

Inflation in France and in the euro zone: a macro-sectoral approach

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In this special report we present two macro-sectoral price-forecasting models, for France and the euro zone, that take explicit account of the wage-price loop. In particular, they make it possible to examine the reactions of consumer prices to external shocks, showing that these are similar in France and in the euro zone, albeit sometimes with differences in response lags. They also highlight the fact that the rise in inflation, in France and in the euro zone, in 1999 and 2000 was mainly due to evolutions in the exchange rate and the price per barrel of crude oil. In H1 2004, the evolutions in inflation can be expected again to be mainly related to evolutions in the exchange rate and the oil price, which on this occasion would contribute to an easing of inflation in France and in the euro zone.

The instrument normally used for forecasting inflation in France and in the euro zone in the "Note de Conjoncture"⁽¹⁾ is based on a refined sectoral breakdown and on modelling in which the future evolution of prices in each sector is mainly explained by past variations (ARMA modelling), combined in the case of certain sectors with variations in other variables, such as the oil price for prices of fuels.

While this modelling turns out to be effective for making forecasts over periods of 1 to 12 months, it has two major drawbacks:

- Because the forecasts are derived from a model based essentially on past evolutions in the sectoral prices being considered, they do not lend themselves easily to macroeconomic interpretation. It is only on the basis of sectoral evolutions that the past evolution in prices is explained. Moreover, while it is perfectly possible to forecast the future evolution in prices, this evolution is not directly supported by intuitive economic explanations, such as the evolution in wages or pressures on the productive system. This type of justification is implicit only.
- Modelling of this kind does not lend itself to simulations permitting the investigation of variants, meaning that it does not provide replies to questions of the type: "by how much would inflation be reduced if the unemployment rate were one point higher?", "... if the euro were to appreciate by 10%?", "... if the oil price were to decline by 10%?".

Hence the interest of having available, alongside this definitely productive instrument, a macroeconomic model making it possible to relate evolutions in prices to those in the principal economic magnitudes (wages, pressures on the productive system, exchange rate, oil price, etc) and to simulate the effects of a shock affecting one or other of these. Such an approach in the case of France was described in the June 2001 Note in this series. What are shown here are the results obtained with an intermediate instrument, modelling macro-sectoral prices.

A macro-sectoral model

The modelling used takes explicit account of mutual interactions between prices and wages

As a first step, because they react differently to the economic situation, prices ⁽²⁾ have been grouped into four main sectors:

- foodstuffs;
- manufactures (i.e., industry excluding energy and food);
- energy;
- services.

The explanatory variables, and above all their respective importance, are a priori different for different sectors. For example, it can readily be understood that the oil

(1) See the «Consumer prices in the euro zone» and «Consumer prices» sections. The latter is available in French only.

(2) The indices used here are the consumer price index (CPI) for France and the harmonised index of consumer prices (HICP) for the euro zone (see box 1 for the differences between the two indices).

price will have a much greater influence on energy prices than on prices of services.

The next step is to choose the variables to be considered for their possible explanatory power regarding evolutions in prices (*see box 2*). These variables can be grouped into four main categories:

- Domestic production costs: wages, productivity, the cost of capital (which can be approximated by interest rates), prices of inputs (notably those of imported raw materials).
- The margins applied to these costs by domestic producers (including distributors) in forming their selling prices. These depend on the pressures affecting the markets (approximated by the productive capacity utilisation rate and the unemployment rate).
- The variables contributing to movements in the prices of imported consumer goods. These include the prices of foreign goods in their respective currencies and the exchange rates.
- Indirect taxes and duties applied to the products consumed, such as value-added tax (VAT) or the special domestic tax on petroleum products in force in France.

Sector-based modelling of this type nevertheless ignores an important phenomenon, namely the mutual interactions between the evolutions in prices and wages. The various sectoral prices combine to form the consumer price index, which is itself one of the principal determinants of wages, which in turn influence price formation in that they represent a major portion of production costs. The modelling is therefore obliged to take explicit account of this mechanism. For the purpose, it incorporates an equation modelling the evolution of wages as a function of the evolution of consumer prices and of the unemployment rate (*see box 2*).

This modelling raises technical difficulties. For example, it is not possible to estimate the different equations in the model separately since this would lead to errors in the estimation of the coefficients (endogeneity bias). The entire system therefore has to be estimated simultaneously, with all the difficulties this implies (*see box 4 "Estimation Strategy and Results"*).

It is worth noting that this modelling has certain limitations for the study of the impact of exogenous shocks, as in the case of the exchange rate. This is because only nominal magnitudes (prices and wages) are modelled, not real magnitudes (employment, volume of activity, etc). This point will be returned to in the section dealing with the examination of shocks.

Greater problems of data availability for the euro zone than for France

In working on the euro zone, one initial problem is the brevity of the macroeconomic series available. As a result, this part of the study covers only the period from 1990 to 2003⁽³⁾. For France, on the other hand, it extends from 1985 to 2003.

In addition, the VAT rates for the euro zone are not available. What is of interest here is not so much this notion in the legal sense, but in the sense of the availability of statistical series for apparent average VAT rates or for the totals of VAT collected. The only data are for the total of the indirect taxes recovered, which also include taxes of a specific nature - on tobacco or petroleum products, for example.

The models provide a fairly precise picture of the aggregate evolutions of prices and wages

This modelling, whose equations are presented in box 4a for the euro zone and 4b for France, gives satisfactory results, as can be seen from examination of the dynamic simulations (*see graphs 1A and 1B*). In total, for the euro zone, the standard deviation of the error commit-

ted in the harmonised index of consumer prices (HICP) for quarterly changes amounts to 0.08 of a point (0.18 of a point, year on year) and for the basic monthly wage to 0.16 of a point (0.40 of a point, year on year). For France, it is 0.20 of a point for the consumer price index, (0.43 of a point, year on year) and 0.18 of a point for the basic monthly wage (0.45 of a point, year on year)⁽⁴⁾.

Each set of sectoral prices is sensitive to specific influences

Quite apart from very strong seasonal influences, prices of foodstuffs depend on wages

Seasonal effects operate mainly in an upward direction on prices in the first and second quarters. In order to take account of the move to the 1990 base for the French price index, a break in the seasonality was introduced starting in 1991. This was because the move to the 1990 base led to a modification in the method used for calculating the prices of fresh produce and this increased their recorded volatility.

Food prices are linked essentially to wages and exchange rates. The prices of basic foodstuffs have only a weak influence in the case of France and have not been included in the modelling of prices in the euro zone.

(3) The data relating to evolutions in compensation in the euro zone published by Eurostat go back only to Q2 1995 and the statistics for the unemployment rate to 1993. These series have therefore been extended backwards using the data available for individual euro-zone countries accounting for more than 85% of dependent employment in the euro zone (the missing countries are the Netherlands, Ireland, Finland and Luxembourg).

(4) The volatility of the French series is greater, the same therefore being true of the mean errors, because of a decision to model prices taking quarter-end data for France rather than quarterly averages as in the case of the euro zone.

BOX 1: THE DIFFERENCES BETWEEN THE FRENCH CONSUMER PRICE INDEX (CPI) AND THE HARMONISED INDEX OF CONSUMER PRICES (HICP)

The principal difference between the CPI and the HICP lies in the treatment of the prices of health care: for this item, the CPI takes the gross prices, whereas the amounts in the HICP are recorded net of social security repayments. This conceptual difference has two consequences. First, it means that health care prices do not necessarily undergo the same evolutions in the CPI as in the HICP. In particular, the removal of certain products or

medical acts from the list of reimbursable items will have no impact on health care prices as measured in the CPI, whereas it could lead to substantial increases in those included in the HICP. Second, health care carries a much higher weighting in the CPI than in the HICP: 9.9% in 2004 compared with 4.5% for the HICP. Conversely, the HICP is more sensitive to variations in the prices of other products, notably fresh produce and energy. ■

BOX 2: THE FORMALISATION OF THE MODEL

(Note: all the magnitudes are in logarithms)

The goods consumed in the euro zone can have two origins, being either imported or produced locally. If, for sector i , P_i denotes the consumer price index, Pn_i the price of goods produced locally, Pm_i that of imported goods and λ_i the proportion of consumption represented by imported goods, we can write:

$$\Delta P_i = \lambda_i \Delta Pn_i + (1 - \lambda_i) \Delta Pm_i$$

The price index of imported goods is a geometric mean of the prices on the foreign markets, denoted by P^* , which are converted into national currency using the exchange rate e , and the prices of the goods produced locally.

