 years

	Standarddeviation of residuals		
Period of 6 years	*<0.10*	*0.10–<0.20*	*≧0.20*
1952-1957	211	21	3
1958-1962	220	14	1
1963-1969	225	9	1
1970-1975	214	14	7

The conclusion is obvious. Changing from a period of 24 years to one of 6 years improves the fit of an exponential trend to the individual price series. The growth rate as a one-parameter description of the series thus gains appreciably in importance in this manner. Of course this is not very surprising, because in fact now four parameters are available to describe the complete time series of 24 years instead of just one.

Next we focus our attention on the frequency distributions of the growth rates characterising each of the 6-year periods. It is to be expected that these distributions will differ from the 24-year one in three aspects. In the first place the average level of the growth rates now has more opportunities to adjust for the changes in the growth of the "general price level". We shall discuss this aspect in more detail when we further subdivide the 24-year period. Secondly, changes in the variation of the growth rates are to be expected. If the growth rates in successive 6-year periods were statistically independent, then - as a consequence of the averaging process - the magnitude of the variation in a 6-year period would be twice as high as that over the entire period. Apart from this it is possible that the variation will fluctuate in time as a consequence of the fact that in some periods the price system may show great unrest. Therefore, one cannot exclude some interdependence between average and variation of the growth rates.

In the third place it is to be expected that during shorter periods extreme values will become more frequent. This may influence the shape of the distribution, which becomes then more skewed to the right.

TABLE 3. Frequency distributions of growth rates over periods of 6 years

Growth rate	*Period* 1952-1957	1958-1963	1964-1969	1970-1975
below −8	–	1	–	–
−7 to −5	10	7	–	–
−4 to −2	43	16	4	–
−1 to 1	98	137	45	4
2 to 4	59	60	95	30
5 to 7	17	10	70	78
8 to 10	7	3	18	67
11 to 13	–	1	2	40
14 to 16	–	–	1	12
17 to 19	–	–	–	3
20 and over	1	–	–	1
Total	235	235	235	235
Average	0.9	0.7	3.9	8.1
Variation	3.4	2.6	2.8	3.6

The shape of the frequency distributions calculated over 6-year periods is in conformity with the expectations mentioned above. Shifts of the average level of the growth rates are apparent, especially in the third and fourth period. The dispersion has become somewhat larger than it is in table 1, partly as a consequence of the occurrance of a few outliers. All growth rates that appear only once in the table may be viewed as such. The three rates falling in the open classes are 27% in the first sexennium, −16% in the second and 23% in the fourth. The skewness to the right is apparent at a first glance.

As regards the variation, the root mean square of the four values in the table equals 3.1, which is a little less than twice the value of the variation of the growth rates based on the 24-year period. This indicates a weak positive correlation between the growth rates in the various periods because in the case of independence this ratio would have been exactly two.

It is obvious that so clear a shift in the average level of the growth rates from the first to the fourth 6-year period has to find its counterpart in the values of the growth rates of the individual commodities. This implies that a purely exponential price development over the entire period has to be exceptional. It was stated earlier that at most half of the series would actually show an exponential development. It seems now that this statement was overoptimistic.

In the following scheme the commodities are classified according to the sign of the difference between their growth rate in a given 6-year period and their growth rate over the entire 24-year period. The symbol + indicates that the partial growth rate is larger than the overall one. The symbol – indicates the opposite. The classification of the 235 commodities leads to the following distribution.

− − + +	125 commodities
− − − +	47 commodities
+ − − +	21 commodities
+ − + +	17 commodities
− + + +	7 commodities
− − + −	7 commodities
− + − +	5 commodities
+ + − +	3 commodities
+ − + −	1 commodity
− + − −	1 commodity
− − − −	1 commodity

Especially the first, second and fifth pattern of the signs - observed at more than 75 percent of the commodities - indicate a super-exponential development in time. Viewed in this light the hypothesis of constant individual growth rates over the entire 24-year period can only be maintained on the average. An average that is larger than the actual growth rates during the first years of the period and smaller during the last years.

Growth rates computed over a period of one year

Dividing the entire period in parts of one year each and calculating the annual growth rates, provides a great amount of detailed information about the Dutch price system. The information becomes available in the form of 24 successive frequency distributions of the growth rates. These distributions are contained in table 4.

