MEASURING INFLATION: AN ATTEMPT TO OPERATIONALIZE CARL MENGER'S CONCEPT OF THE INNER VALUE OF MONEY

M.M.G. Fase and C.K. Folkertsma

ABSTRACT

This paper attempts to operationalize Carl Menger's concept of the 'innerer Tauschwert des Geldes', i.e. the inner value of money. Since the change in the inner value of money is the component of price movements which is due to monetary influences, the operationalization provides an alternative measure of inflation. We consider several approaches for gauging the change in the inner value of money. Of these, we use Quah and Vahey's structural VAR model to identify the price movements in the Netherlands and the EU due to monetary shocks.

Key words: core inflation, monetary policy, European Monetary Union
JEL codes: E31

1 INTRODUCTION

The main objective of this paper is to identify the component of observable price changes, which is due to monetary as opposed to real shocks. It attempts to operationalize Carl Menger's old concept of the inner value of money as the true measure for inflation. This operationalization is applied to the Netherlands and the European Union, yielding a measure of price changes, which reflects more closely the theoretical notion of inflation as a monetary phenomenon.

According to the definition adopted here, inflation is any increase in prices induced by monetary factors. Contrary to Friedman's well-known definition of inflation as 'a steady and sustained rise in prices' (Friedman (1963) p. 1), a non-recurring price change is considered as (short-term) inflation as long as it is due to monetary influences. Clearly, without stating that the price changes are induced by monetary factors, inflation would not be 'always and everywhere a monetary phenomenon' (Friedman (1963), p. 17), since short periods of rising prices may, after all, be due to real factors alone. The adoption of the broader inflation concept seems justified since in economic theory the important distinction is not between the effects of a temporary and a sustained price increase but between anticipated and unanticipated changes. Furthermore, from the perspective of monetary policy, it is interesting to measure any movement in prices brought about by monetary shocks, irrespective of whether the movements are temporary or sustained.

This paper is organised as follows. Section 2 argues why the change in the consumer price index (CPI) and comparable indices are inappropriate for measuring inflation. Section 3 goes into Carl Menger's distinction between 'innerer' and 'äußerer Tauschwert des Geldes' which is our main inspiration for this research (Fase (1986, pp. 9-10)). Section 4 proposes a decomposition of price changes. Four possible inflation gauges are examined, the aim being to establish which components of price changes they identify. Section 5 discusses a method to identify the change in the inner value of money insofar as price rises are caused by monetary shocks. Section 6 applies this method to Dutch and European data. Conclusions are drawn in the final section.

2 CHANGES IN PRICE INDICES AS INFLATION GAUGE

The change in the CPI published monthly is seen by the public and by politicians as the measure of inflation on an annual basis. The change in this index gauges the increase in expenditure on a package of goods and services consumed by the representative household. Roughly, the rise in the CPI reflects the loss of purchasing power of money as the representative household experiences it. Application of this index is justifiable if the aim is to determine changes in the spending potential of households, which are caused by price movements ensuing from changes in monetary policy, or from changes in fiscal policy and other real causes. However, this gauge is inappropriate for measuring inflation as defined by Friedman or price level changes brought about by monetary shocks as the CPI reflects every change in consumer prices.

Several attempts have been made to restructure the CPI into a better measure of inflation. For instance, in addition to the ordinary CPI, a price index is published in the Netherlands, which has been adjusted for changes in indirect taxation and subsidies, and various statistical methods have been developed to identify the trend component in the change in prices. But even when an adjustment is made for the direct influence of changed taxes and subsidies on expenditure, the index still reacts to price changes which have been generated by second-order effects of tax and subsidy adjustments and other real influences. Furthermore, weighting the price index means that some prices will determine the general price level thus measured to a greater extent than others. For an assessment of changes in purchasing power, the weighting scheme has a theoretical foundation but there is no clear rationale for gauging inflation by means of weighting. Finally, the basket of goods consumed by households is but a sub-set of the goods marketed within the economy. Notably the prices of the various factors of production are left out of account.

Its partial nature, the weighting aspect and the impossibility to distinguish between real and monetary causes of price changes make the CPI an unsuitable instrument for gauging inflation. For similar reasons, other frequently used price indices such as the producer price index or the implicit deflator of gross domestic product do not constitute better tools for measuring inflation either.

3 MENGER'S CONCEPT OF 'INNERER TAUSCHWERT'

At the end of the nineteenth century, Carl Menger (Menger (1923)) introduced the dual concept of the 'innerer' (i.e. inner) and the 'äußerer Tauschwert' (i.e. outer value) of a commodity, and of money in particular. By the outer value of a commodity, he meant the price of that commodity or the amount of money, which is to be exchanged for the commodity in equilibrium. Analogously, the outer value of money is its purchasing power, viz. the commodity bundle that can be exchanged for one unit of account. In Menger's terminology the CPI thus measures the change in the outer value of money. While Menger stressed that the ratio at which two goods are exchanged in equilibrium is ultimately determined by the (marginal) subjective valuation of the goods involved, he avers that a change in the relationship may be caused by changes affecting only one of the goods. He calls these changes movements in the inner value of a good. Analogously, changes in the inner value of money are those price changes, which are due to purely monetary factors.

According to Menger, a decrease in the inner value of money must lead to a proportional increase in all goods prices. After all, if the changes relate solely to money, the relative goods prices will, in his view, remain unchanged. However, he does acknowledge that a proportional rise in all prices need not necessarily constitute a fall in the inner value of money, because this may also be caused by real factors affecting the production of all commodities simultaneously. That is why Menger is sceptical about the possibility of measuring changes in the inner value of money. He mentions measurement based on the distribution of price changes as a possible way of operationalization. If all prices rise by the same percentage, the hypothesis that the inner value of money has fallen is more likely than the hypothesis that the inner value of all goods has gone up to the same extent. The likelihood of this conclusion rests on the fact that the first explanation relates to the changes in the value of fewer objects of exchange. If not all goods prices go up by the same percentage, then the change in the inner value of money could, on the basis of the same argument, be estimated with the aid of the mode of the frequency distribution of the price changes. However, Menger indicates himself that the method becomes less convincing as the spread of the price changes increases.

Menger's concept of the inner value of money is closely related to the definition of inflation used in this paper. Inflation *is* the change in the inner value of money. Thus Menger's classical concept of the inner value of money turns out to have a very modern interpretation. This was already observed by Hayek (1934, p. XXXI) who noted that 'the actual terms employed are somewhat misleading' but 'the underlying concept of the problem is extra-ordinarily modern'. In the light of the relevance of Menger's concept it is interesting to search for a more convincing operationalization. The main characteristic of Menger's concept should, however, remain intact. This characteristic is that a change in the inner value of money should ultimately lead to a proportional rise in all commodity prices. As suggested by Menger, a suitable starting point for operationalization is the frequency distribution of price changes. The following section deals with this approach and discusses possible gauges for the change in the inner value of money.

4 INNER VALUE OF MONEY: A FRAMEWORK FOR THE DECOMPOSITION OF PRICE CHANGES

The observed change in the price of a good may be caused by various factors. The change in relative and absolute prices may be due to monetary or real causes or an error of measurement may have occurred. If P_{kt} is the price of good *k* at time *t* and

$$\pi_{kt} = \ln P_{kt} - \ln P_{k(t-1)}$$

is the increase in the price of good *k*, then the observed price change may be broken down into

$$\pi_{kt} = \alpha_t^M + \alpha_{kt} + \beta_{kt} + \varepsilon_{kt} \qquad k = 1,...,K. \tag{1}$$

$\alpha_t^M + \alpha_{kt}$ is the price rise at time *t* of good *k*, which is underlain by monetary factors, such as an expansion of the money supply. Although an expansion of the money supply should, at least in the long run, lead to a proportional rise in all prices, the transmission of monetary shocks will, at least temporarily, disturb relative prices. α_t^M is the change in the inner value of money, i.e. the proportional rise in all goods prices as a result of a monetary shock following the completion of all adjustment processes. α_{kt} reflects the temporary deviation of the relative prices from the new long-run equilibrium during the transmission of a monetary shock [1]. ε_{kt} is the error of measurement which may arise in the observation of prices. β_{kt} is the price change in period *t* which is caused by real factors. Real shocks may effect a change in supply and demand in all markets. This disturbance of the general equilibrium of the economy will, if the equilibrium is stable, lead to new relative prices.