$$\Delta Pm_i = \beta \Delta Pn_i + (1 - \beta)(\Delta P^*_i - \Delta e)$$

The prices of the goods produced locally are obtained by applying a mark-up (at a rate TM) to the production costs. The latter are a function of unit wage costs, in other words wages w adjusted for productivity π_i (because a rise in productivity means that more can be produced with an identical quantity of work), of the oil price denoted by *brent*, of the prices of imported inputs denoted by Pcm_i , converted into local currency, and of the cost of capital denoted by r . We therefore have:

$$\begin{aligned} \Delta Pn_i &= \Delta TM_i + \gamma_i(\Delta w - \Delta \pi_i) + \delta_i(\Delta \text{brent} - \Delta e) \\ &\quad + \varepsilon_i(\Delta Pcm_i - \Delta e) + \eta_i \Delta r \end{aligned}$$

The mark-up rate is a function of firms' market power. The higher the demand in relation to the supply, the greater the market power. As an indicator of this, it is possible to use the productive capacity utilisation rate, denoted by CUR . One may also use the unemployment rate: the higher this rate, the weaker will be demand and hence the lower the mark-up rate.

$$\Delta TM_i = \mu_i \Delta CUR - \nu_i \Delta U - \theta_i U$$

Wages depend on expectations of consumer prices and on productivity: workers try to maintain their share of value added in the form of wages in relation to the remuneration of other factors of production. Wages are also negatively influenced by the unemployment rate U : the higher the unemployment rate, the lower the bargaining power of workers and hence the smaller the wage increases. One then has the wages equation:

$$\Delta w = \Delta P^a + \Delta \pi^a - \rho U$$

The consumer price is, by definition, the geometric mean of consumer prices in each sector:

$$\Delta P = \sum_i \alpha_i \Delta P_i \quad (1)$$

In the end, the system governing the evolution of prices takes the form:

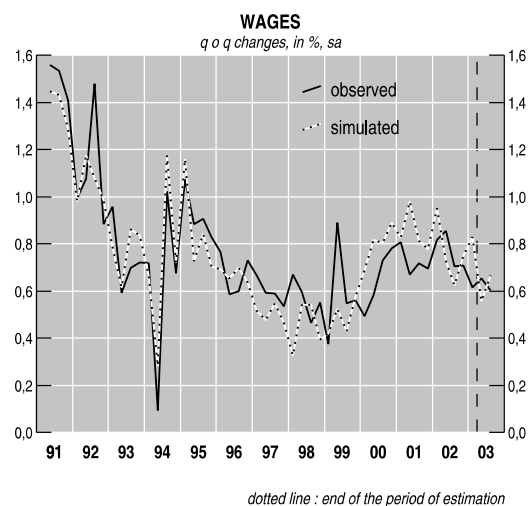
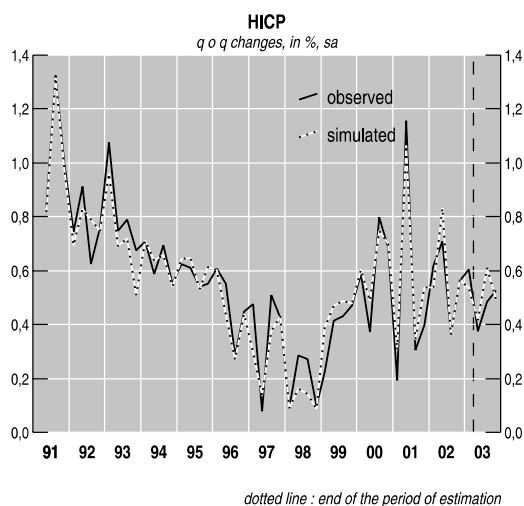
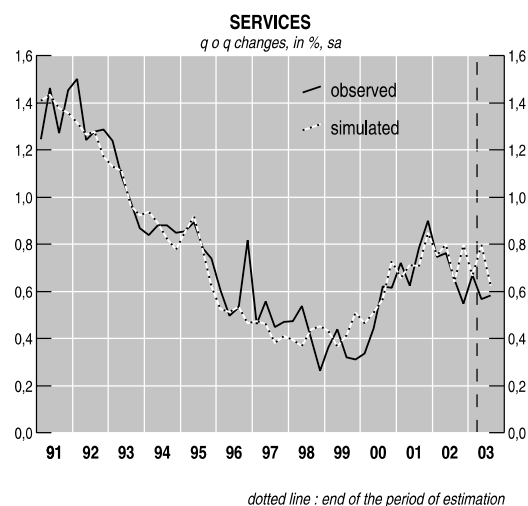
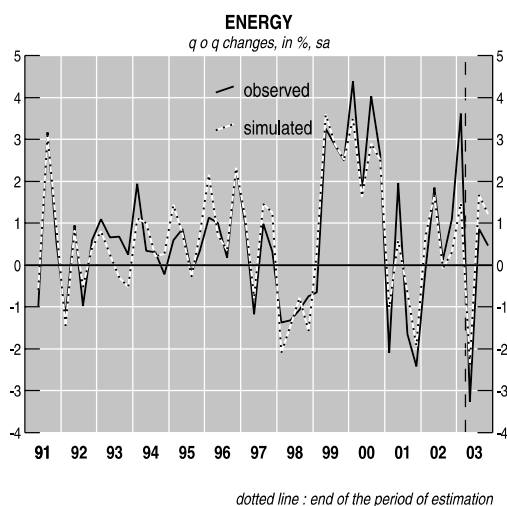
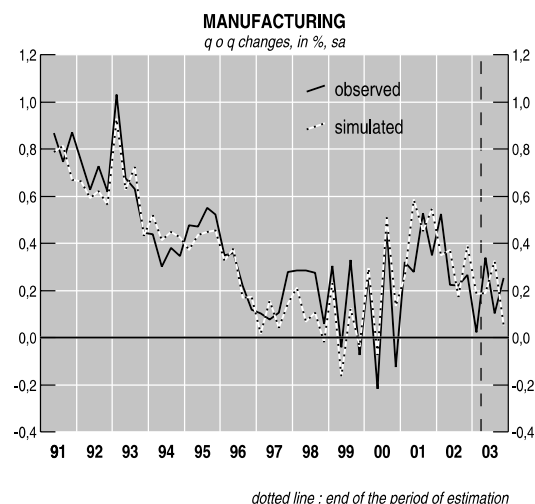
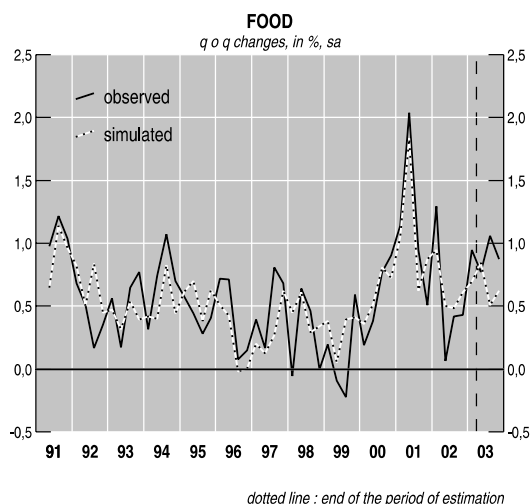
$$\begin{cases} \Delta P = \sum_i \alpha_i \Delta P_i \\ \Delta w = \Delta P - \rho U + C \\ \Delta P_i = a_i \Delta w + b_i \Delta \text{brent} + c_i \Delta Pcm_i + d_i P^*_i + f_i \Delta e \\ \quad + g_i \Delta r + h_i \pi_i + j_i \Delta CUR + k_i U + l_i \Delta U \\ \quad + m_i \Delta \pi_i + C'_i \end{cases}$$

It may in addition be necessary to introduce lags for each of the variables considered in order to take propagation times into account. ■

(1) The form of this expression is more complex than this in practice: weights can vary over time and it is necessary to ensure the chaining of the index in terms of level.

