The oil price : are we to expect an inflationary spiral ?

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The past rise in the oil price, consisting of a doubling between April 2003 and October 2004, has automatically pushed consumer prices upwards, notably via the prices of energy products. Is there a risk that this rise in prices will lead to runaway inflation of the kind seen at the time of the second oil shock, when the price per barrel trebled ? Or, on the contrary, is the present economic context of a kind that will avert the engagement of a spiral of continuous price increases?

In the past, upward shocks on inflation have not systematically produced a self-sustaining surge in prices. In the United States, there have on some occasions been an acceleration in inflation rates and sometimes more measured rises following an inflationary shock. In France, until 1983, a price shock always produced an upward spiral in inflation which then became self-sustaining. Since then, however, there has been no sign of this phenomenon.

The study presented here, based on a modelling of American and French inflationary regimes, attempts to detect cases of the past engagement of inflationary spirals of this kind and also to evaluate the risk of their occurrence. It emerges from the study that, despite the past rise in the price of Brent, it is most unlikely that this will trigger off a major slippage in prices in either France or the United States.

Evolutions in inflation : a return to a credible target or a self-sustaining phenomenon?

In the past, very different price evolution scenarios have been seen in the western economies following shocks leading to abrupt rises in inflation. On some occasions, the shocks were limited to no more than «blips», with inflation rapidly returning to a more moderate level. In particular, this was what occurred between December 1998 and September 2000, when the oil price rose from $9.9 to $33.0 per barrel, with inflation automatically gathering speed. Even so, there was no tendency for the price rise to snowball and inflation in France never exceeded 2.2% in the two following years.

In contrast, certain shocks were followed by definite surges in prices. This was the case, for example, at the end of the 1970s, following the two oil shocks and especially the second of these occurring in 1979, when inflation in France rose by more than 3% per quarter in 1980 *(see graph 2)*. The sequences of events leading to this self-sustaining acceleration in prices transited through wages: more rapid inflation led to a more rapid rise in nominal wages which in turn led to more inflation.

This shows that, depending on circumstances, evolutions in prices have turned out to be highly diverse, despite being the consequence of identical shocks.

In order to understand the determining factors leading to the engagement of one sequence of events rather than another, we have resorted to a modelling in which inflation can correspond to two alternative regimes : a credible-target regime and a self-sustaining regime.

In the first case, economic agents take the view that, while it may take some time - following a surge in prices, for example - inflation will return to a certain level. This is particularly the case if the central bank has an inflation target and if this target is credible. In this case, agents expect inflation to return to this target level.

In the second case, the more inflation they have seen in the past, the more inflation they expect (the adaptive expectations mechanism). This type of situation is favourable to a snowballing of inflation, via the wage-price loop. What happens in this case is that, the more agents see prices rise, the

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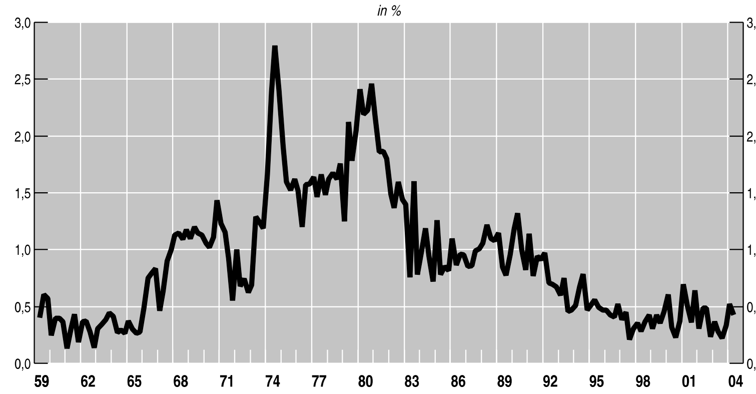
QUATERLY EVOLUTION IN THE HOUSEHOLD CONSUMPTION DEFLATOR, EX FOOD AND ENERGY