The component of the price changes that must be identified is the change in the inner value of money α_t^M. The decomposition of price changes according to (1) may help to examine to what extent the measuring results obtained with the aid of various inflation gauges will approximate the change in the inner value of money. The first gauge to be considered here is the change in the CPI as the gauge most commonly used in practice. For the change in the CPI, say π_t^C, which is defined as the weighted sum of individual price changes by

$$\pi_t^C = \sum_k w_{kt} \pi_{kt} \ , \tag{2}$$

with $w_{kt} = \frac{x_{k0} P_{k(t-1)}}{\sum_i x_{i0} P_{i(t-1)}} > 0$ and $\sum_k w_{kt} = 1$, one has, in view of the decomposition (1) that

$$\pi_t^C = \alpha_t^M + \sum_k w_{kt}\alpha_{kt} + \sum_k w_{kt}\beta_{kt} + \sum_k w_{kt}\varepsilon_{kt} \ . \tag{3}$$

We see that the change in the CPI does not simply measure the change in the inner value of money α_t^M. We note that, generally speaking, neither the weighted sum of the relative price effects of transmission $\sum_k w_{kt}\alpha_{kt}$, nor the sum of the budget-share weighted price changes caused by real factors $\sum_k w_{kt}\beta_{kt}$ equal 0 [2]. Finally, it cannot be ruled out that measurement errors — the term $\sum_k w_{kt}\varepsilon_{kt}$ — affect π_t^C.

[1] In his discussion of the inner value of money, Menger abstracted from the problem that monetary shocks might lead to a temporary disturbance in relative prices.

[2] $\sum_k w_{kt}\beta_{kt} = 0$ holds only if the demand and supply functions of the economy fulfill highly exceptional conditions.

However, other inflation gauges based on, for instance, the frequency distribution of price changes, may be considered. As the change in the inner value of money is a component of the general price rise, the average, the median or, as Menger proposed, the modal price changes form alternative ways of measuring inflation.

The average price change π_t^A would only identify the change in the inner value of money if it may be assumed that the average price rise caused by real factors and transmission equals nil. After all $\pi_t^A = \frac{1}{K}\sum_k \pi_{kt}$, and, on the basis of decomposition (1)

$$\pi_t^A = \alpha_t^M + \frac{1}{K}\sum_k \alpha_{kt} + \frac{1}{K}\sum_k \beta_{kt} + \frac{1}{K}\sum_k \varepsilon_{kt}$$

or, if the calculation of the average price changes is based on a large number of goods

$$\pi_t^A \approx \alpha_t^M + \frac{1}{K}\sum_k \alpha_{kt} + \frac{1}{K}\sum_k \beta_{kt} \; . \tag{4}$$

The latter equation follows under mild conditions from the law of large numbers [3]. There are, however, no arguments in economic theory to justify the hypothesis that the relative price changes caused by real or monetary factors average nil. In fact, it is extremely unlikely that $\frac{1}{K}\sum_k \beta_{kt}$ equals zero after an increase in VAT by 1%. Therefore, the average price change as such is not a suitable statistic for the change in the inner value of money.

The *median* and the *modal* price change, too, lead to a breakdown of the changes in the inner value of money and price changes caused by real factors only on the basis of certain ad hoc assumptions. For the median price change π_t^M , and the modal price change π_t^X ,

$$\pi_t^M = \alpha_t^M + z_t \tag{5}$$

and

$$\pi_t^X = \alpha_t^M + s_t \tag{6}$$

respectively, with z the median and s the mode of the joint distribution of α_{kt}, β_{kt} and the measurement errors ε_{kt} . Like the change in the CPI and the average price change, the median and the modal price change are also on the whole unable to identify the change in the inner value of money. It is clear from this discussion that the changes in the inner value of money cannot be gleaned with the aid of purely descriptive statistics. None of the gauges is capable of distinguishing between general price level increases caused by monetary factors and those resulting from real shocks. In addition, all gauges, except the average price change, are sensitive to errors of measurement. Therefore, we follow another route to identify the changes in the inner value of money.

5 THE MODEL OF QUAH AND VAHEY AND THE INNER VALUE OF MONEY

5.1 The model

Quah and Vahey (1995) recently proposed a model for solving the problem of measuring monetary inflation. This is a structural VAR model. The approach of Quah and Vahey is underlain by the notion that in the long run inflation, being a monetary phenomenon, is output-neutral, with the proviso that unexpected inflationary shocks in the short and medium term may influence real income. Measuring

[3] Where the change in the CPI is concerned, the law of large numbers applies only under highly implausible assumptions with regard to the budget shares w_{kt} .

inflation by means of the CPI or other price indices can, however, be misleading as has been shown in the previous section, since price changes brought about by real factors are not eliminated. Therefore, Quah and Vahey suggest decomposing measured inflation into so-termed core inflation and a residual. Core inflation is defined as the component of measured inflation, which is output-neutral in the long run.

Quah and Vahey assume that the first differences of (the logarithm of) output and measured inflation are stationary stochastic processes. Furthermore, they assume that the change in measured inflation, $\Delta\pi$, and the growth rate of output, Δy, can be explained by contemporaneous and lagged effects of two types of shocks ε_1 and ε_2. Therefore,

$$\begin{pmatrix}\Delta\pi_t \\ \Delta y_t\end{pmatrix} = A_0\begin{pmatrix}\varepsilon_{1t} \\ \varepsilon_{2t}\end{pmatrix} + A_1\begin{pmatrix}\varepsilon_{1t-1} \\ \varepsilon_{2t-1}\end{pmatrix} + A_2\begin{pmatrix}\varepsilon_{1t-2} \\ \varepsilon_{2t-2}\end{pmatrix} + A_3\begin{pmatrix}\varepsilon_{1t-3} \\ \varepsilon_{2t-3}\end{pmatrix} + ... \quad (7)$$

The shocks ε_{it} of this structural VAR model are serially and contemporarily uncorrelated with zero expectation and unit variance [4]. Finally, they assume that one of the shocks, the 'core inflation shock', ε_{1t}, does not affect the level of output in the long run. The change in the output-neutral component of measured inflation, i.e. the change in core inflation, is then defined as $\Delta\pi_t^c = \sum_{j=0}^{\infty} A_{j,11}\varepsilon_{1,t-j}$, with $A_{j,11}$ the element (1,1) of matrix A_j.