TABLE 4. Frequency distributions of growth rates over periods of one year

Growth rate	'52	'53	'54	'55	'56	'57	'58	'59	'60	'61	*Year* '62	'63	'64	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'75
below −32	4	2	2	2	–	–	–	–	2	1	–	–	–	–	–	1	–	–	1	2	–	–	3	1
−32 to −28	–	1	–	1	–	–	–	–	2	–	–	1	–	–	1	–	–	–	–	–	–	1	–	1
−27 to −23	4	1	2	2	–	1	2	–	5	1	1	1	1	1	–	–	–	–	–	1	1	–	3	2
−22 to −18	7	3	1	6	2	7	1	1	3	1	3	1	2	1	–	2	1	4	3	1	–	–	2	1
−17 to −13	20	3	1	6	3	8	2	4	4	3	3	1	1	3	1	3	3	1	1	1	2	1	2	1
−12 to − 8	24	12	5	33	5	2	12	9	5	5	8	6	4	1	5	5	6	4	2	–	2	5	1	3
− 7 to − 3	23	36	21	21	11	19	25	17	22	16	20	14	13	13	15	16	17	20	15	14	7	11	4	5
− 2 to 2	90	141	119	113	127	103	151	147	153	155	134	117	68	101	77	87	99	84	75	45	61	50	13	39
3 to 7	36	26	39	37	53	55	30	24	28	40	36	55	83	69	76	81	75	75	75	97	85	79	32	74
8 to 12	11	4	24	4	16	17	7	18	6	5	9	20	30	26	35	30	20	37	34	42	50	40	55	67
13 to 17	7	3	6	5	5	9	2	6	–	4	12	7	17	7	16	5	6	3	11	25	15	23	47	24
18 to 22	2	–	2	1	6	5	–	3	2	1	1	4	6	5	7	3	3	2	10	1	4	6	31	7
23 to 27	2	1	6	1	3	2	–	1	1	2	1	3	6	2	2	1	1	2	2	2	1	6	20	6
28 to 32	1	1	1	–	–	2	1	2	–	–	2	4	3	2	–	1	1	2	3	2	–	–	11	2
33 and over	4	1	6	3	4	5	2	3	2	1	5	1	1	4	–	–	3	1	3	2	7	13	11	2
Total	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235	235
Average	−1	−1	3	−1	4	3	0	2	−1	1	2	3	5	4	4	3	3	3	5	5	7	9	13	7
Variation	12	7	11	9	13	11	7	8	9	6	10	8	8	9	7	7	8	8	10	9	12	17	15	11

Comparing growth rates based on periods of one year with those based on 24 years, the same kind of remarks can be made as when comparing growth rates based on 6-year periods with the latter. The course of the average growth rates now reflects details of the annual changes of the general price level which provides a kaleidoscopic picture.

Periods (i.e. years) of very fast growth and of sluggish price movements follow each other, apparently without system. The turbulent year 1974 - characterised by a 14 percent average price rise - is conspicious. It is nevertheless remarkable that even in so inflationary a year there are so many commodities that fall in price as compared with the previous year. The variation of the distributions is accordingly substantial, while there are many outliers.

If the growth rates were independent in successive years, then the average variation of the distributions shown in table 4 ought to be $\sqrt{24}$ times as large as the variation of the growth rates based on the 24-year period; so it would become 9 (percent). The root mean square of the values in table 4 equals 10, which agrees nicely with the value to be expected under the hypothesis of independence. This is an important observation which will play its role when selecting a measure of inflation in section 4.

An aspect which has been mentioned already in passing, is the interdependence between average and variation of the growth rates. Table 4 clearly illustrates this phenomenon. The year 1952 is exceptional. It is possible, however, to provide a technical explanation for the large variation in 1952 which will not be considered in this paper.