UNITED STATES

in %



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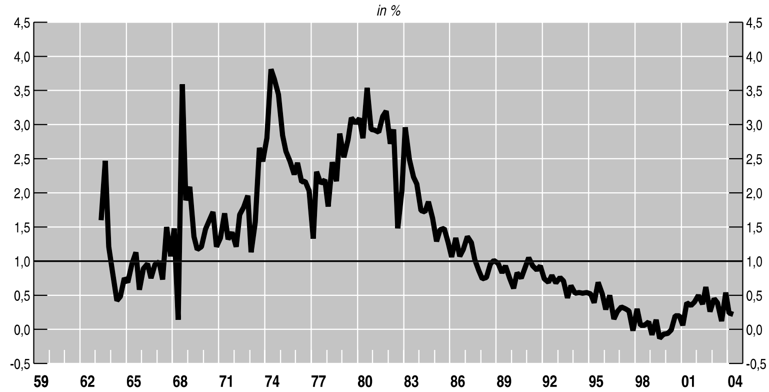
QUATERLY EVOLUTION IN THE HOUSEHOLD CONSUMPTION DEFLATOR, EX FOOD AND ENERGY

FRANCE

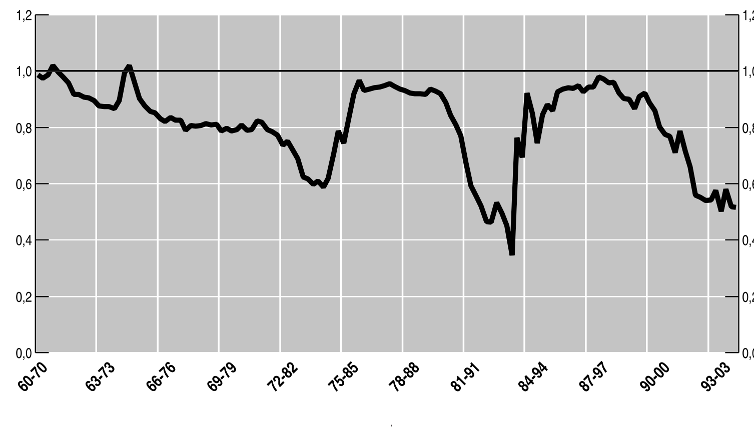
in %



3

ESTIMATION OF INFLATION BY ITS LAGS (AR4) : SUM OF THE AUTO-REGRESSIVE TERMS BY ESTIMATION PERIOD

UNITED STATES



How to read the graph : the timescale indicates the estimation period, which extends over 10 years.

more they increase their expectations of inflation, with the result that wage-earners demand larger rises in order to safeguard their purchasing power. Faced with this rise in labour costs, employers then increase their prices in order to preserve their margins, leading to additional inflation. This therefore leads in turn to a further rise in expectations of inflation and the mechanism previously described is again engaged, dragging inflation into an upward spiral. Contemporaneous inflation then adjusts to past inflation by a factor of unity, whereas in the previous case the adjustment was only partial.

It should be noted that this modelling takes the option of not introducing the unemployment level into wage formation in the form of a Phillips effect and not to take into consideration a possible impact on the formation of expectations of inflation. The resulting interpretation, notably in the case of France, might be slightly modified if greater allowance were made for the role played by unemployment in the formation of agents' expectations.

In the framework of this modelling based on two inflation regimes, we have tried to see whether the transition from one regime to the other might be encouraged by fluctuations in the oil price. We have applied this model to the American and French cases. The modelling and the estimation method used are set out in the box.

In reality, the idea that we have explored here is that inflation in a given country does not definitely correspond to one or other regime but alternatively one or the other.