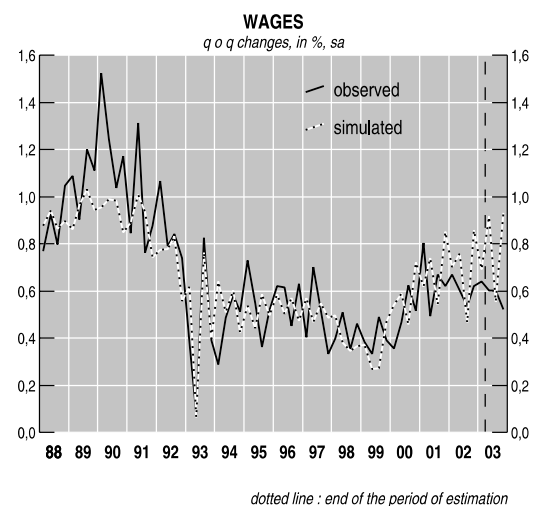
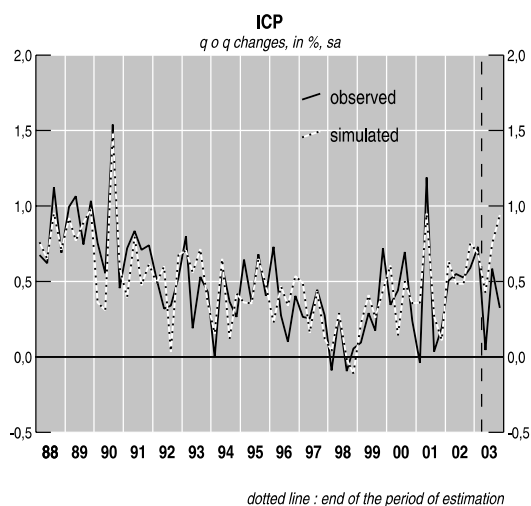
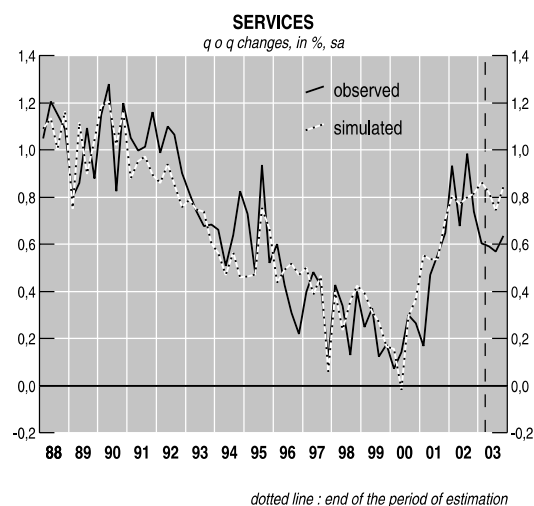
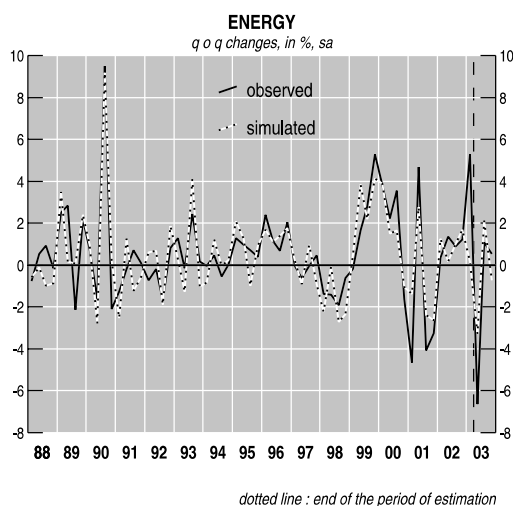
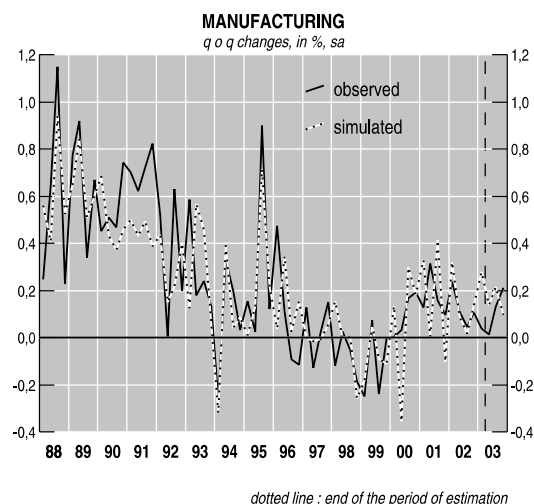
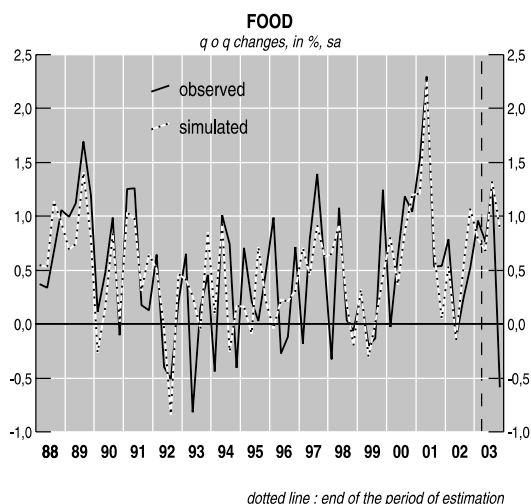
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A - EURO ZONE: OBSERVED VARIATIONS AND VARIATIONS OBTAINED BY DYNAMIC SIMULATION, SEASONALLY-ADJUSTED DATA



1

B - FRANCE: OBSERVED VARIATIONS AND VARIATIONS OBTAINED BY DYNAMIC SIMULATION, SEASONALLY-ADJUSTED DATA



Consumer prices for energy naturally show considerable sensitivity to the oil price

The energy sector is the one in which prices are the most sensitive to the oil price. Excluding wage-price loop effects, a rise of 10% in the oil price leads, as early as the same quarter, to a rise of more than 1% in consumer prices for the sector in both the euro zone and France and to a rise of slightly over 1.5% one year later. Moreover, since oil prices are quoted in dollars, variations in the exchange rate have a marked influence on the evolution of prices of energy products.

On the other hand, there is no sign of a demand effect on energy prices.

Econometrically, in the case of France, wage movements seem to have only a negligible impact on energy prices, which is not true of the euro zone.

Another specific French feature is the pattern of seasonality of energy prices, which shows a rise in Q3, whereas for the euro zone it is in Q1 that there is a seasonal rise in prices.

Prices of services depend mainly on wages

The equations obtained for both France and the euro zone suggest that prices of services track evolutions in wages but with substantial time lags. It should be pointed out that the figures for wages used here are measured net and therefore constitute an approximation of the cost of labour. This raises no major problem, since the two magnitudes move together except in the event of modifications in social security contributions. For example, when these contributions fall, the result is to overestimate the evolution in labour costs when net wages are used, and hence also the evolution in consumer prices. In France, this phenomenon is particularly marked in the case of services, since the proportion of the workforce in that sector paid the

minimum wage or a little above is larger than in the rest of the economy and because cuts in contributions have mainly concerned the lowest-paid workers.

There is also a significant demand effect, seen here in a negative impact of the unemployment rate on prices of services, but with very long response times, longer than 1 year.

Manufactured goods are more exposed to international competition and their prices are subject to a high degree of seasonality and to the periods of sales

The exchange rate, which influences the prices charged by foreign competitors when expressed in euros, is a major determinant of the price of manufactured goods. These goods, being easily tradable, are particularly exposed to international competition. However, for both France and the euro zone, it is only the euro-dollar exchange rate that is significant, although one might have expected the exchange rates of other competitors to intervene as well. Moreover, and somewhat surprisingly, it is only since the end of 1999 that the exchange rate has played a visible role for the euro zone.

The prices of manufactured goods are also influenced by the evolution of prices of imported raw materials, which are used as inputs in the productive process, and by wages, with a repercussion time on prices of manufactured goods spread over one to four quarters. This is because wages have a direct impact on the prices of the goods produced, via the costs of production and distribution, but also an indirect impact through the inputs used.

In the case of the euro zone, the degree of seasonality has been intensified since 2001 through the introduction of regulated timing of sales in Spain and Italy starting in January of that year. Because only a short time has passed since this modification was introduced, it

was not possible to envisage introducing new seasonal parameters for the period since that date. Dummy variables have therefore been introduced for the first two quarters following this modification, with prices lagged by two quarters subsequently correctly taking into account the seasonality resulting from the sales periods.

Wages largely determined by prices

The central element in wage bargaining is the evolution in the purchasing power of wages. This in turn is in the first place determined by the evolution in nominal wages vis-à-vis the expected evolution in prices. In order to form their expectations regarding evolutions in prices, economic agents base themselves partly on the observation of past inflation and partly on other elements, including the inflation target aimed at by the central bank. According to the estimations carried out, it seems that the importance attached in this mechanism to past evolutions in prices is greater for the euro zone as a whole than for France. It was therefore possible with a considerable degree of certainty to apply unitary indexation of wages on past inflation (meaning that a given rise in prices finally leads to an identical rise in wages) for the euro zone (with a time-horizon of one year), but not for France ⁽⁵⁾.

Furthermore, unemployment exerts downward pressure on the variation in wages (the Phillips effect). In other words, the higher the unemployment rate, the smaller the tendency for wages to rise. The unemployment rate enters the picture both in terms of its absolute

(5) Over the long term, one should theoretically find unitary indexation of wages on prices. However, we have here given preference to the modelling of short-term evolutions, for the purpose of current economic analysis, rather than the long-term behaviour. This has obliged us to relax this constraint in the case of France.

value (even though this coefficient is fragile in practice, it has been maintained because of the substantial volume of literature explaining the existence of such a phenomenon) and in terms of its variation. A change in the unemployment rate is entirely passed through into wages (leaving aside the wage-price loop) in less than one year.