The parameters of the stochastic process generating inflation and output are, however, unknown and must be determined empirically. Here an identification problem arises: only the reduced form of the vector autoregressive representation of (7)

$$\begin{pmatrix}\Delta\pi_t \\ \Delta y_t\end{pmatrix} = D_1\begin{pmatrix}\Delta\pi_{t-1} \\ \Delta y_{t-1}\end{pmatrix} + D_2\begin{pmatrix}\Delta\pi_{t-2} \\ \Delta y_{t-2}\end{pmatrix} + ... + D_p\begin{pmatrix}\Delta\pi_{t-p} \\ \Delta y_{t-p}\end{pmatrix} + \begin{pmatrix}\upsilon_{1t} \\ \upsilon_{2t}\end{pmatrix} \quad (8)$$

can be estimated. The moving average representation of (7), however,

$$\begin{pmatrix}\Delta\pi_t \\ \Delta y_t\end{pmatrix} = \begin{pmatrix}\upsilon_{1t} \\ \upsilon_{2t}\end{pmatrix} + C_1\begin{pmatrix}\upsilon_{1t-1} \\ \upsilon_{2t-1}\end{pmatrix} + C_2\begin{pmatrix}\upsilon_{1t-2} \\ \upsilon_{2t-2}\end{pmatrix} + C_3\begin{pmatrix}\upsilon_{1t-3} \\ \upsilon_{2t-3}\end{pmatrix} + ... \quad (9)$$

shows that the shocks e in the structural form (7) are not identified. Indeed, comparing the coefficients in (7) and (9) shows that $\upsilon_t = A_0\varepsilon_t$ and $C_i A_0 = A_i$, $i = 1,2,...$ with the matrix A_0 unknown.

With the aid of the estimated covariance matrix of the reduced-form disturbances $\mathrm{E}\,\upsilon_t\upsilon_t^T = \Omega$ and the hypothesis that in the long run core inflation is output-neutral, all elements of A_0 can be identified. After all, $\mathrm{E}\,\upsilon_t\upsilon_t^T = A_0 A_0^T$ so that the covariance matrix yields three restrictions for the four elements of A_0. The neutrality of core inflation implies that the model parameters must meet a fourth restriction: after *k* periods, a core inflation shock leads to a change in the output *level* of size $\varepsilon_{1t+k}\sum_{j=0}^{k} A_{j,21}$. On the basis of neutrality, $\sum_{j=0}^{\infty} A_{j,21} = 0$ should therefore hold. In other words, the element (2,1) of matrix $\sum_{i=0}^{\infty} C_i A_0$ must equal zero.

Once the matrix A_0 has been determined with the aid of these restrictions, the structural form (7) can be constructed using the residuals and the estimated parameters from the reduced form (8).

4 The normalization of the variance of the structural shocks does not have any consequences for the estimations of other outcomes of the model.

Subsequently, core inflation or the output-neutral component of measured inflation, which is not directly observable, may be derived from the parameters and the shocks of the structural form.

5.2 A closer look at the model

Quah and Vahey assume that observed inflation and output are explained by no more than two types of exogenous shocks. The reasons why core inflation depends on just one type of exogenous shock are that it is due entirely to monetary influences and that monetary policy is conducted by a single institution, viz. the central bank. The assumption that all other changes in measured inflation and output may be explained by a single second type of shock which invariably influences the two endogenous variables in the same way may be seen as no more than an approximation. The latter assumption can, however, be relaxed if the number of endogenous variables in the model is increased by the number and nature of possible structural shocks. A desirable extension of the model would consist of the explicit treatment of indirect tax rate changes. It seems unlikely that the effect of a changed VAT rate is identical to that of an oil price change or of a variation in government spending.

In Quah and Vahey's model, the identification of structural shocks is underlain by the economic hypothesis that in the long run inflation does not affect output. There seems to be a consensus among economists about this property of inflation. Inflation is a monetary phenomenon and thus, in the absence of money illusion, it has no long-run real impact. The bone of contention lies mainly with the short-run effects of inflation or the speed with which the short-run turns into the long-run Phillips curve. The influence that inflation may have in the short and the medium run on the level of output is, however, not restricted by the identification method. The model of Quah and Vahey also permits the validity of the identification method to be tested. As inflation is a monetary phenomenon, the second type of shocks, viz. output shocks, should, in the long run, not affect measured inflation. However, should measured inflation be found to be influenced by output shocks even in the long run, doubts would arise about the validity of the identification procedure proposed by Quah and Vahey.

Finally, there is an identification problem related to the model of Quah and Vahey. As the model is estimated in first differences of the endogenous variables, it is not core inflation itself that is identified, but the change in core inflation. The level of core inflation itself remains unknown and undetermined.

5.3 The relationship between the inner value of money and core inflation

The main question that arises upon consideration of Quah and Vahey's model is what relationship exists between the change in the inner value of money and Quah and Vahey's concept of core inflation.

Quah and Vahey's core inflation is that part of measured inflation which is output-neutral in the long run. The decompositions of two possible inflation gauges, viz. the change in the CPI of equation (3) and the average price change of equation (4), indicate that in the long run three components do not affect the level of output, and may therefore be identified as part of core inflation. These components are

- the change in the inner value of money
- the (weighted) average of temporary relative price changes brought about by monetary shocks, and
- measurement errors.

Of course, the (weighted) average of the relative price changes generated by monetary shocks is output-neutral in the long run because these price effects will disappear if the equilibrium is stable.

Consequently, it may be concluded that the method of Quah and Vahey is, in theory, capable of decomposing the influence of real and monetary shocks on inflation, measured by one of these two gauges. However, for both gauges, Quah and Vahey's core inflation does not correspond wholly to the change in the inner value of money. Core inflation derived from the CPI or the average price change at time t is the (weighted) average of the price changes at that time, insofar as caused by monetary factors, but not the change in the inner value of money, i.e. the proportional change in all prices following a monetary shock after the new long-run equilibrium is reached. Thus, in the absence of measurement errors, the difference between core inflation and the decrease in the inner value of money depends on transitory relative price changes due to monetary shocks.

The use of the unweighted average price change as the inflation series which is to be decomposed by Quah and Vahey's model probably yields the least distorted estimation of the change in the inner value of money because, on the one hand, weighting the CPI in order to measure inflation is theoretically unfounded and, on the other, errors of measurement have a negligible effect on this inflation gauge. Moreover, when calculating the average price, one is in principle not limited to consumer commodities only. For the other two gauges, the median and the modal price change, it is not possible to determine, without the aid of further and highly detailed assumptions, which components would be identified as core inflation by the Quah and Vahey method.

Although Quah and Vahey's core inflation does not exactly correspond to the change in the inner value of money, core inflation derived from the average price change is thus far the best available operationalization to measure Menger's concept. In the next section we use this operationalization to calculate the change of the inner value of money for the Netherlands and for the European Union.

6 MEASURING THE INNER VALUE OF MONEY

6.1 The Netherlands

Quah and Vahey's VAR model (8) for the Netherlands is estimated with monthly data from the period 1991-1995. For real output the deseasonalized average daily output of the production industries excluding construction was chosen. For observed inflation we used the average price change, calculated on the basis of the 200 price series which also underlie the CPI.

Before estimating Quah and Vahey's VAR model, we tested if the non-stationarity assumptions are indeed satisfied by the Dutch data. The results of the tests for the non-stationarity of the average price change and real output, summarised in Table 1 of Appendix I, indicate that the series are integrated of order one. Completing the specification of the model, we determined the order of the VAR model. Based on preliminary estimations we included 3 lagged variables in our final model [5]. The results of the estimation are presented as impulse-response functions shown in Figure 1 and 2, which indicate how real output and measured inflation respond to the structural shocks. Note that these impulse-responses show the movements in the *level* of *measured* inflation and output.

Figure 1 shows that a core inflation shock leads to a permanent increase in inflation, while after less than a year output has returned to its initial level. The speed with which the effect of an unanticipated inflation impulse on real output wears off is not determined by the identification method. Indeed, the identification implies solely that core inflation has become output-neutral after an infinite number of periods. It is noteworthy that an inflation shock decreases output in the first month, while the opposite was to be expected on the basis of the short-run Phillips curve. The confidence intervals are, however, so large that there is no telling whether this effect is significant.

Figure 2 shows that an output shock leads to a permanent rise in measured inflation, too. This effect is, however, not significant. This confirms the hypothesis that core inflation shocks do indeed reflect monetary influences. Finally, Figure 2 shows that an output shock has a permanent impact on real output.