A first descriptive method consists of seeing whether it is possible to explain inflation in terms of its past evolutions. To be more precise, this preliminary analysis is based on a modelling making it possible to explain evolutions in prices by evolutions in the previous four quarters (four-order auto-regressive modelling). These

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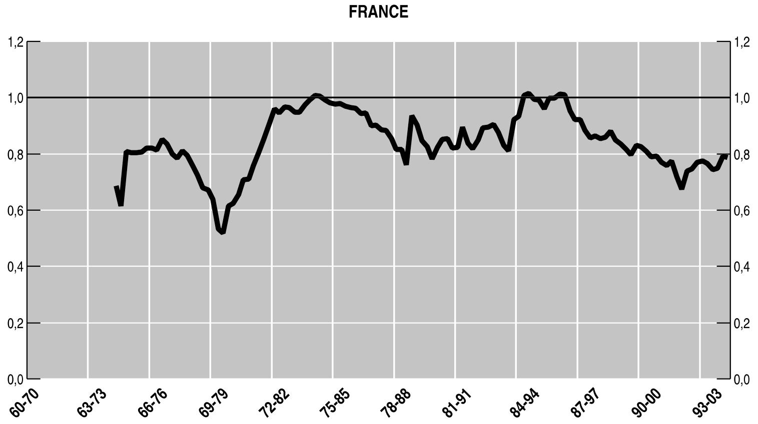
ESTIMATION OF INFLATION BY ITS LAGS (AR4) : SUM OF THE AUTO-REGRESSIVE TERMS BY ESTIMATION PERIOD



How to read the graph : the timescale indicates the estimation period, which extends over 10 years.

models are estimated over a rolling 10-year period, for both the United States and France. Graphs 3 and 4 show the evolution of the coefficients derived from these two modellings depending on the estimation period : the closer the value is to unity, the more plausible the assumption of a self-sustaining phenomenon.

It emerges from this, for example, that at the end of the 1970s and in the early 1980s, French inflation depended heavily on its past values *(cf. graph 4)* : this would correspond to a phase in which inflation was self-sustaining. More generally, it turns out that the coefficients obtained vary considerably as a function of the period considered.

Table 1 : Modelling adopted for the American household consumption deflator, ex food and energy

	Coeff.	variable	Estimation	T-stat
State 0	α_1^0	Inflation in t-1	0.694	12.04
	α_4^0	Inflation in t-4	0.215	4.00
	β^0	Unemployment	-0.062	-2.39
	μ_0	Constant	0.062	2.48
	σ_0	Standard deviation of residual	0.144	13.57
	γ_0	Constant transition function	3.313	4.48
State 1	α_1^2	Inflation in t-1	0.500	3.39
	β^1	Unemployment	-0.185	-2.25
	σ_1	Standard deviation of residual	0.325	7.81
	γ_1	Constant transition function	2.007	2.57

Estimation period : 1959-2004
The likelihood ratio test, as presented by Garcia (1995), carried out on the autoregressive modelling of order 4, rejects the null hypothesis of absence of change of regime, even at the 1% level. All the parameters introduced carry the expected sign and are significant at the 5% level, γ_1 non significantly different from 0 means that p^{11} is not significantly different from 0,5. Moreover, they are robust to a modification in the estimation period, beeing modified by less than one standard deviation if the estimation is carried out for the periods 1964-2004, 1959-1998, 1959-1990 and less than two standard deviations for the period 1974-2004. The change of estimation period does not modify the diagnosis concerning the régime *(cf. graph 5)*.

It would therefore indeed seem that the laws governing the evolution in inflation are not the same from one period to another, confirming the underpinnings of the model that we shall now go on to exploit.

In order to refine our analysis, we have attempted to identify periods during which inflation was in a credible-target regime (hereinafter state 0) and periods in which it was in a self-sustaining regime (hereinafter state 1).

United States inflation has generally been in a credible-target regime apart from certain particular episodes.

In order to refine our analysis and to identify the tendencies followed by inflation, we have applied the two-regime model described in box 1 to the prices of American household consumption ex food and energy (the most volatile items) derived from the quarterly national accounts.