In the case of France, the real SMIC (official minimum wage) may also explain part of the variations in wages (*see the special article "Prévoir l'évolution des salaires en France" in the March 2002 "Note de Conjoncture" -French version only-*). It was not, however, selected as an explanatory variable because of its partly endogenous nature. In fact, each year the rise in the SMIC must be at least equal to half the rise in the purchasing power of the basic hourly working wage. When the increase is above this minimum, the difference is referred to as a "coup de pouce" (nudge). In order to palliate the problems of the SMIC's endogeneity, one solution would be to take only this discretionary component of the minimum wage. However, this variable turns out not to be significant.

It can also be seen that from the beginning of 2000 to the beginning of 2002 - corresponding to the period of wage restraint in France following the introduction of the 35-hour week - the evolution of wages in France and in the euro zone has been less dynamic than the simula-

tions indicate. However, the wage restraint in France is not solely responsible for the difference at the level of the euro zone, explaining in practice less than one-quarter. This modelling therefore seems to indicate that the rise in wages was less substantial than it should have been in the whole of the euro zone and not only in France. One explanation of the phenomenon could be a surprise regarding inflation, in other words inflation higher than agents had been expecting and higher than the rate on which the wage increases had been based. Inflation in fact showed a break in 1999 in the downward tendency that had begun in the early part of the 1990s (falling from 4% for the euro zone and 3.5% for France to less than 1%) before moving back up to more than 2% in 2000, mainly under the impact of the higher oil price and the depreciation of the euro (*see below*).

Similar impacts of external shocks on prices in the euro zone and in France

The inflationary impact of a rise in the oil price is principally concentrated on the energy sector

A 10% rise in the oil price has a significant instantaneous effect on consumer prices of energy products, both in France and in the euro zone (*see table 1*). The consequences for prices in other sectors are felt only in delayed fashion and stem mainly from wage growth. The rise in prices of energy prod-

ucts leads to a rise in the overall price index and hence to wage growth, which in turn produces a rise in prices in all sectors. At overall level, one finds within a one-year time-horizon a consumer price rise of 0.10 of a point for the euro zone and 0.14 of a point for France. The reaction of energy prices seems to be more marked in France than in the euro zone, possibly because of a somewhat shorter propagation delay in France. After 5 quarters the results are virtually identical (off the table).

The exchange rate has substantial effects on consumer prices

An appreciation of the euro naturally tends to bring inflation down, via the traditional imported disinflation effect. This effect seems to be slightly more pronounced in France, although acting more slowly, than in the euro zone as a whole, principally because of a more marked reaction on the part of energy prices (*see table 2a*).

Nevertheless, there are two possible reasons for thinking that the impact of the exchange rate on prices is underestimated:

- First, the effects on volumes are not taken into account. For example, an appreciation in the exchange rate also affects prices via induced variations in activity and unemployment (*see section below on "inherent limitations"*) and these are not included in the present model.

TABLE 1: EFFECTS ON INFLATION OF A 10% RISE IN THE OIL PRICE

	Food	Manufactured	Energy	Services	Price	Wages
<i>(in %)</i>						
Euro zone						
1 st quarter	0.00	0.00	1.06	0.00	0.10	0.01
2 nd quarter	0.00	0.00	1.06	0.00	0.10	0.01
3 rd quarter	0.01	0.00	1.06	0.00	0.10	0.02
4 th quarter	0.02	0.00	1.06	0.00	0.10	0.06
France						
1 st quarter	0.00	0.00	1.17	0.00	0.09	0.00
2 nd quarter	0.00	0.05	1.11	0.00	0.10	0.01
3 rd quarter	0.01	0.04	1.48	0.00	0.13	0.03
4 th quarter	0.02	0.04	1.65	0.00	0.14	0.06

TABLE 2A: EFFECTS ON INFLATION OF A 10% RISE IN THE EURO AGAINST THE DOLLAR

	Food	Manufactured	Energy	Services	Price	Wages
<i>(in %)</i>						
Euro zone						
1 st quarter	0.00	0.00	-1.18	0.00	-0.11	-0.02
2 nd quarter	-0.01	-0.09	-1.18	0.00	-0.15	-0.02
3 rd quarter	-0.18	-0.14	-1.18	0.00	-0.19	-0.03
4 th quarter	-0.20	-0.26	-1.18	-0.01	-0.23	-0.09
France						
1 st quarter	0.00	-0.11	-1.30	0.00	-0.13	0.00
2 nd quarter	0.00	-0.07	-0.96	0.00	-0.10	-0.02
3 rd quarter	-0.01	-0.09	-1.05	0.00	-0.11	-0.04
4 th quarter	-0.32	-0.26	-1.89	0.00	-0.28	-0.07

TABLE 3: EFFECTS OF A 10% RISE IN UNEMPLOYMENT

	Food	Manufactured	Energy	Services	Price	Wages
<i>(in %)</i>						
Euro zone						
1 st quarter	0.00	0.00	0.00	0.00	0.00	0.00
2 nd quarter	-0.11	0.00	0.00	0.00	-0.03	-0.38
3 rd quarter	-0.11	0.00	0.00	-0.03	-0.04	-0.39
4 th quarter	-0.16	-0.02	-0.07	-0.06	-0.07	-0.53
France						
1 st quarter	0.00	0.00	0.00	0.00	0.00	-0.03
2 nd quarter	-0.02	-0.01	0.00	0.00	-0.01	-0.06
3 rd quarter	-0.04	-0.01	0.00	0.00	-0.01	-0.11
4 th quarter	-0.07	-0.03	0.00	0.00	-0.02	-0.15

- Second, in the case of the euro zone exchange rates are only partially taken into account, with only the rate versus the dollar entering the equation.

A rise in the unemployment rate has a lagged disinflationary effect

A rise in the unemployment rate has noticeable effects on wages and on prices of foodstuffs. Naturally, one finds a more pronounced downward impact on wages than on consumer prices, since a rise in unemployment, by reducing workers' bargaining power, does indeed lead to a reduction in real wages (*see table 3*).

The time taken for this shock to be propagated is very substantial: at the end of one year, the impact on inflation in the euro zone is less than 0.1 of a point and half this in France.

It is found that wages in the euro zone are much more sensitive to such an external unemployment shock than wages in France. This divergence stems partly from a difference in the time-pattern of response to the shock, being much faster in the euro zone: looking beyond two years (off the table), it appears that the impact on French wages comes close to that for wages in the euro zone.

A rise in the productive capacity utilisation rate (CUR) has a substantial and relatively rapid impact in the case of the euro zone

Starting in the same quarter as the occurrence of the shock itself, a rise of 10 points in the CUR increases inflation in the euro zone by almost half a point (*see table 4*). This takes effect almost exclusively through a rise in prices of energy products. Thereafter, the propagation mechanism operating through wages becomes engaged

and the impact of the rise in the CUR on prices of foodstuffs, which is substantial but lagged by two quarters, also comes into play. The end-result is a rise in consumer prices of almost 1% after one year.

In the case of France, the CUR was found not to be a relevant variable in explaining prices.

In France, a rise in VAT is rapidly passed on to the manufacturing and services sectors, but only partially in the short term

A rise in VAT leads to an immediate adjustment in prices in the manufacturing, food and services sectors and a more delayed adjustment in energy (*see table 5*). These estimates have to be treated with caution, notably for foodstuffs. The sensitivity of prices to the rate of VAT is in fact difficult to estimate, because there has been so little variation in the rate during the period examined. According to these

TABLE 4: EFFECTS ON A 10-POINT RISE IN THE CUR

	Food	Manufactured	Energy	Services	Price	Wages
Euro zone						
1 st quarter	0.02	0.00	4.30	0.00	0.41	0.06
2 nd quarter	0.02	0.00	4.27	0.00	0.40	0.06
3 rd quarter	1.58	0.00	4.27	0.01	0.75	0.13
4 th quarter	1.64	0.58	4.31	0.02	0.96	0.33

TABLE 5: EFFECTS ON A 1-POINT RISE IN THE VAT RATE

	Food	Manufactured	Energy	Services	Price	Wages
France						
1 st quarter	0.30	0.40	0.00	0.83	0.52	0.00
2 nd quarter	0.23	0.27	0.31	0.83	0.49	0.08
3 rd quarter	0.31	0.33	0.23	1.00	0.59	0.16
4 th quarter	0.35	0.33	0.25	1.00	0.60	0.30

TABLE 2B: EFFECTS OF A 10% RISE IN THE EURO AGAINST THE DOLLAR, MZE-CORRECTED

	Food	Manufactured	Energy	Services	Price	Wages
Euro zone						
1 st quarter	0.00	0.00	-1.21	0.00	-0.12	-0.02
2 nd quarter	-0.01	-0.09	-1.26	0.00	-0.15	-0.02
3 rd quarter	-0.20	-0.14	-1.32	0.00	-0.20	-0.04
4 th quarter	-0.24	-0.26	-1.34	-0.01	-0.26	-0.11

estimates, the repercussion is complete after a time-horizon of one year in services but still only partial in the other sectors.