Vining and Elwertowski [3] have investigated the relation between average and variation of growth rates in the U.S.A. They examined a much larger number of commodities and found a positive interdependence, which however is not so pronounced as the authors suggest in the verbal text of their paper. Leaving the year 1952 out of consideration we find a correlation coefficient of 0.7. Although this value is perhaps not extremely high, we still consider this interdependence a striking result of our investigations. It means that statements like "everything becomes more expensive all the time" are a poor description of periods with high inflation, because during such periods not only the average growth rate but also the variation is high, so that individual commodities may show price movements in different directions. Put differently: high inflation is usually accompanied by great price instability.

The problem of the extreme values

Looking at the distributions of the one-year growth rates the great number of extreme values or outliers is immediately conspicious. As these outliers exert considerable influence on the size of the average as well as the variation, they do cause difficulties when trying to measure inflation. It might be considered to eliminate a number of observations from the material on the basis of a priori considerations.

There are at least two ways to tackle the problem of the outliers in the context of our investigations. Looking at the 24-year period in its entirety one can point out those commodities whose one-year growth rates frequently are outliers in the distributions. The essence of this approach is to eliminate complete series from the data for the reason that these series do not contribute usefully to the description of the inflation process. A consequence of this procedure is that the remaining frequency distributions will incidently show some outliers, but this is inevitable, because it is inherent to the concept of variation. A valid objection, however, is that this approach is completely determined by the data available at a given instant of time. Inclusion into the series of new material would necessitate repeting the procedure.

A second way to tackle the problem of the outliers is to adjust directly the available distributions. This can be done, for instance, by discarding 5 percent of the most extreme values out of every distribution, or by discarding the observations that fall outside the so-called two or three sigma limits. The flexibility of this approach is its greatest advantage. Adding new data to the series causes no difficulties at all; one examines the new distributions of growth rates and discards a number of observations according to the recipe decided upon. It is not even necessary to know what commodities actually have been eliminated.

Proceeding according to the first method we discarded twelve complete series. Originally 126 outliers (defined as extreme values lying outside the three sigma limits) were contained in the distributions of the one-year growth rates, of which 77 belonged to the twelve discarded commodities. The remaining 49 outliers, belonging to 38 different commodities have been accepted as occasionally strongly deviating observations. The twelve commodities mentioned (nearly all producer goods) are - with one exception - all coming from the agrarian sector. The movement of their prices is obviously strongly influenced by the size of the harvest. Therefore, in our view, these series ought not to be included in a measure of inflation to be constructed by means of the prices of individual commodities.

3. The interdependence between one-year growth rates

The growth rates of the prices of individual commodities computed for the entire 24-year period show considerable variation. They vary from + 11 percent to −3 percent (see table 1). It is therefore possible to rank the commodities according to the magnitude of the increase of their prices. Whether it is possible to consider inflation as a general phenomenon in the manner described in the introduction depends on the persistency of the observed ranking if the growth rates are computed over smaller periods.

In this connection it is possible to formulate two contradictory hypotheses. The first one is that all commodities have their own position in the ranking of the price movement. The 24-year growth rates are the best estimator in our possession to determine this ranking. If the growth rates are calculated over a shorter period, for instance of one year, then it is practically certain that the ranking observed in that year will deviate from the "true" one because of accidental factors. Nevertheless the rank correlation between the vectors of one-year growth rates will be high. In such a situation, where every commodity has its own rank, the concept of a general measure of inflation has no significance, because inflation can only be interpreted in the context of a given basket of commodities. This situation would contradict our model of inflation.

Under the second hypothesis the observed ranking of the one-year growth rates as well as that of the 24-year ones is seen as a random permutation of the numbers 1 to 235 inclusive. The correlations between the vectors of rankings of the growth rates of two different years will not differ significantly from zero. Then inflation is not tied to a commodity, but to a process, it is some kind of average. The concept of a general measure of inflation becomes meaningful and the extent of the inflation can be measured by means of the price increases of a (large) number of commodities, the choice of the commodities being essentially immaterial.

The increase of the variation of the growth rates to be observed when gradually moving from one 24-year period to twentyfour one-year ones is in conformity with the second hypothesis. It now becomes important to investigate the (inter)dependence between the growth rates of different one-year periods. The results of these investigations will determine whether we are able to interpret sensibly the term inflation. Therefore, we now turn to the examination of the relation between one-year growth rates.