Table 1 shows the results of the estimates derived from the model, obtained over the period 1959-2004. The coefficients of the determinants of inflation (in this case, lagged inflation and the unemployment rate) are estimated in state 0 and state 1. It will be seen that, when a credible inflation target exists (state 0), the sum of the auto-regressive terms α_1^0 and α_4^0 being close to 1, there is strong persistence of inflation. It takes, on average, two years for the deviation of inflation from its target to be reduced by half. The latter is, moreover, estimated to amount to 2.75% per year [(1)].

The Phillips effect, represented by β^0 and β^1, i.e. the fact that a higher level of unemployment will tend to reduce inflation by curbing wage claims, is significant in both regimes but more marked when in-

(1) The 95% confidence interval is 1.15%-4.13%. This is obtained by numerical simulation, using the variance-covariance matrix estimated from the parameters, using 10^7 drawings.

Table 2 : Modelling adopted for the American household consumption deflator, ex food and energy

		With influence of oil (q o q changes) on the probability of transition (δ_0 et δ_1)		With influence of oil (y o y) on the probability of transition (δ_0 et δ_1)		With influence of public déficit on the probability of transition (δ_0 et δ_1)	
		Estimation	T-stat	Estimation	T-stat	Estimation	T-stat
State 0	α_1^0	0.702	12.16	0.700	10.14	0.692	10.72
	α_4^0	0.204	3.79	0.204	3.35	0.210	3.60
	β^0	-0.055	-1.82	-0.052	-1.99	-0.047	-1.75
	μ_0	0.068	2.44	0.068	2.49	0.070	2.62
	σ_0	0.146	12.16	0.144	13.21	0.144	13.55
	γ_0	3.789	2.82	3.213	4.22	4.335	3.06
	δ_0	-9.138	-0.95	-1.583	-0.54	-39.532	-1.06
State 1	α_1^2	0.496	3.33	0.518	3.65	0.529	3.65
	β^1	-0.190	-1.95	-0.223	-2.91	-0.214	-2.96
	σ_1	0.322	7.80	0.317	8.14	0.315	7.80
	γ_1	1.928	2.47	2.005	2.04	3.567	2.07
	δ_1	2.684	0.42	9.575	1.35	-50.915	-1.20

flation starts to snowball. Lastly, the degree of persistence in either regime seems strong[(2)].

As the influence of the evolution in oil prices, whether taken on a quarterly or a year-on-year basis, is not significant *(cf. table 2)*, these variables have been excluded from the model. Equally, the influence of the American public deficit as a share of GDP is not significant.

Between 1960 and 2004, the probability of being in state 0 (interpreted as that in which a credible inflation target exists) is above 50% for more than 80% of the time *(cf. graph 5)*. Several episodes in which American inflation tips over into state 1 (non-stationary inflation) can be identified.

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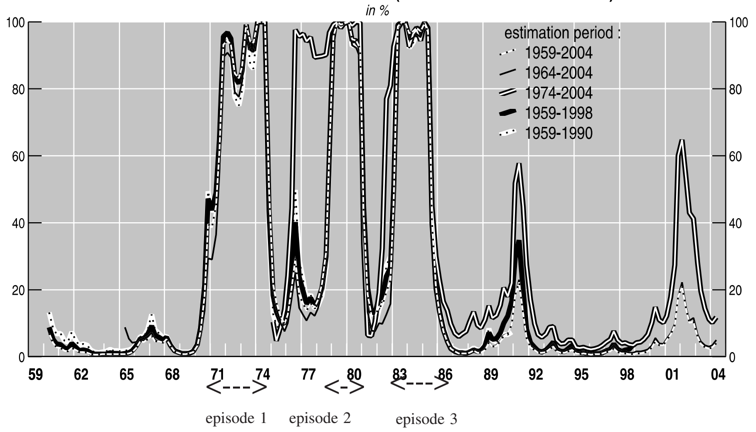
MODELLING ADOPTED FOR THE AMERICAN HOUSEHOLD CONSUMPTION DEFLATOR, EX FOOD ANS ENERGY, WITH NO INFLUENCE OF OIL ON THE PROBABILITES OF TRANSITION