[5] Details are provided in Appendix I.

Response to core inflation shock

Figure 1a Measured inflation

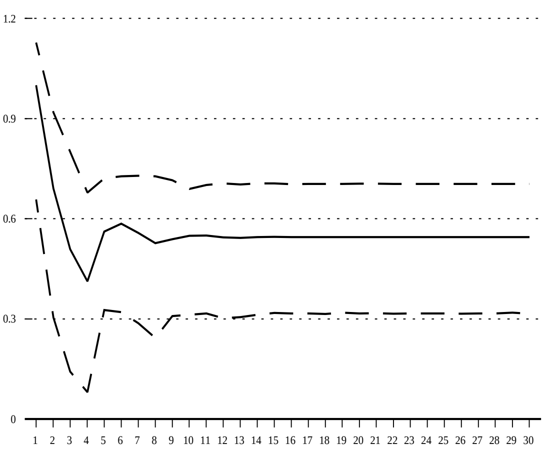
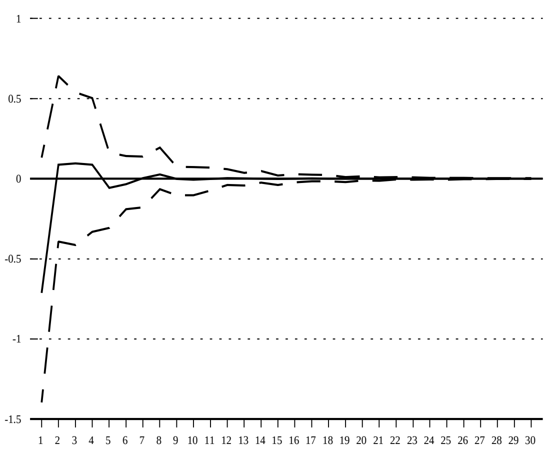


Figure 1b Output



Response to output shock

Figure 2a Measured inflation

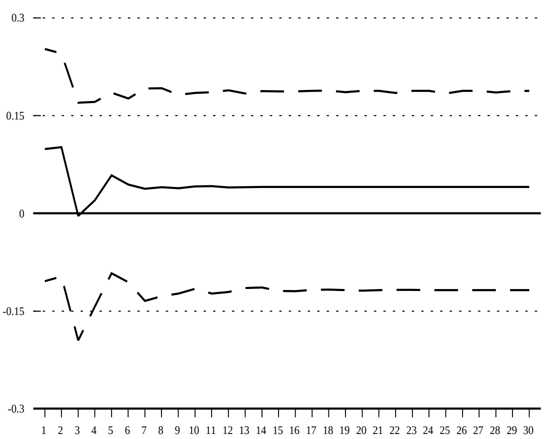
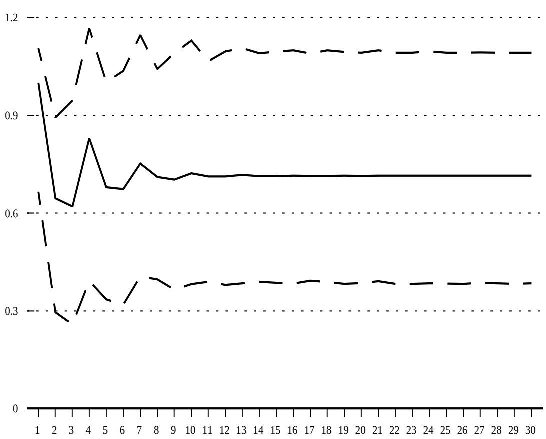


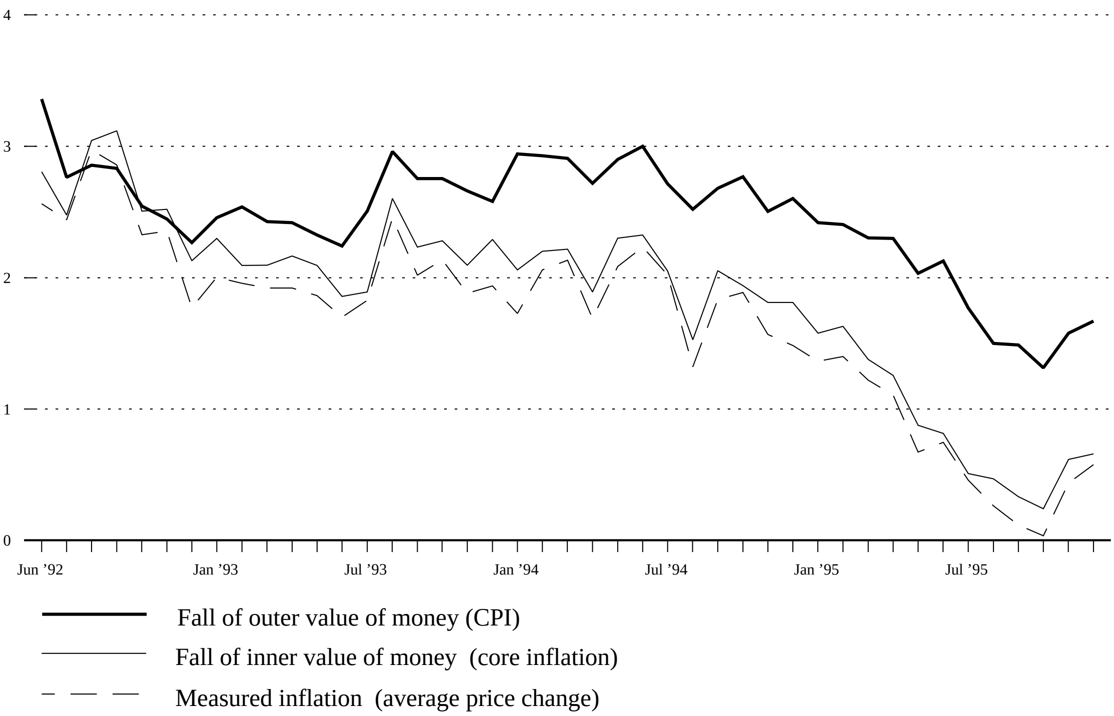
Figure 2b Output



Explanatory note: The horizontal axis shows time in months. The vertical axis shows the deviation (in percent) of inflation and (log-)output, respectively, from the initial level. The core inflation shock ε_1 and the output shock ε_2 have been so chosen that in the first period measured inflation would be up by one percentage point, and the level of (log-)output by one percent. The shock lasts but one period. The 95% confidence intervals — based on 1000 replications — for the impulse-response functions are also shown (see Runkle (1987) for details).

The ultimate objective of the model is the identification of price changes, which have been caused by monetary factors. Figure 3 shows the average price change or measured inflation, the core inflation derived from the average price change and the conventional measure of inflation based on the CPI. Phrased differently, using core inflation based on the average price change to operationalize the decrease in the inner value of money, Figure 3 depicts the movement in the outer and inner value of money. As noted before, the level of core inflation cannot be identified, merely the change in that level. The chart is therefore based on the assumption that in the month preceding the sample period core inflation coincides with the average price change.