The rank correlations between one-year growth rates

The product-moment correlation coefficient is not a suitable measure for the relation between the growth rates because of the large number of outliers that characterises the distribution of these growth rates. Because of this, we decided to employ the rank correlation coefficient. Out of 24 years, 276 combinations of two years can be selected. The Spearman rank correlation was calculated between 235 paired growth rates which provided us with a large correlation matrix. If it is assumed that the observed rank correlations are the result of random causes only, then their distribution will approximate the normal one with expectation zero and standard deviation 0.07.

However, the observed frequency distribution of all rank correlations shows an average of 0.14 and a standard deviation of 0.11 (see table 5).

TABLE 5. Frequencies of rank correlations between one-year growth rates

rank correlation	*observed frequencies*	*expected frequencies*
–0.25 to –0.15	1	3
–0.15 to –0.05	12	59
–0.05 to 0.05	35	155
0.05 to 0.15	107	59
0.15 to 0.25	74	3
0.25 to 0.35	39	0
0.35 to 0.45	8	0

Although it is clear that the growth rates are not strictly independent, the observed correlations are small, so the relationship is only weak. There is no question of the individual commodities having a fixed place in the ranking of all commodities. Therefore, we feel justified to interpret inflation as some kind of average phenomenon that can be measured by means of appropriate indices.

4. The time series of the index of inflation

The consumer index as an index of inflation

One-year growth rates were discussed in section 2. It is possible, of course, to calculate growth rates based on even shorter periods. Given the fact that the data consist of monthly figures; the month is the shortest period available. Then the growth rates are the relative monthly changes of the partial price index numbers. According to the conclusion in section 3, namely that inflation can be seen as an *average*, the size of the inflation in a given month is nothing but the average of the frequency distribution of the growth rates of that month. The time series of the inflation index is thus nothing but the unweighted average of the partial price index numbers; a very simple construction indeed.

There are some problems, however. The frequency distributions of one-year growth rates were already characterized by a large variation and do contain many outliers that strongly influence the average. It is mandatory to eliminate first those commodities that are responsible for the majority of these outliers. We have established - by means of factor analysis - that 53 commodities (19 consumer goods and 34 producer goods) ought not to be included in the computation of the unweighted average price index number.

This means that more than one third of the producer goods do not belong in a measure of inflation. This ratio is much smaller in the sector of the consumer goods.

Practical considerations lead us to adopt the consumer index - i.e. the unweighted average of all 141 consumer goods - as our index of inflation. So all producer goods were removed. The reasons are twofold. First the time path of the consumer index is very similar to that of the 182 commodities we originally selected. Secondly the consumer index is a much more transparent construction; continuing the computations after the year 1975 is simple and it is straight forward to include a larger number of commodities.

We shall continue this section by analysing the time path of the consumer index and shall consider the terms consumer index and inflation index synonymous.

The long term development: super-exponential growth

Table 7 contains the time series of the consumer index for the years 1952 to 1975 inclusive. The series is also drawn in figure 1. If one neglects short term fluctuations for the moment, the impression is unmistakebly one of a trend rising faster and faster. Exponential growth, that is growth at a constant growth rate, is thus insufficient to describe this long term development. As we already explained in section 2, part of this explosive development might be the consequence of the averaging of a number of partial indices, each growing exponentially but at a different rate. If we speak of super-exponential growth of inflation it is meant that the inflation rate increases in the course of time. In figure 1 we have also drawn a curve representing the trend of the inflation index. It has been obtained by fitting the function:

$$\log z_t = a_0 + a_1 t + a_2 t^2 \qquad (t = 1,2,\ldots, 288)$$

to the series z_t of the index numbers of the months January 1952 till December 1975 by means of the method of least squares.

The graph shows that even this quadratic exponential function is not completely capable of following the structural development of the inflation. However, one has to take into account that frequently the observed index lies above the calculated trend for two years at a time.

Too much ought not to be read into the mathematical representation of the trend movement. It is nothing but one of the (many) ways the structural development of inflation can be described by employing only a few parameters. The short term development of the growth rate of inflation is far more interesting as it constitutes a much richer source of information.