PROBABILITY OF BEING IN STATE 1 (NON-STATIONARY INFLATION)

in %



Episode 1 : in 1971, This may seem somewhat surprising at first sight. One might have expected this to happen after the first oil shock, which began only on 17 October 1973. However, other events seem to have triggered off this change of regime. As of 18 March 1968, the dollar was no longer backed by the gold reserves, even though it remained convertible into gold. This meant that there was in effect a dual gold market : monetary gold was traded at a fixed rate, while at the same time a free market in gold developed in which prices deviated from the official price.

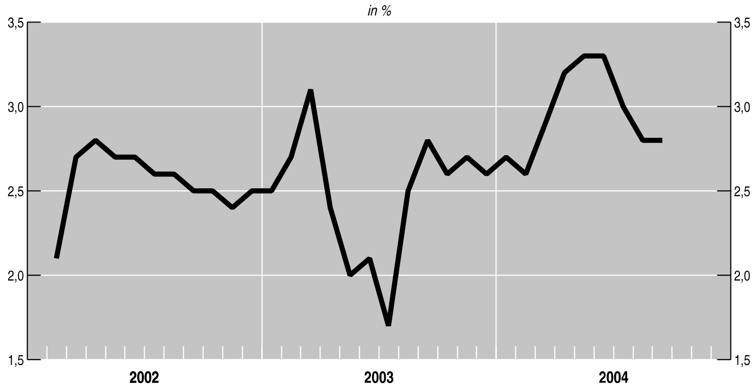
The latter part of 1970 saw confidence in the dollar rapidly eroding and agents beginning to convert their dollars into gold, leading to an appreciation of almost 14% in the gold price compared with its official level until Q2 1971. In

(2) The probability of remaining in state 0, measured by $\frac{e^{\gamma_0}}{1+e^{\gamma_0}}$, is 96% and the probability $\frac{e^{\gamma_1}}{1+e^{\gamma_1}}$ that an inflationary spiral will continue once it has begun is 88%.

6

AMERICAN HOUSEHOLDS' EXPECTATIONS REGARDING INFLATION

in %



source : University of Michigan

Table 3 : Modelling adopted for the French household consumption deflator, ex food and energy

	Coeff.	variable	Estimation	T-stat
State 0	α_1^0	Inflation in t-1	0.300	2.88
	α_2^0	Inflation in t-2	0.260	2.73
	α_3^0	Inflation in t-3	0.313	3.45
	β^0	Unemployment	-0.080	-2.52
	μ_0	Constant	0.042	1.59
	σ_0	Standard deviation of résidual	0.142	12.78
	γ_0	Constant transition function	8.360	1.46
State 1	α_2^1	Inflation in t-2	0,279	2,18
	β^1	Unemployment	-0,296	-1,38
	σ_1	Standard deviation of résidual	0,450	10,80
	γ_1	Constant transition function	4,058	3,96

Estimation period : 1968-2004

The likelihood ratio test, as presented by Garcia (1995), carried out on the autoregressive modelling of order 4, rejects the null hypothesis of absence of change of regime, even at the 1% level. The parameters are significant and carry the expected sign, although there is a slight weakness concerning the Phillips effect in state 1. In addition, they show satisfactory robustness to a modification of the estimation period, beeing modified by less than one standard deviation if the estimation is carried out for the periods 1973-2004 or 1978-2004, the same beeing true on the period 1968-1998 with the exception of the coefficients relating to state 0 which vary by less than two standard deviations. For the period 1968-1990, the coefficients relating to state 1 differ by less than one standard deviation but those relating to state 0, in which inflation spends little time, are very substantially modified.