The inherent limitations in the approach adopted

The principal shortcoming of the approach adopted is that it takes as endogenous ⁽⁶⁾ only nominal variables (prices and wages) and not real magnitudes. This can have effects on the quality of the analytical variants presented earlier. In particular, in the modelling adopted here, a variation in the exchange rate or the oil price, regardless of its amplitude, will have no effect on the unemployment rate or the capacity utilisation rate.

The fact that the real magnitudes are treated as totally exogenous can lead to underestimating the variant-based impacts, for example in the case of the exchange rate. An appreciation in the euro (whether versus the dollar or in terms of the

effective exchange rate) leads to a loss of competitiveness and hence to a decline in activity, which in turn induces a rise in unemployment and a fall in the productive capacity utilisation rate. These then in turn produce a decline in inflation.

From the standpoint of short-term forecasting, however, this is a minor inconvenience. For example, in a variant involving a 10% appreciation in the exchange rate of the euro and incorporating the modifications in the CUR and the unemployment rate that this implies in the framework of the MZE model for the euro zone (*see table 2b*), the only modification in the results is a slight strengthening of the impact of prices and wages.

A fresh look at the recent past

Even though the models presented here are not structural but rather designed to describe the dynamic

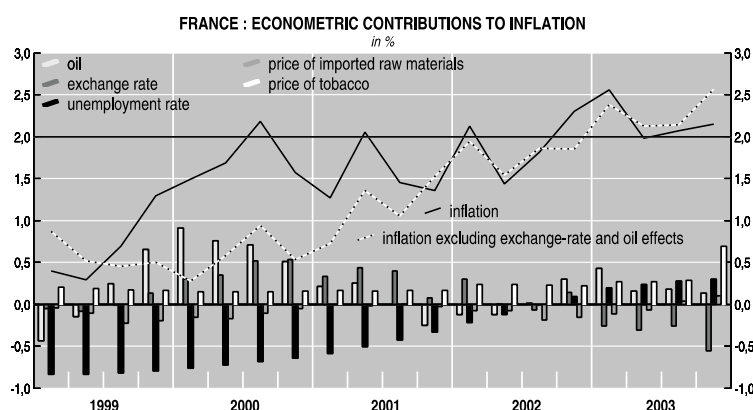
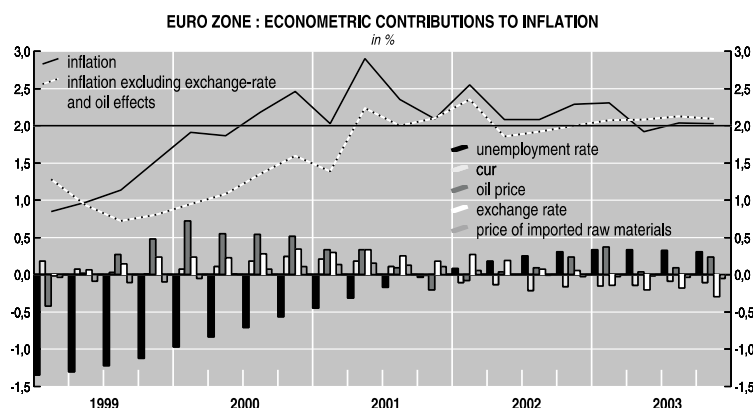
of prices for short term forecasting purposes, they provide elements for past developments of inflation.

The spurt in inflation in the euro zone and in France in 1999 and 2000 seems to have been in large part due to the combined effects of evolutions in the oil price and the exchange rate

From 1999 on, evolutions in the exchange rate (depreciation of the euro, generating imported inflation) and in the oil price contributed substantially to the increase in inflation in the euro zone and in France (*see graphs 2*). The price per barrel of crude oil in fact rose from less than \$13 in 1998 to over \$28 in 2000 and then remained

(6) A variable whose evolution is modelled, by opposition to an exogenous variable whose evolution is taken as given.

2



above \$24 on an annual average basis. At the same time, the euro depreciated by 24% versus the dollar between the end of 1998 and the end of 2001, recovering only in H2 2002. These evolutions therefore entirely explain the rise in inflation between Q1 1999, when it was only 0.8% in the euro zone and 0.4% in France, and Q1 2000, when it reached 1.9% in the euro zone and 1.5% in France. Thereafter, their contributions to inflation remained substantial until the mid-

dle of 2001. All in all, had there not been the combined effects of the evolutions in the exchange rate and the oil price, inflation in the euro zone would have settled down above the 2% level only at the middle of 2001 instead of the middle of 2000, while inflation in France would have exceeded this threshold only at the beginning of 2003.

Conversely, following the upward movement in the euro seen since the middle of 2002, the exchange

rate contributed to the easing of inflation in 2003. This would have brought inflation, in France and in the euro zone, below the 2% level had there not been the upturn in the oil price in 2002 and the early part of 2003, with the Brent price rising from less than \$22 in Q4 2001 to over \$29 in Q1 2003.

Between 2000 and 2002, in France and in the euro zone, the decrease in unemployment seen between 1997 and 2001 made a major contribution - roughly one point - to the rise in inflation. Again one encounters, the lagged effect of the economic cycle on the evolution of prices.

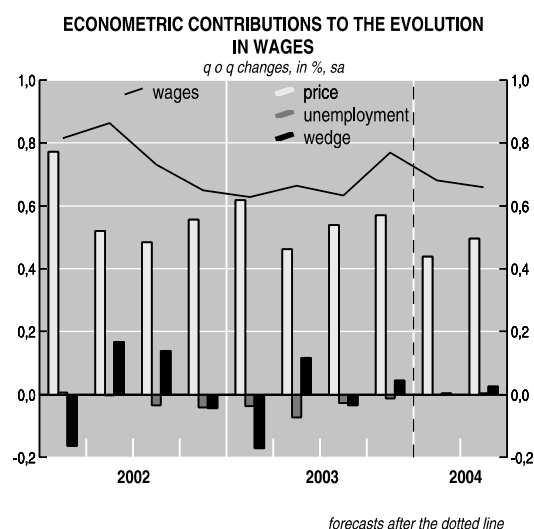
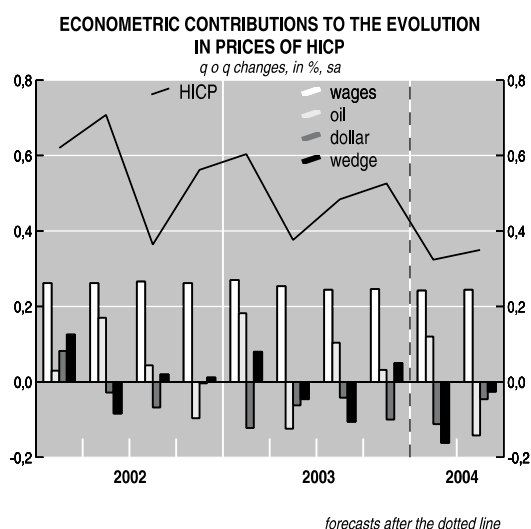
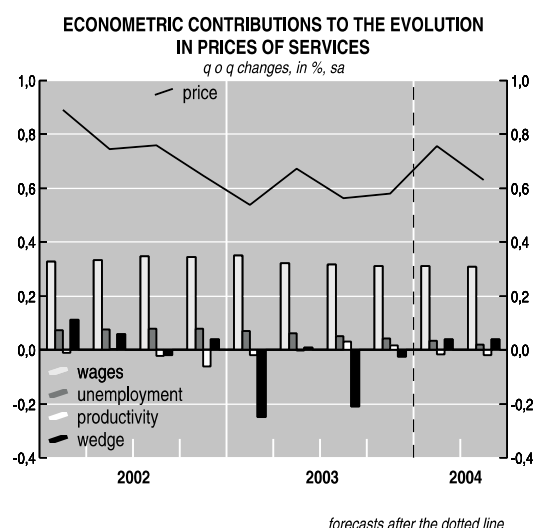
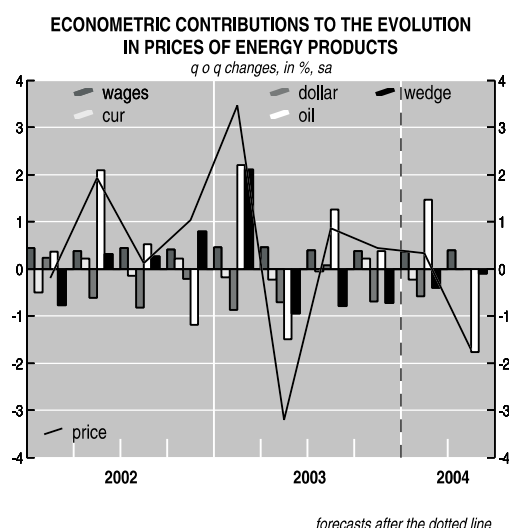
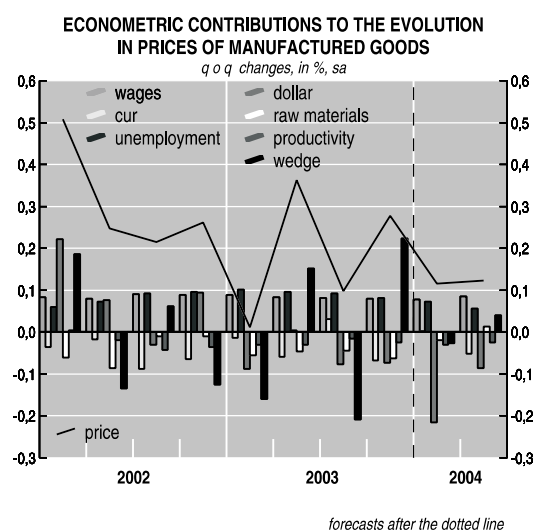
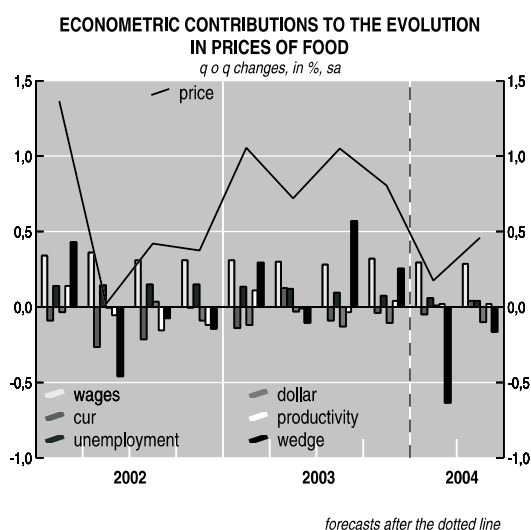
In 2003, inflation was resilient in France because of rises of tobacco prices.