The short term development: waves of inflation

The concept "short term growth rate" is introduced to assist in describing and analysing the short term development of the consumer index. This short term growth rate is defined as the three-month moving average of the percentage changes of the consumer index of a given month relative to that dating 12 months back. The moving average was chosen because otherwise the rounding of the inflation index to integers would lead to considerable disturbances.

Figure 1. Time series of unweighted average of consumer prices

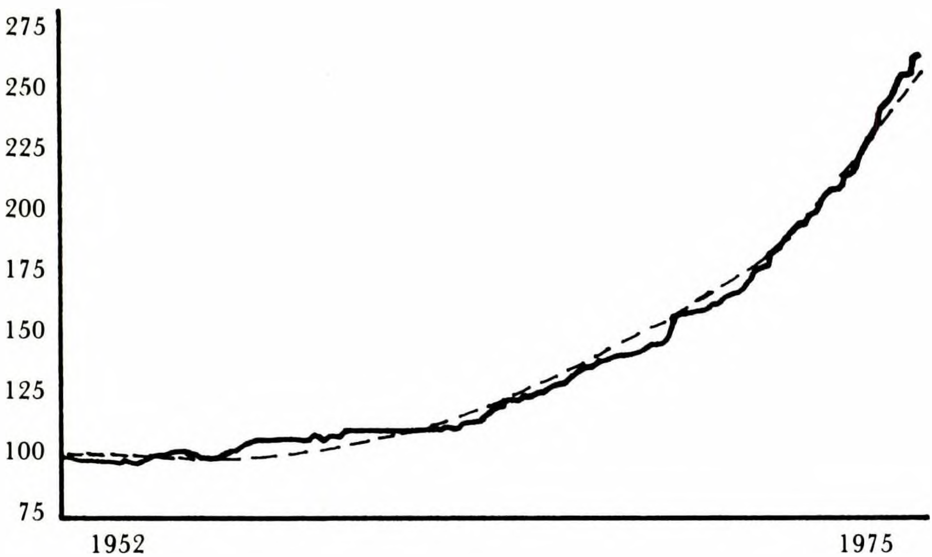
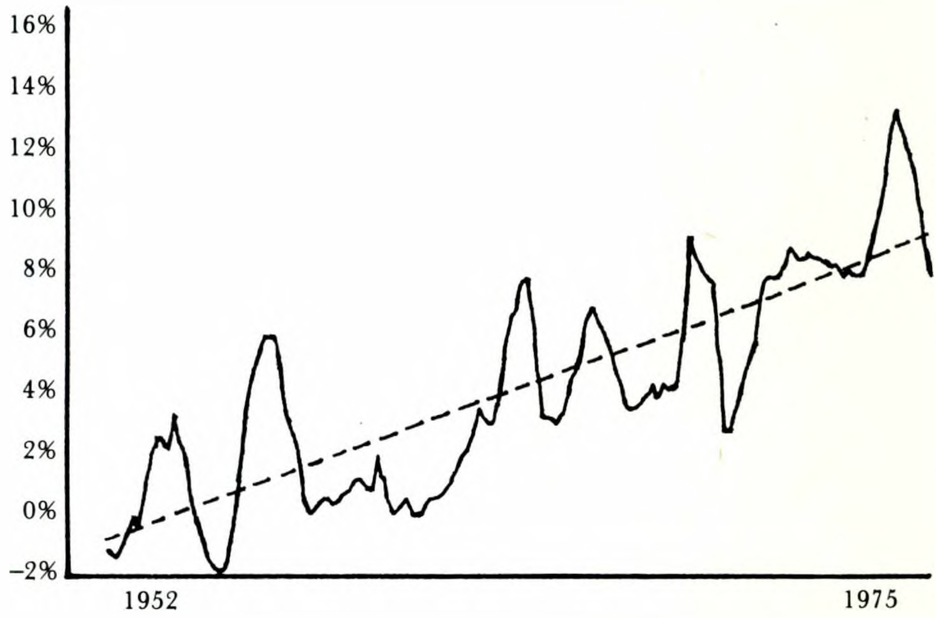


Figure 1 is little suited to investigate the short term growth rates; for this purpose figure 2 was constructed. Herein the short term growth rate is plotted against time. Figure 2 contains a lot of new information additional to figure 1. One must not loose sight of the fact that the growth rate is the relative derivative of the price index number. Periods of accelerating rate of inflation - shown as a rising part of the graph - are followed by periods of slowing down inflation and a few times even by price decreases in an absolute sense, indicated by negative short term growth rates. It is clear that periods of slowing down inflation have not been of long duration, how spectacular some of these periods might have been. The tendency towards accelerating price increases has been resumed again and again, leading to a rising long term growth rate, the structural one. The sequel to this section being completely dedicated to the discussion of the short term growth rate, we shall further omit the adjective "short term".