Moreover, this modelling presents a stable diagnosis, when the estimation period is modified, concerning the current state *(cf. graph 7)*.

parallel, the probability of being in state 1 rose to 45%. On 15 August 1971 there came the announcement of the ending of convertibility into gold and the probability then broke through the 50% level, remaining thereafter at a higher level, notably during the first oil shock.

Episode 2 : early 1979, in other words, at the time of the second oil shock.

Episode 3 : early 1983.

At this time, there was a decline in interest rates from more than 14.5% at the beginning of 1982 to below 9% at the beginning of 1983 and a simultaneous distinct deterioration in public finances, with the budget deficit rising from 2.2 GDP points in 1981 to 5.6 GDP points in 1983. This public finance variable, however, has no significant effect on the probabilities of transition, which is not surprising in that it is only in one case at the origin of an inflationary spiral, and even then in combination with other events.

It is noticeable, moreover, that the probability of being in an inflationary spiral remains low until Q2 2004. This result is in conformity with the survey of American households carried out by the University of Michigan, showing that households' expectations of inflation remained moderate *(cf. graph 6)* and, as of the summer of 2004, returned to the inflation-target level previously obtained (2.75%).

In France, the introduction of stronger discipline in the 80's, notably through the ending of price-indexing of wages succeeded in making the low-inflation target credible.

In order to identify the tendencies followed by inflation in France, we have used, as in the case of the United States, the consumer price index for French households ex food and energy (the most volatile items) derived from the quarterly national accounts.

Table 3 shows the results obtained for the period 1968-2004. The coefficients for variations in the oil price are not significant (cf. table 4). There is also strong persistence of inflation even when it is in the stationary state, with the sum of the auto-regressive terms α_1^0, α_2^0 and α_3^0 close to 1. This means that it takes more than a year on average to reduce by half the deviation of inflation from its target, estimated at 1.35% per year. This final estimate, however, is very imprecise: at the 95% confidence level, the value lies between - 0.52% and 2.34% [(3)].

(3) This estimate was obtained by numerical simulation, using the variance-covariance matrix estimated from the parameters, with 10^7 drawings.

Table 4 : Modelling adopted for the French household consumption deflator, ex food and energy

		With influence of oil (quaterly changes) on the probability of transition (δ_0 et δ_1)		With influence of oil (y o y changes) on the probability of transition (δ_0 et δ_1)	
		Estimation	T-stat	Estimation	T-stat
State 0	α_1^0	0.300	2.85	0.303	2.90
	α_2^0	0.260	2.73	0.258	2.74
	α_3^0	0.313	3.42	0.309	3.54
	β^0	-0.080	-2.52	-0.079	-2.51
	μ_0	0.042	1.58	0.044	1.69
	σ_0	0.142	12.76	0.142	12.84
	γ_0	8.344	1.61	8.258	1.42
	δ_0	0.743	0.04	-0.302	-0.03
State 1	α_1^2	0.279	2.18	0.282	2.20
	β^1	-0.295	-1.38	-0.302	-1.40
	σ_1	0.450	10.80	0.451	10.75
	γ_1	4.010	3.92	4.262	3.02
	δ_1	2.451	0.24	10.344	1.22

It also emerges that unemployment has an influence on inflation, albeit fragile in the case of the inflationary spiral : β^0 is significant and negative as expected, with unemployment curbing workers' wage claims, and β^1 is also negative but significant only at the 17% level. The persistence in either state is very strong, with the probabilities of remaining in the same state, $\frac{e^{\gamma_0}}{1+e^{\gamma_0}}$ and $\frac{e^{\gamma_1}}{1+e^{\gamma_1}}$, greater than 98%.