A more profound reading of the inflation forecast made in the Note

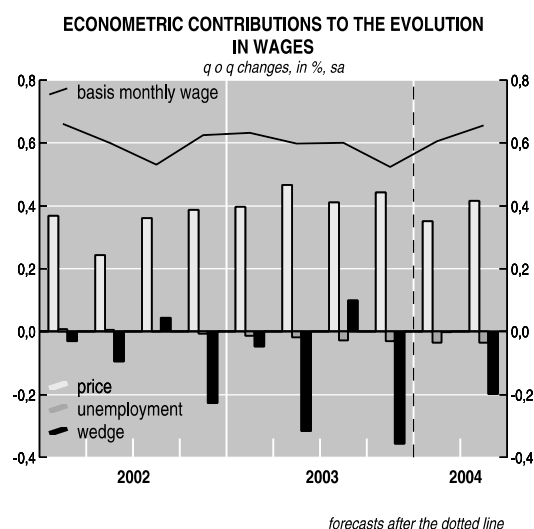
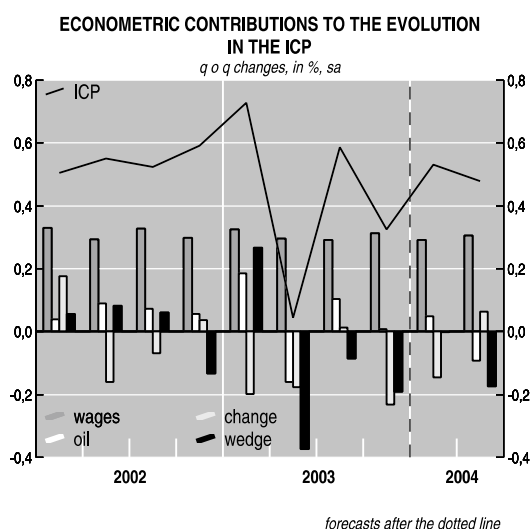
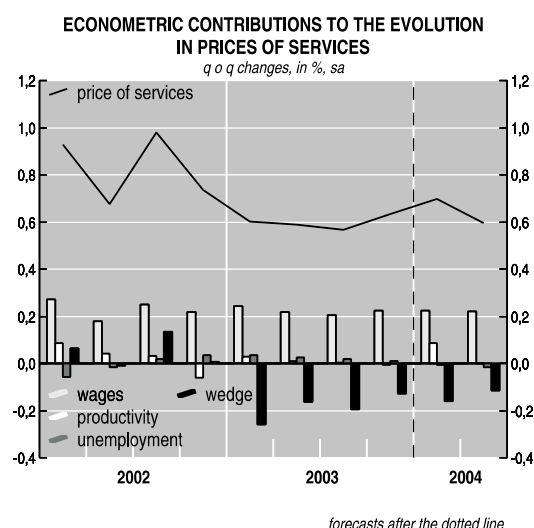
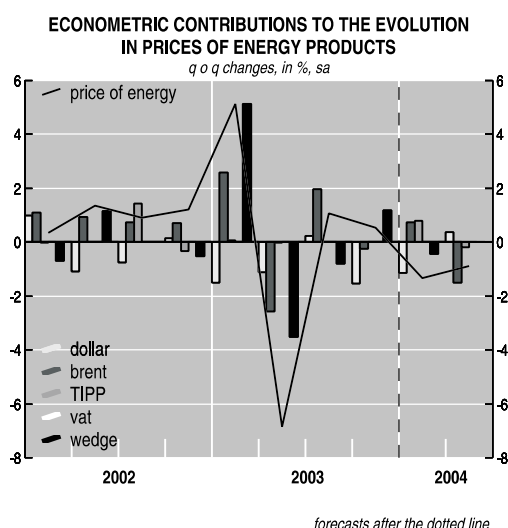
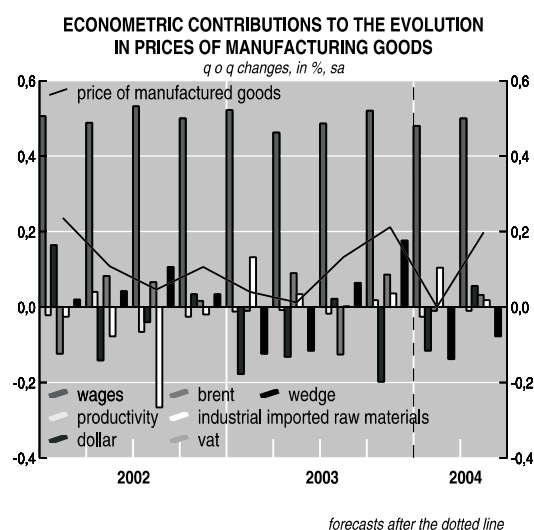
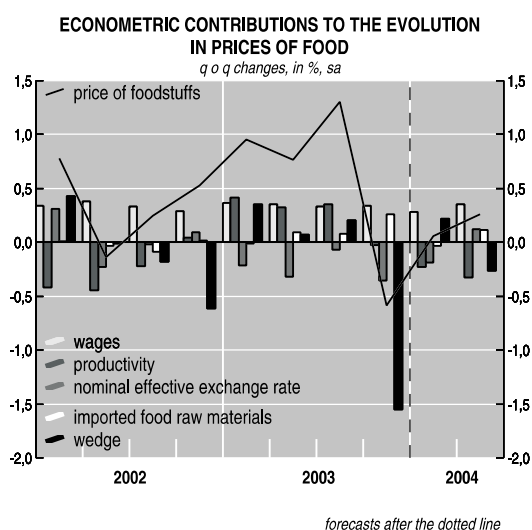
The model presented above permits a fresh macroeconomic reading of the forecast set out in the section in the Note entitled "Consumer prices in the euro zone", by determining the contributions of the various economic variables to inflation in individual sectors (*see graphs 3*).

In France and in the euro zone, the substantial past appreciation of the euro can be expected to still exert downward pressure on prices in H1 2004. This phenomenon is likely to be particularly marked in Q1 in the case of consumer prices of energy products. At the same time, the decline in the oil price in Q2 can be expected to make a major negative contribution to the evolution in energy prices in that quarter after a strong positive on in Q1. ■

A - EURO ZONE: FORECAST OF INFLATION RATES AND CONTRIBUTIONS



B - FRANCE: FORECAST OF INFLATION RATES AND CONTRIBUTIONS



BOX 3: REGRESSION BETWEEN SERIES WITH DIFFERENT SEASONAL PATTERNS

Certain series considered here are of a seasonal nature (a priori different in each case) and others not. In order to take this fact into account, dummy quarterly indicators have been introduced into all the equations.