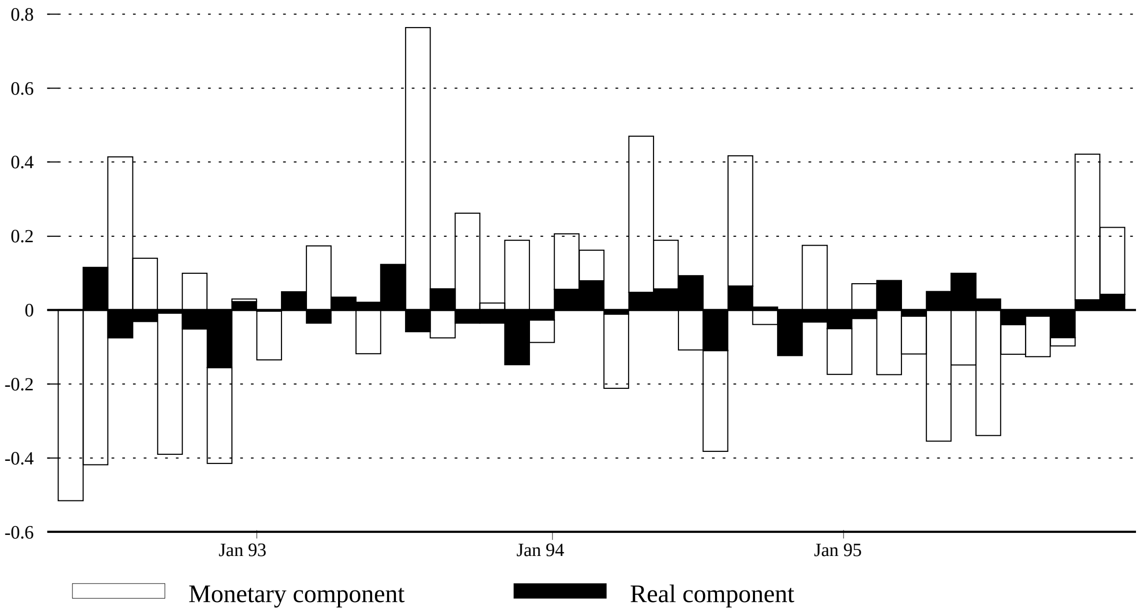
Figure 3 Change of inner and outer value of money (percent)



The remarkable thing about the pattern in Figure 3 is that the discrepancy between measured inflation and core inflation does not show any trend over time. This means that the average price change is either relatively insensitive to price changes generated by real factors or - and this is more likely - that over the sample period real shocks had but a relatively small influence on the price level. This second interpretation is also supported by the breakdown of the impulses on *measured* inflation υ_{1t}. The shocks υ_{1t} relating to measured inflation, i.e. the average price change, are, after all, related to the structural shocks ε_{1t} and ε_{2t} through $\upsilon_{1t} = A_{0,11}\varepsilon_{1t} + A_{0,12}\varepsilon_{2t}$. Figure 4 shows, for every month of the sample period, the monetary component $A_{0,11}\varepsilon_{1t}$, and the real component $A_{0,12}\varepsilon_{2t}$ of the inflation shock υ_{1t}. The chart shows that the effect of real shocks on measured inflation has indeed been fairly small over the past three years by comparison with the effect of monetary shocks.

The movements in the average price change and derived core inflation in Figure 3 shows that a number of periods stand out where the average price change over- or underestimates the monetary influences on inflation. Figure 4 shows, for example, that the drop in the average price change in December 1992 is only partially the result of monetary policy. Simultaneous real impulses lead to a drop in the average price change as well. On the other hand, the increase in the average price change in February and March 1994 is not caused by a monetary shock only, but real factors drove prices up as well. Finally, in the second half of 1995, the average price change first dropped more substantially and then rose more considerably than core inflation. Again real and monetary impulses worked in the same direction leading to an overestimation of the monetary effects on measured inflation.

Figure 4 Historical decomposition of inflation shocks υ_{1t}



From a comparison of the movements in the inner and the outer value of money, i.e. core inflation and the change in the CPI, it becomes evident that a notable difference between the two is that from July 1993 onwards the fall in the outer value of money is much more pronounced than that in the inner value of money. It goes without saying that the weighting of the CPI explains this phenomenon, because certain goods and services whose prices continued to rise after July 1993 figure fairly prominently in the CPI, such as actual and imputed rents. In the case of the average price change and derived core inflation, the marked rise in the prices of these items is partially offset by the smaller increase or even fall in prices of the bulk of goods and services.

6.2 European Union

Attempting to measure the inner and outer value of money on a European level by the methods described so far presents problems of its own, most notably the problem that a common European currency does not yet exist. Therefore, in order to measure the value of money, one first has to define a European concept of money. Here we define European money as the aggregated money stocks of the various nations using purchasing power parities to convert all nominal values into ecu. Thus, the European money stock at time *t* is defined as

$$M_{tEU} = \sum_i e_{ti} M_{ti} \ , \tag{10}$$

with e_{ti} denoting the purchasing power parity of country *i* at time *t* and M_{ti} the money stock of country *i* at time *t*. A matching definition of the outer value of European money takes the form

$$P_t^L = \sum_i w_i \frac{e_{ti}}{e_{0i}} P_{ti}^L \text{, with } w_i = \frac{\sum_j e_{oi} p_{0ij} x_{0ij}}{\sum_{lj} e_{0l} p_{0lj} x_{0lj}}, \tag{11}$$

which is a weighted average of the national CPI's P_{ti}^L of the various countries, with weights w_i equal to the countries, shares in aggregate European final consumption in 1985. Finally, as European average price change we use

$$\pi(\text{avg.}) = \frac{1}{IJ} \sum_{ij} \ln e_{ti} p_{tij} - \ln e_{(t-1)i} p_{(t-1)ij} \tag{12}$$

where *I* denotes the number of countries considered and *J* the number of commodities per country.

In order to estimate Quah and Vahey's VAR model (8) for Europe we used monthly data for the period January 1985 to December 1995 for Austria, Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden and the United Kingdom. As the series reflecting real output, the deseasonalized average daily output of the national production industries, excluding construction, was chosen. European real output was constructed as the weighted average of national real output, with weights equal to each country's share in European gross added value on the basis of factor prices. Measured inflation in this application is the European average price change, calculated on the basis of the 11 price series per country which also underlie the national CPI's.

Before we estimated the model for the European Union we tested if the series for measured inflation and real output show non-stationary behaviour. The test results indicate that for the European Union these conditions for the identification method are satisfied. For the model specification to be complete, the lag order of the VAR model must be chosen. Based on preliminary estimates and several standard criteria we choose a lag length of three [6]. The estimation results for the structural VAR model are again presented as impulse-response functions for measured inflation, i.e. European average price change, and European (log-)output, shown in Figures 5 and 6.

A core inflation shock leads to a permanent increase in inflation. In the same way as for the Netherlands it is observed that the effect of an inflation impulse on output wears off quickly and that output returns to its initial level within 12 months. Similarly, the European results suggest that an inflation shock may decrease output in the first month. The confidence intervals reveal, however, that this effect is not significant.

Contrary to the model for the Netherlands, however, the model for the European Union implies that a real shock has a significant and permanent effect on inflation. This casts some doubt on the hypothesis that monetary effects are correctly identified by this approach applied to European data. Indeed, the prediction that a permanent rise in the output level by 0.5% implies a permanent rise in inflation in the absence of any monetary effects, contradicts economic theory.

This failure of the model to decompose the European average price change into a purely monetary and a purely real component can probably be explained by the assumptions underlying the structural VAR model. Implicitly the model assumes that only two types of shocks drive inflation and output. Furthermore, it is assumed that each realisation of a shock has the same effect on the endogenous variables. If applied to one country, the assumption of a single typical inflation shock is justifiable because of the existence of a single monetary base. For Europe, however, a single monetary base does not yet exist. Moreover, the transmission of monetary shocks may differ between countries due to diverging institutional arrangements. Both facts may imply that a monetary shock originating in e.g. Italy leads to a different effect on European output than an unanticipated inflation shock in, for instance, Germany.