Figure 2. Time series of short-term growth rates of the consumerindex



Seven dominant waves of inflation can be distinguished in the complete time series of figure 2. During the first wave from 1954 to 1955 a growth rate of 3 percent was reached towards the end of 1954. This wave was subjugated completely in the sense that the growth rate was reduced to below 0 percent. Moreover, the index itself had returned to 100 at the end of the wave, which implies that this disturbance did not cause any permanent lessening of purchasing power of money.[1]

[1] The loss of purchasing power is defined as the ratio: $100\,(z_t - z_{t-k})/z_t$ or $100\,(1 - z_{t-k}/z_t)$, where t indicates the month in which the inflation wave ended and k represents the length of this wave.

The second wave during 1956/58 was a rather violent disturbance during which a growth rate of 6 percent was reached in the middle of 1957. This wave too has been completely “conquered” in August 1958 when the growth rate was reduced to 0 percent once more. Nevertheless a permanent loss of purchasing power of about 8 percent has been the aftermath of this disturbance.

The third wave of 1959/60 was only a small ripple in a calm sea. In the middle of 1960 the growth rate had risen to 2 percent after which it fell back to 0 percent towards the end of the same year. The permanent loss of purchasing power amounted to 2 percent.

After 1961 matters took a turn for the worse. The fourth wave of 1961/65, showing a growth rate of 8 percent during the middle of 1964, differs from the preceding waves in two aspects. First it took 4 years to reach its top. During this period the growth rate rose practically without interruption. Secondly the wave was never conquered completely. It ends at a level of 3 percent towards the middle of 1965, the lowest value for the rest of the period. The loss of purchasing power due to this wave of inflation equals 14 percent.

The fifth wave of 1966/67 and the sixth of 1968/69 were also not subdued. The fifth wave reached a maximum of 7 percent in the middle of 1966 and a minimum of 4 percent one year later. The sixth wave nearly reached 10 percent in March 1969 and ends a year later at a level of 3 percent. In five years a loss of purchasing power of 27 percent was suffered, inflation started to become a serious problem.

The last wave is the most interesting one. It started in 1970 at a level of 3 percent mentioned already, stayed for some years at 8 to 9 percent to reach the astonishing value of 14 percent towards the end of 1974. Thereafter it fell back to 8 percent in December 1975. We now know that this fall continued for some time; the minimum of 4 percent was only reached in 1979. At the time of writing - the beginning of 1980 - it looks as if the trend is going up again.

The characteristics of the seven waves of inflation are condensed in table 6.

TABLE 6. Characteristics of the seven waves of inflation

period	*length in months*			*loss in pur-*	*short term growth rate*		
	total	*up*	*down*	*chasing power*	*begin*	*top*	*end*
1954/55	26	13	13	0%	0%	3%	–2%
1956/58	31	14	17	8%	–2%	6%	0%
1959/60	27	21	6	2%	0%	2%	0%
1961/65	54	41	13	14%	0%	8%	3%
1966/67	26	12	14	10%	3%	7%	4%
1968/69	31	19	12	17%	4%	10%	3%
1970/75	68	56	12[2]	36%	3%	14%	8%

[2] Until December 1975

The position of the last wave is a unique one because it reached its minimum more than five years later than its top. It was only possible to reduce the rate of inflation to this minimum after 9 years. This minimum is about 4 percent; a level of 0 percent is completely out of the picture nowadays.

It is possible to distinguish three sub-periods on the basis of the extent to which it proved possible to reduce a wave of inflation.

1. 1952-1960. These 9 years were characterised by a maximum growth rate that never surpassed 6 percent. Each wave was completely subdued.
2. 1961-1969. During these 9 years the maximum growth rate became 10 percent. No wave of inflation was completely subdued, that is the minimum was never lower than 3 percent.
3. From 1970 onwards. This period is actually but one very long wave of inflation reaching a maximum of 14 percent.