This means that for a series Y_t , assuming that its seasonal character is constant over time, its seasonally-adjusted equivalent is:

$$\left\{ \begin{array}{l} \tilde{Y}_t = \left(\sum_{i=1}^4 \alpha_i \cdot trim_i \right) Y_t \\ \sum_{i=1}^4 \alpha_i = 4 \end{array} \right.$$

where $trim_i$ takes the value 1 for quarter i , otherwise 0. If the series shows no seasonal pattern, all the coefficients will be equal to 1.

With logarithmic magnitudes denoted in lower case, if one postulates the existence of a relationship of the type:

$$\Delta \tilde{y}_t = \lambda \Delta \tilde{x}_t + C$$

the latter can be rewritten using the unadjusted series ⁽¹⁾:

$$\Delta y_t + \sum_{i=1}^4 \ln(\alpha_i) \cdot trim_i(t) - \sum_{i=1}^4 \ln(\alpha_i) \cdot trim_{i+1}(t) = \lambda \Delta x_t + \lambda \sum_{i=1}^4 \ln(\beta_i) \cdot trim_i(t) - \lambda \sum_{i=1}^4 \ln(\beta_i) \cdot trim_{i+1}(t) + C$$

Or, regrouping the terms according to the dummy quarterly variables:

$$\Delta y_t = \lambda \Delta x_t + \sum_{i=1}^4 \gamma_i \cdot trim_i(t) + C$$

$$\text{or } \sum_{i=1}^4 trim_i(t) = 1$$

$$\Delta y_t = \lambda \Delta x_t + \sum_{i=1}^3 (\gamma_i - \gamma_4) \cdot trim_i(t) + C + \gamma_4 = \lambda \Delta x_t + \sum_{i=1}^3 \gamma_i' \cdot trim_i(t) + C'$$

it is therefore necessary, as a result of working on the unadjusted data, to introduce into the equations dummy variables for three quarters. ■

(1) N.B.: only one of the variables $trim_i$ is non-null in each quarter, so that at each date:

$$\ln \left(\sum \alpha_i trim_i \right) = \ln(\alpha_j trim_j) = \ln(\alpha_j) trim_j = \sum \ln(\alpha_i) trim_i$$

BOX 4: ESTIMATION STRATEGY AND RESULTS

The general method adopted to estimate the system of equations is the one known as FIML (Full Information Maximum Likelihood). This method has two main disadvantages, however:

- the optimisation algorithm can lead to a local maximum; the initialisation of the coefficients therefore takes on a certain importance;
- as all the equations are estimated simultaneously, a wrong specification of one of the equations leads to a wrong estimation of the coefficients in all the equations and not merely the one that is badly specified. In order to initialise the coefficients in a relevant manner and to verify the specification of each equation, an estimation was carried out, equation by equation, using the ordinary least squares method, allowing up to six lags for the exogenous variables and for the endogenous variable in question and then eliminating the lags having a Student's T value of less than 1. In a second stage, the modelling was refined through recourse to the FIML estimation, initialising the coefficients by those obtained by the least squares method for each equation.

Working on the unadjusted data, quarterly dummy variables were introduced into all the equations (*see box 3*).

All the estimations were carried out under TROLL.

The Student's T values are shown under the respective coefficients. JB shows the threshold of acceptance of the hypothesis of normality of the residual according to the Jarque-Bera test (a low value will therefore mean rejection of this hypothesis).

Notations

In the equations shown below, all the variables are expressed as logarithms.

trim1, trim2 and trim3 are quarterly dummy variables, i.e. trim1 takes the value 1 for the first quarter of each year.

I_{xxqy} : designates the dummy variable taking the value 1 in quarter y of year xx.

I_{xxqy-} : designates the dummy variable taking the value 1 starting in quarter y of year xx.

Palim: consumer prices of foodstuffs

Pmanuf: consumer prices of manufactures

Penergy: consumer prices of energy products

Pserv: consumer prices of services

Ptotal: consumer price index (HICP)

smb: basic monthly wage

u: unemployment rate

e: euro-dollar exchange rate (convention: 1€ = e \$)

eff: nominal effective exchange rate of the euro for France

brent: Brent price in dollars per barrel

matpal: price in foreign currency of imported agricultural raw materials

matpin: price in foreign currency of imported industrial raw materials

matind: price in euros of imported industrial raw materials

CUR: productive capacity utilisation rate in industry

tvanrj: VAT rate for energy

tvaal: VAT rate for foodstuffs

tvama: VAT rate in the manufacturing sector

tvase: VAT rate in services

tipp: domestic tax on petroleum products

π_{ind} : productivity in industry, defined as the ratio between value added in volume and total employment

π_{serv} : productivity in services, defined as the ratio between value added in volume and total employment

π_{agri} : productivity in agriculture, defined as the ratio between value added in volume and total employment

BOX 4: ESTIMATION STRATEGY AND RESULTS

The euro zone

Estimation period: 1991q2-2003q2

The explanatory variables are significant at the 5% threshold, with the exception of productivity in the equation for the price of services and the unemployment rate in absolute level in the equation for wages in the euro zone, which are significant only at the 10% threshold, and productivity in the equation for prices of manufactures, which is significant only at the 15% threshold. These variables have nevertheless been retained in view of the strong theoretical backing for their presence.

• Consumer prices of foodstuffs

$$\begin{aligned} \Delta Palim = & \frac{0,294}{3,58} [\Delta smb + 0,5 \cdot \Delta smb(-2)] - \frac{0,012}{3,08} u(-5) + \frac{0,134}{3,75} [\Delta Tuc(-2) + 0,5 \cdot \Delta Tuc(-4)] - \frac{0,018}{2,42} \Delta e(-2) \\ & - \frac{0,079}{2,70} \Delta \pi_{agri}(-4) + \frac{0,009}{3,55} I_{01q2} + \frac{0,009}{7,36} trim1 + \frac{0,003}{2,22} trim2 - \frac{0,002}{1,39} trim3 + \frac{0,029}{3,01} \\ R^2 = & 82\% \quad SER = 0,32\% \quad DW = 1,94 \quad JB = 21\% \end{aligned}$$

• Consumer prices of manufactures

$$\begin{aligned} \Delta Pmanuf = & \frac{0,064}{1,32} \Delta Pmanuf(-1) - \frac{0,240}{3,05} I_{99q3-} \cdot \Delta Pmanuf(-1) + \frac{0,655}{9,11} \Delta Pmanuf(-2) + \frac{0,061}{2,50} \Delta smb(-2) \\ & + \frac{0,051}{3,43} \Delta tuc(-3) - \frac{0,006}{4,20} u(-5) - \frac{0,010}{4,09} I_{99q3-} \cdot [\Delta e(-1) + 2 \cdot \Delta e(-6)] - \frac{0,016}{1,47} \Delta \pi_{ind} \\ & + \frac{0,007}{3,61} [matind(-2) + matind(-3)] + \frac{0,004}{4,07} I_{93q1} - \frac{0,007}{7,89} I_{01q1} + \frac{0,006}{5,54} I_{01q2} - \frac{0,000}{0,27} trim1 \\ & - \frac{0,000}{0,44} trim2 - \frac{0,004}{6,71} trim3 + \frac{0,014}{4,40} \\ R^2 = & 97\% \quad SER = 0,12\% \quad DW = 1,87 \quad JB = 93\% \end{aligned}$$

• Consumer prices of energy products

$$\begin{aligned} \Delta Penergy = & \frac{0,194}{3,32} [\Delta smb(-2) + 2 \cdot \Delta smb(-4)] + \frac{0,370}{3,78} \Delta Tuc - \frac{0,124}{6,18} \Delta e + \frac{0,110}{15,53} \Delta brent + \frac{0,042}{7,54} \Delta brent(-4) \\ & + \frac{0,010}{3,46} trim1 - \frac{0,005}{1,89} trim2 + \frac{0,003}{0,88} trim3 - \frac{0,001}{0,47} \\ R^2 = & 86\% \quad SER = 0,74\% \quad DW = 2,14 \quad JB = 19\% \end{aligned}$$