Although the identification of the monetary component of the average price change by the structural VAR model applied to the European Union is less convincing compared to the application to the Netherlands, we present in Figure 7 the change in the inner and outer value of European money. The chart shows that the inner value of money decreased less than the outer value of money in 1988-89, catching up in 1990-91. In the third and fourth quarters of 1992, however, the fall in the inner value of money was more marked than that in the outer value. In the last quarter of 1993 and 1994 the fall of the inner value decelerated once more, catching up with the decrease in the inner value of European money. Incidentally, in 1992 the year when the changes in the inner and the outer value diverged quite sharply, the UK and Italy moved out of the EMS.

[6] Details are presented in Appendix I.

Response to core inflation shock

Figure 5a Measured inflation

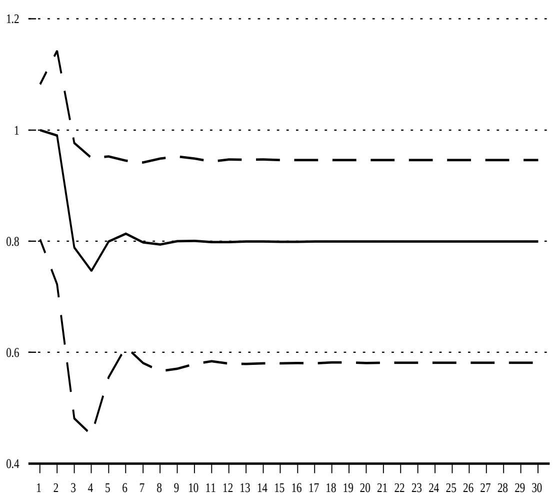
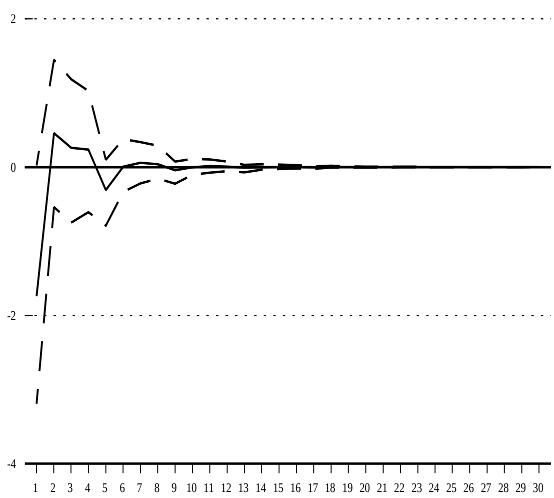


Figure 5b Output



Response to output shock

Figure 6a Measured inflation

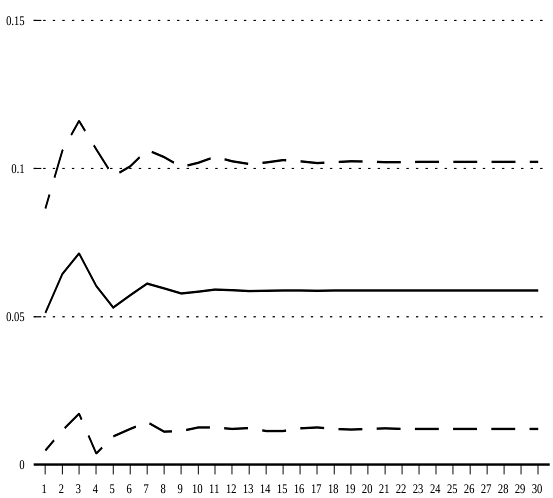
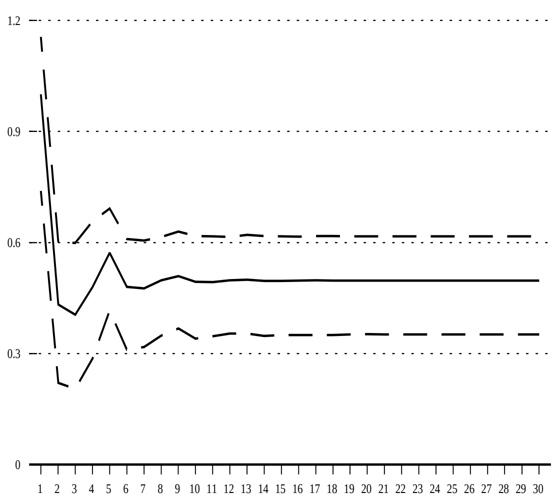
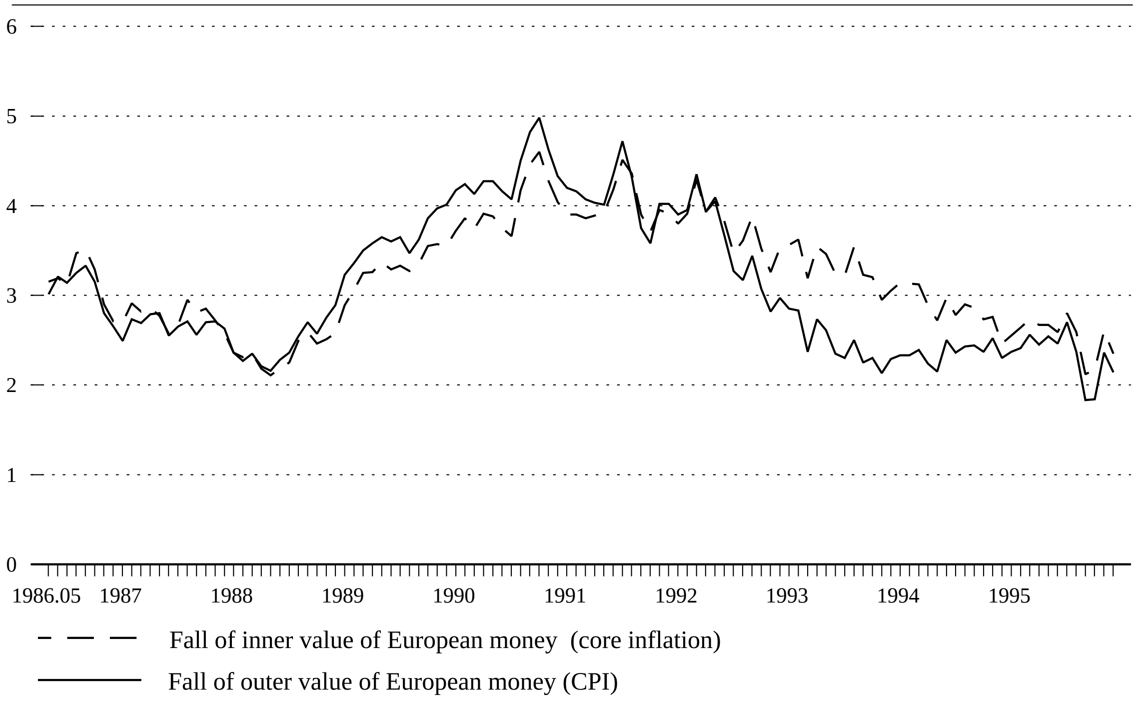


Figure 6b Output



Explanatory note: The horizontal axis shows time in months. The vertical axis shows the deviation (in percent) of inflation (log-)output, respectively, from the initial level. The core inflation shock ε_1 and the output shock ε_2 have been so chosen that in the first period measured inflation would be up by one percentage point, and the level of (log-)output by one percent. The shock lasts but one period. The 95% confidence intervals for the impulse-response functions are also shown.

Figure 7 Change of inner and outer value of European money



7 CONCLUSIONS

This paper was motivated by the fact that the most commonly used measure of inflation, the change in the CPI, does not match the concept of inflation used in economic theory: it cannot distinguish between monetary and real causes leading to price changes nor between a one-off and a permanent price rise. From the point of view of a monetary authority which aims to stabilize the value of money, the former shortcoming is especially disturbing since the central bank may be held accountable for price rises which are not caused by monetary policy or it may take inappropriate policy actions on the basis of a biased inflation measure.