5. Final remarks

Our measure of inflation is based on 141 price series, a relatively small number. No other series, however, dated back to 1951, so that no more data were available to describe the history of inflation during the last 25 years. That is quite different today. The registering of prices has been extended markedly, so that it would be possible to compute a consumer index based on 600 commodities from 1970 onwards. It might be useful to remove a number of series of prices of final products from the material because they give rise to many outliers as a consequence of continuous fluctuations of the size of harvests. Examples are goods like potatoes and coffee. The specific consequences of the size of harvests ought not to be included in the index of inflation. The influence of a few outliers, fortunately, will be hardly noticeable in an arithmetic average of so large a number of commodities. In so far any extreme growth rate is incidental it will therefore exert a negligeable influence on the index of inflation.

The situation is different where extreme changes in the prices of raw materials are involved, such as the explosion of the prices of energy in 1974 and 1979. The direct influence of price increases of commodities like petrol, electricity and natural gas is negligeable, but the indirect influence exerted via the technology matrix will be incorporated in the prices of almost all other commodities and therefore in the index of inflation.

Originally the consumer index has been calculated until December 1975, but recently the Dutch Central Bureau of Statistics has continued this series for the years 1976 and 1977.

However, as time passes on, this index of inflation will be only of historical interest. The Bureau does publish every month the (weighted) official consumer price index, which has its own place and significance in social and economic policy decisions. This index, however, is not an appropriate index of inflation.

We advocate to compute and publish additionally the monthly (unweighted) consumer index. If this index would be recalculated from 1970 on, now based on a sufficient large number of price series, an up to date measure of inflation which will not suffer from the disadvantages of the official consumer price index, would become available. It is our opinion that such an index is widely needed.

TABLE 7. Unweighted averages of price indices of 141 consumer goods (1951 = 100)

	Month											
Year	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
1952	100	100	100	100	99	99	99	99	99	99	99	99
1953	99	99	98	98	98	98	98	98	99	99	99	98
1954	99	99	100	100	100	101	101	101	101	101	102	102
1955	102	102	102	102	102	101	101	101	100	100	100	100
1956	100	100	100	100	101	101	101	102	102	103	104	105
1957	105	105	106	106	107	107	107	108	108	108	108	108
1958	108	108	108	108	108	108	107	108	108	108	109	109
1959	108	109	109	108	108	109	108	109	109	110	110	110
1960	110	110	109	109	110	110	110	110	110	110	110	110
1961	110	110	110	110	110	110	110	110	110	110	111	111
1962	110	111	111	111	111	111	111	112	112	113	113	113
1963	113	114	115	115	115	115	114	115	116	117	118	118
1964	121	122	122	123	123	124	124	124	125	125	125	125
1965	125	126	126	127	127	128	127	129	130	130	131	131
1966	131	133	134	135	136	137	136	137	138	138	138	139
1967	138	139	140	141	141	142	141	142	143	143	144	144
1968	144	145	146	146	147	148	147	148	149	149	150	151
1969	157	159	160	160	160	160	159	160	160	161	162	162
1970	162	163	164	165	165	166	166	167	168	170	170	171
1971	173	175	177	178	178	180	179	180	182	184	185	187
1972	188	190	192	193	194	196	194	195	198	200	201	202
1973	204	206	208	209	210	211	210	211	214	216	217	218
1974	221	223	227	229	231	233	233	235	240	245	247	248
1975	250	252	255	257	258	259	258	259	263	266	267	268

References

[1] Balk, B. M., Driel G. J. van and Ravenzwaaij C. van, *Inflatie in Nederland van 1952 tot 1975*, The Hague: Staatsuitgeverij, 1978 (English summary).

[2] *Inflation accounting*, Report of the Inflation Accounting Committee, Chairman F.E.P. Sandilands Esq. CBE, London: H. M. Stationary Office, 1975.

[3] Vining Jr, Daniel R. and Elwertowski, Thomas C., "The relationship between relative prices and the general price level", *The American Economic Review nr 66*, 1976.