• Consumer prices of services

$$\begin{aligned} \Delta Pserv = & \frac{0,083}{6,14} [\Delta smb(-1) + \Delta smb(-2) + 15 \cdot \Delta smb(-3) + \Delta smb(-4) + \Delta smb(-6)] - \frac{0,007}{4,38} u(-5) \\ & - \frac{0,091}{1,67} \pi_{serv}(-2) - \frac{0,003}{7,80} I_{96-} + \frac{0,010}{22,11} trim1 + \frac{0,008}{16,70} trim2 + \frac{0,012}{24,45} trim3 + \frac{0,014}{3,46} \\ R^2 = & 96\% \quad SER = 0,11\% \quad DW = 1,60 \quad JB = 27\% \end{aligned}$$

• Monthly basic wage

$$\begin{aligned} \Delta smb = & (1 - 5 \cdot 0,145) \Delta smb(-1) + \frac{0,145}{12,76} [\Delta Ptotal + 3 \cdot \Delta Ptotal(-3) + \Delta Ptotal(-4)] - \frac{0,003}{1,72} u(-3) \\ & - \frac{0,042}{4,17} \Delta u(-1) + \frac{0,002}{1,75} trim1 + \frac{0,005}{5,86} trim2 + \frac{0,006}{5,47} trim3 + \frac{0,004}{1,15} \\ & + I_{95-} \cdot \left[\frac{0,001}{0,68} trim1 + \frac{0,011}{9,80} trim2 - \frac{0,015}{9,68} trim3 + \frac{0,001}{0,60} \right] \\ R^2 = & 97\% \quad SER = 0,17\% \quad DW = 2,01 \quad JB = 77\% \end{aligned}$$

Unitary indexation of wages on prices was imposed. This restriction is accepted by the data.

BOX 4: ESTIMATION STRATEGY AND RESULTS

The France

Estimation period: 1986q4-2003q2

• Consumer prices of foodstuffs

$$\begin{aligned} \Delta Palim = & -0,236 \cdot \Delta Palim(-1) + 0,733 \cdot \Delta smb(-1) - 0,117 \cdot \Delta \pi_{agri} - 0,124 \cdot \Delta \pi_{agri}(-2) - 0,150 \cdot \Delta eff(-3) \\ & \quad \quad \quad 2,69 \quad \quad \quad 3,53 \quad \quad \quad 3,82 \quad \quad \quad 3,79 \quad \quad \quad 5,57 \\ & + 0,028 \cdot \Delta matpal(-5) + 0,328 \cdot \Delta \ln(1 + tvaal) + 0,015 \cdot I_{01q2} - 0,002 \cdot trim1 - 0,005 \cdot trim2 \\ & \quad \quad \quad 3,48 \quad \quad \quad 1,04 \quad \quad \quad 3,79 \quad \quad \quad 0,78 \quad \quad \quad 1,74 \\ & + 0,002 \cdot trim3 + I_{91-} \cdot \left(\begin{array}{cccc} 0,011 \cdot trim1 & 0,010 \cdot trim2 & -0,010 \cdot trim3 & -0,003 \end{array} \right) + 0,006 \\ & \quad \quad \quad 0,64 \quad \quad \quad 3,46 \quad \quad \quad 2,75 \quad \quad \quad 2,86 \quad \quad \quad 1,39 \quad \quad \quad 2,46 \end{aligned}$$

$$R^2 = 77\% \quad DW = 2,15 \quad JB = 89\% \quad SER = 0,46\%$$

• Consumer prices of manufactures

$$\begin{aligned} \Delta Pmanuf = & -0,309 \cdot \Delta Pmanuf(-1) + 0,228 \cdot \Delta smb(-1) + 0,433 \cdot \Delta smb(-3) + 0,407 \cdot \Delta smb(-4) \\ & \quad \quad \quad 4,05 \quad \quad \quad 2,19 \quad \quad \quad 4,72 \quad \quad \quad 4,44 \\ & - 0,037 \cdot \Delta \pi_{ind}(-2) - 0,011 \cdot \Delta e - 0,018 \cdot \Delta e(-3) + 0,005 \cdot \Delta brent(-1) + 0,025 \cdot \Delta matpin(-4) \\ & \quad \quad \quad 1,92 \quad \quad \quad 2,57 \quad \quad \quad 3,92 \quad \quad \quad 3,68 \quad \quad \quad 4,98 \\ & + 0,467 \cdot \Delta \ln(1 + tvama) + 0,003 \cdot trim1 + 0,004 \cdot trim2 + 0,003 \cdot trim3 \\ & \quad \quad \quad 4,81 \quad \quad \quad 3,42 \quad \quad \quad 4,32 \quad \quad \quad 3,30 \\ & - I_{95-} \cdot \left(\begin{array}{cccc} 0,001 \cdot trim1 & 0,003 \cdot trim2 & 0,001 \cdot trim3 & 0,001 \end{array} \right) - 0,004 \\ & \quad \quad \quad 1,04 \quad \quad \quad 3,55 \quad \quad \quad 0,65 \quad \quad \quad 1,41 \quad \quad \quad 3,83 \end{aligned}$$

$$R^2 = 78\% \quad DW = 1,98 \quad JB = 86\% \quad SER = 0,20\%$$

• Consumer prices of energy products

$$\begin{aligned} \Delta Penergy = & -0,260 \cdot \Delta Penergy(-1) - 0,139 \cdot \Delta e - 0,092 \cdot \Delta e(-3) + 0,122 \cdot \Delta brent + 0,026 \cdot \Delta brent(-1) \\ & \quad \quad \quad 2,62 \quad \quad \quad 3,46 \quad \quad \quad 2,44 \quad \quad \quad 8,64 \quad \quad \quad 1,41 \\ & + 0,036 \cdot \Delta brent(-2) + 0,027 \cdot \Delta brent(-3) + 0,384 \cdot \Delta tipp + 0,374 \cdot \Delta(1 + tvanrj) + 0,045 \cdot I_{90q3} \\ & \quad \quad \quad 2,65 \quad \quad \quad 1,91 \quad \quad \quad 3,62 \quad \quad \quad 1,63 \quad \quad \quad 2,84 \\ & - 0,006 \cdot trim1 - 0,005 \cdot trim2 + 0,006 \cdot trim3 + 0,002 \\ & \quad \quad \quad 1,01 \quad \quad \quad 1,02 \quad \quad \quad 1,12 \quad \quad \quad 0,51 \end{aligned}$$

$$R^2 = 72\% \quad DW = 2,28 \quad JB = 76\% \quad SER = 1,50\%$$

• Consumer prices of services

$$\begin{aligned} \Delta Pserv = & 0,215 \cdot \Delta Pserv(-2) + 0,285 \cdot \Delta smb(-4) - 0,081 \cdot \Delta \pi_{serv}(-3) - 0,009 \cdot u(-6) + 0,898 \cdot \Delta \ln(1 + tvase) \\ & \quad \quad \quad 3,25 \quad \quad \quad 3,75 \quad \quad \quad 2,05 \quad \quad \quad 4,40 \quad \quad \quad 4,51 \\ & + 0,009 \cdot I_{87q1} - 0,004 \cdot I_{97q4} - 0,002 \cdot I_{00q1} + 0,004 \cdot trim1 + 0,004 \cdot trim2 + 0,000 \cdot trim3 \\ & \quad \quad \quad 6,11 \quad \quad \quad 3,07 \quad \quad \quad 1,97 \quad \quad \quad 4,09 \quad \quad \quad 4,05 \quad \quad \quad 0,30 \\ & + I_{91-} \cdot \left(\begin{array}{cccc} -0,001 \cdot trim1 & -0,001 \cdot trim2 & 0,002 \cdot trim3 & -0,003 \end{array} \right) + 0,024 \\ & \quad \quad \quad 1,23 \quad \quad \quad 1,11 \quad \quad \quad 1,71 \quad \quad \quad 3,66 \quad \quad \quad 4,55 \end{aligned}$$

$$R^2 = 90\% \quad DW = 1,75 \quad JB = 89\% \quad SER = 0,16\%$$

• Monthly basic wage

$$\begin{aligned} \Delta smb = & 0,377 \cdot \Delta smb(-2) + 0,151 \cdot \Delta Ptotal(-1) + 0,174 \cdot \Delta Ptotal(-2) + 0,187 \cdot \Delta Ptotal(-3) - 0,003 \cdot u \\ & \quad \quad \quad 5,20 \quad \quad \quad 3,12 \quad \quad \quad 3,72 \quad \quad \quad 4,39 \quad \quad \quad 1,82 \\ & - 0,006 \cdot I_{93q2} + 0,004 \cdot trim1 + 0,003 \cdot trim2 + 0,000 \cdot trim3 + 0,007 \\ & \quad \quad \quad 3,79 \quad \quad \quad 7,89 \quad \quad \quad 4,76 \quad \quad \quad 0,41 \quad \quad \quad 1,62 \end{aligned}$$

$$R^2 = 75\% \quad DW = 2,02 \quad JB = 80\% \quad SER = 0,17\%$$