This paper investigated possible operationalizations of Carl Menger's concept of the inner value of money. A change in the inner value of money is defined as the change in prices, which is solely brought about by monetary causes. On examining different descriptive statistics of price changes more closely, we found that neither the change in the CPI, nor the average price change or the mode or median of the price change frequency distribution is capable of identifying changes in the inner value of money. Furthermore, we also tried to decompose the price changes measured by the average price change into a real and monetary component using the economic hypothesis that inflation is output-neutral in the long run. It was argued that this approach, which is based on a model of Quah and Vahey, does indeed identify the monetary component of price changes but not the inner value of money. The difference between the two is that the former responds to price changes which are caused by the transmission of monetary shocks, whereas the latter is defined in terms of price changes following a monetary shock after all adjustment processes have been completed. Despite this difference, core inflation or the monetary component of the average price change is the best available operationalization of the decrease in the inner value of money and is wholly in accordance with economic theory.

Applying the approach to the Netherlands and the European Union, we found that the change in the inner and that in the outer value of money have diverged considerably and persistently in the periods examined. This finding indicates that using the CPI as a gauge for inflation is not only theoretically inappropriate but that even in practical applications it yields distorted information on the actual inflationary tendencies. The change in the inner value of money may be seen as an alternative measure that matches the concept of inflation used in economic theory more closely than the change in the CPI. Moreover, from the point of view of monetary policy, it seems to be the more adequate measure of inflation in terms of accountability.

APPENDIX I

I.1 **The model for the Netherlands: non-stationarity tests and lag order**

With the aid of the two augmented Dickey-Fuller tests, the stationarity of the base series and their first differences were examined. For the (log-)output series *y*, the test statistic $T(\rho - 1)$, with *T* the sample size and ρ the autocorrelation between successive observations, and the Dickey-Fuller *t*-test $\frac{\rho - 1}{\sigma_\rho}$ indicate the existence of non-stationarity; the first differences Δy, however, do form a stationary process. The hypothesis that the output series is integrated of order one is thus confirmed. The hypothesis that the average price change is also integrated of order one may also be accepted.

Table 1 Results of the Augmented Dickey-Fuller test

Variabele	Lag length	Excluding trend		Including trend	
		$T(\rho - 1)$	$(\rho - 1)/\sigma_\rho$	$T(\rho - 1)$	$(\rho - 1)/\sigma_\rho$
y	5	0.46***	0.05***	-9.91***	-0.94***
Δy	4	-231.39	-6.41	-238.87	-6.78
π(aver.)	1	-3.04***	-1.16***	-15.36***	-2.68***
$\Delta\pi$(aver.)	1	-66.66	-6.64	-66.32	-6.51

Notes: The number of lagged variables in the test regression has been so chosen that the disturbance term is not serially correlated. ***/**/* means that the hypothesis that a unit root is present cannot be rejected at a significance level of 10%/5%/1%, respectively.

The number of lagged variables to be included in the VAR model is determined with the aid of various criteria and test statistics. The criteria of Akaike, Hannan-Quinn and Schwartz indicate a lag length of 1 to 3. Although the Box-Pierce Portmanteau test and Godfrey's Lagrange multiplier test do not indicate serial correlation of the residuals if the model includes but one lagged variable, and the log-likelihood ratio test, too, does not show that, by comparison with a lag length of 3, this specification is overly restrictive, three lagged variables were included. It seems unlikely that the change in inflation and the growth rate of output can be explained by current inflation and output as well as inflation and output of the previous month only. It also turned out that a deterministic trend is not significant, so that, apart from the lagged variables, only a constant term was added to the model.

I.2 **The model for the European Union: non-stationarity tests and lag order**

The results of the test for the non-stationarity of the European average price change and European real output are summarised in Table 2. With the aid of the two augmented Dickey-Fuller tests, the stationarity of the base series and their first differences were examined. For the (log-)output series *y*, the test statistic $T(\rho - 1)$, and the Dickey-Fuller *t*-test indicate the existence of non-stationarity; the first differences Δy, however, do form a stationary process. The hypothesis that the output series is integrated of order one is thus confirmed. The hypothesis that the average price change is also integrated of order one may also be accepted.

Table 2 Results of the Augmented Dickey-Fuller test

Variabele	Lag length	Excluding trend $T(\rho-1)$	Excluding trend $(\rho-1)/\sigma_\rho$	Including trend $T(\rho-1)$	Including trend $(\rho-1)/\sigma_\rho$
y	3	-5.21***	-1.58***	-7.89***	-1.43***
Δy	3	-307.70	-8.19	-311.77	-8.22
π(aver.)	2	-3.58***	-1.16***	-4.03***	-1.28***
$\Delta\pi$(aver.)	2	-140.69	-7.69	-141.03	-7.69

Notes: The number of lagged variables in the test regression has been so chosen that the disturbance term is not serially correlated. ***/**/* means that the hypothesis that a unit root is present cannot be rejected at a significance level of 10%/5%/1%, respectively.

As in the model for the Netherlands, the number of lagged variables to be included in the VAR model is determined with the aid of the criteria of Akaike, Hannan-Quinn and Schwartz. The criterion of Schwartz points towards a lag length of 1, whereas the other two criteria indicate a lag length of 3. The model with 1 lagged variable is, however, not correctly specified since the Box-Pierce Portmanteau test and Godfrey's Lagrange multiplier test indicate serial correlation of the residuals. The log-likelihood ratio test, too, rejects a lag length of 1 maintaining the model with three lagged variables.

APPENDIX II: INFLATION IN THE NETHERLANDS AND EUROPE MEASURED BY DIFFERENT GAUGES

In this appendix the numerical values underlying Figure 3 and 7 as well as some additional series are presented. Table 3a contains the monthly series for the Netherlands depicted in Figure 3. Table 3b shows the annual averages of these series. Furthermore, Table 3a presents the series for the change in the derived CPI, endogenous inflation and underlying inflation. The derived CPI excludes changes in indirect taxes and consumption-based taxes, such as motor vehicle tax. The endogenous inflation is the change in the derived CPI excluding the prices, which are administered in the Netherlands, e.g. gas, rents and imputed rents. Finally, the underlying inflation is calculated as the change in the CPI excluding the prices of vegetables, fruits and energy.

Table 4a contains the monthly series depicted in Figure 7 and Table 4b presents the annual averages of these series.

Table 3a Inflation in the Netherlands measured by different gauges (percent)

Month		Change in the CPI	Change in the derived CPI	Endogenous inflation	Under-lying Inflation	Average price change	
						measured	core inflation
1992	June	3.36	2.61	2.12	3.56	2.56	2.80
	July	2.76	2.21	1.78	3.64	2.44	2.47
	August	2.85	2.31	1.91	3.72	2.97	3.04
	September	2.83	2.29	1.61	3.78	2.86	3.12
	October	2.54	2.28	1.64	3.59	2.33	2.51
	November	2.45	2.28	1.64	3.59	2.35	2.52
	December	2.26	1.90	1.13	3.21	1.77	2.13
1993	January	2.46	2.29	1.76	3.40	2.00	2.30
	February	2.54	2.28	1.75	3.47	1.96	2.09
	March	2.43	2.26	1.73	3.26	1.92	2.09
	April	2.42	2.16	1.60	3.34	1.92	2.16
	May	2.32	2.07	1.47	3.25	1.86	2.09
	June	2.24	1.98	1.35	3.17	1.70	1.86
	July	2.51	2.44	2.04	3.24	1.83	1.89
	August	2.96	3.00	2.80	3.59	2.45	2.60
	September	2.75	2.70	2.67	3.37	2.02	2.23
	October	2.75	2.41	2.24	3.37	2.13	2.28
	November	2.66	2.23	1.99	3.19	1.88	2.09
	December	2.58	2.33	2.13	3.11	1.94	2.29
1994	January	2.94	2.42	1.76	3.20	1.73	2.06
	February	2.93	2.50	1.88	3.00	2.06	2.20
	March	2.91	2.49	1.86	2.98	2.13	2.22
	April	2.72	2.30	1.61	2.70	1.69	1.89
	May	2.90	2.48	1.85	2.70	2.08	2.30
	June	3.00	2.58	1.99	2.71	2.23	2.32
	July	2.71	2.29	1.47	2.69	2.02	2.05

Table 3a (continued)

Month		Change in the CPI	Change in the derived CPI	Endogenous inflation	Under-lying Inflation	Average price change	
						measured	core inflation
	August	2.52	2.10	1.21	2.41	1.32	1.53
	September	2.68	2.36	1.57	2.57	1.83	2.05
	October	2.77	2.36	1.56	2.66	1.89	1.94
	November	2.50	2.18	1.32	2.48	1.57	1.81
	December	2.60	2.19	1.33	2.58	1.48	1.81
1995	January	2.42	2.28	1.53	2.40	1.36	1.58
	February	2.40	2.17	1.39	2.39	1.40	1.63
	March	2.30	2.16	1.38	2.46	1.22	1.38
	April	2.30	2.16	1.38	2.46	1.11	1.26
	May	2.03	1.98	1.13	2.20	0.67	0.87
	June	2.13	1.98	1.14	2.38	0.75	0.81
	July	1.77	1.71	1.05	2.02	0.46	0.51
	August	1.50	1.43	0.67	1.75	0.26	0.47
	September	1.49	1.42	0.67	1.73	0.12	0.33
	October	1.31	1.25	0.42	1.56	0.03	0.24
	November	1.58	1.51	0.79	1.74	0.44	0.62
	December	1.67	1.52	0.79	1.66	0.58	0.66

Table 3b Inflation in the Netherlands measured by different gauges (percent)

Year	Change in the CPI	Change in the derived CPI	Endogenous inflation	Under-lying Inflation	Average price change	
					measured	core inflation
1992*)	2.72	2.27	1.69	3.58	2.47	2.66
1993	2.55	2.35	1.96	3.31	1.97	2.16
1994	2.77	2.35	1.62	2.72	1.84	2.02
1995	1.91	1.80	1.03	2.06	0.70	0.86

*) For 1992 the averages are based on the figures for June – December.

Table 4a European inflation measured by different gauges (percent)

Month		Change in European CPI	European average price change	
			measured	core inflation +)
1986	May	2.67	3.01	3.15
	June	2.70	3.21	3.19
	July	2.49	3.14	3.12
	August	2.53	3.25	3.47
	September	2.64	3.33	3.51
	October	2.34	3.15	3.29
	November	2.16	2.80	2.90
	December	2.11	2.65	2.71
1987	January	2.19	2.49	2.70
	February	2.24	2.73	2.91
	March	2.37	2.69	2.82
	April	2.43	2.79	2.86
	May	2.40	2.80	2.77
	June	2.31	2.55	2.57
	July	2.59	2.65	2.67
	August	2.63	2.71	2.95
	September	2.55	2.56	2.81
	October	2.78	2.70	2.85
	November	2.72	2.71	2.72
	December	2.58	2.63	2.58
1988	January	2.31	2.36	2.36
	February	2.31	2.27	2.31
	March	2.45	2.35	2.35
	April	2.50	2.21	2.18
	May	2.62	2.16	2.11
	June	2.72	2.28	2.18
	July	2.82	2.36	2.25
	August	3.10	2.54	2.49
	September	3.17	2.70	2.59
	October	3.20	2.57	2.46
	November	3.38	2.75	2.51
	December	3.61	2.89	2.58
1989	January	3.94	3.23	2.89
	February	4.19	3.36	3.06
	March	4.20	3.50	3.25
	April	4.44	3.58	3.26
	May	4.55	3.65	3.37
	June	4.52	3.60	3.29
	July	4.45	3.65	3.33
	August	4.22	3.47	3.27
	September	4.24	3.62	3.35
	October	4.36	3.86	3.55
	November	4.36	3.97	3.57
	December	4.34	4.01	3.55
1990	January	4.26	4.17	3.72
	February	4.24	4.24	3.86
	March	4.32	4.13	3.74
	April	4.36	4.27	3.91

Table 4a (continued)

Month		Change in European CPI	European average price change measured	core inflation +)
	May	4.32	4.27	3.88
	June	4.25	4.16	3.75
	July	4.28	4.07	3.66
	August	4.68	4.50	4.17
	September	4.94	4.82	4.46
	October	5.10	4.98	4.60
	November	4.73	4.62	4.27
	December	4.51	4.33	4.04
1991	January	4.47	4.20	3.90
	February	4.51	4.16	3.90
	March	4.36	4.07	3.86
	April	4.02	4.03	3.89
	May	4.09	4.01	3.92
	June	4.32	4.35	4.18
	July	4.55	4.72	4.51
	August	4.17	4.32	4.36
	September	3.84	3.75	3.90
	October	3.92	3.58	3.71
	November	4.41	4.02	3.95
	December	4.37	4.02	3.91
1992	January	4.31	3.90	3.80
	February	4.28	3.95	3.91
	March	4.35	4.35	4.29
	April	4.39	3.93	3.93
	May	4.33	4.05	4.09
	June	4.03	3.67	3.83
	July	3.62	3.27	3.47
	August	3.51	3.17	3.61
	September	3.50	3.44	3.88
	October	2.96	3.07	3.52
	November	2.70	2.82	3.26
	December	2.68	2.97	3.53
1993	January	2.80	2.85	3.56
	February	2.81	2.83	3.62
	March	2.82	2.37	3.19
	April	2.70	2.73	3.54
	May	2.64	2.61	3.46
	June	2.68	2.35	3.24
	July	2.85	2.30	3.22
	August	2.97	2.50	3.54
	September	2.89	2.25	3.23
	October	2.87	2.30	3.20
	November	2.84	2.13	2.95
	December	2.94	2.29	3.05
1994	January	2.74	2.33	3.14
	February	2.68	2.33	3.13
	March	2.56	2.39	3.12

Table 4a (continued)

Month		Change in European CPI	European average price change measured	core inflation +)
	April	2.57	2.24	2.89
	May	2.62	2.15	2.72
	June	2.58	2.50	2.97
	July	2.45	2.36	2.78
	August	2.51	2.43	2.90
	September	2.45	2.44	2.86
	October	2.41	2.37	2.73
	November	2.36	2.52	2.76
	December	2.48	2.30	2.46
1995	January	2.53	2.37	2.55
	February	2.63	2.41	2.64
	March	2.76	2.56	2.73
	April	2.80	2.45	2.67
	May	2.71	2.54	2.67
	June	2.86	2.46	2.59
	July	2.69	2.70	2.80
	August	2.75	2.37	2.59
	September	2.83	1.83	2.12
	October	2.69	1.84	2.17
	November	2.74	2.36	2.60
	December	2.75	2.14	2.35

+) Cf. note to Table 4b.

Table 4b European inflation measured by different gauges (percent)

Year	Change in European CPI	European average price change measured	core inflation +)
1986 *)	2.46	3.07	3.17
1987	2.57	2.66	2.74
1988	3.08	2.53	2.40
1989	4.38	3.73	3.41
1990	4.60	4.47	4.10
1991	4.21	4.10	4.05
1992	3.41	3.31	3.65
1993	2.83	2.34	3.24
1994	2.48	2.38	2.77
1995	2.75	2.28	2.49

*) For 1986 the averages are based on the figures for May – Dec.

+) As in Table 3, it is assumed that in April 1992 core inflation coincided with measured average price change.

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