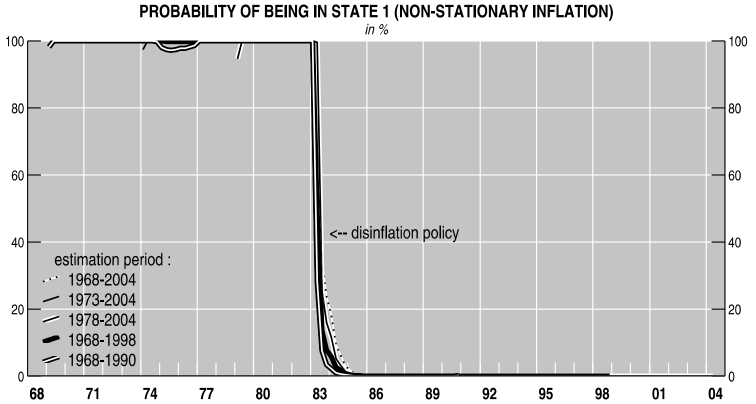
Here again, if one attempts to reintroduce variations in the oil price as a determinant of the probability of transition, the parameters are not significant.

These results differ widely from those obtained for the United States, where there is no alternation between the two states but initially a predominance of state 1 (interpreted as the situation in which the there is no credible inflation target) followed, from 1983 on, by a situation in which the economy remains in state 0 (existence of a credible inflation target). This change in state corresponds, with a slight lag, to the ending of price-indexing of wages in mid-1982 and to the policy of competitive disinflation.

7

MODELLING ADOPTED FOR THE FRENCHHOUSEHOLD CONSUMPTION DEFLATOR, EX FOOD ANS ENERGY, WITH NO INFLUENCE OF OIL ON THE PROBABILITES OF TRANSITION

PROBABILITY OF BEING IN STATE 1 (NON-STATIONARY INFLATION)

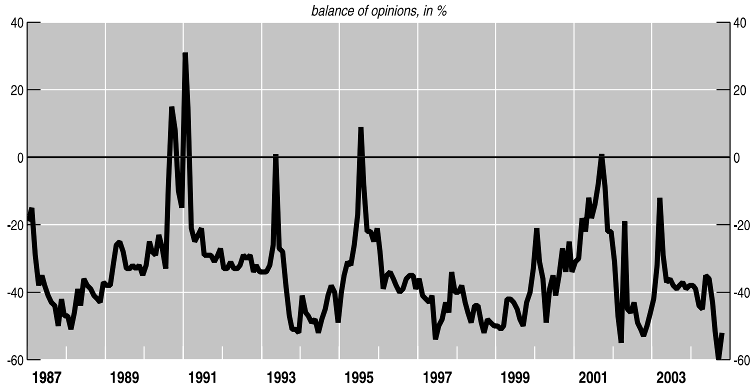


Moreover, it turns out that the probability of being in an inflationary spiral is, until Q2 2004, extremely low. This tends to confirm the diagnosis that can be made on the basis of the household survey, showing that the outlook for the evolution in prices is at a low level and has even shown a tendency to decline since April 2003 *(cf. graph 8)*. ■

8

HOUSEHOLD SURVEY - EXPECTATIONS REGARDING CHANGES IN PRICES

balance of opinions, in %



ENCADRÉ : THE MODELLING OF THE TWO INFLATION REGIMES

We want to test the possibility that inflation may follow two distinct regimes, depending on the period considered : one in which there exists a credible inflation target on which expectations can be co-ordinated and the other in which there is no such target and expectations are adaptative. This means that in the first case the sum of the auto-regressive terms is strictly less than unity and in the second is equal to unity.

In the first case, known as state 0, one obtains the following dynamic :

$$\pi_t = \alpha_1^0 \pi_{\tau-1} + \alpha_2^0 \pi_{t-2} + \alpha_3^0 \pi_{t-3} + \alpha_4^0 \pi_{t-4} + (1-\alpha_1^0 - \alpha_2^0 - \alpha_3^0 - \alpha_4^0)\bar{\pi} + \beta^0 (u_t - \bar{u}_t) + \varepsilon_t \quad \text{with} \sum_i \alpha_i^0 < 1$$

where π_t is inflation (in this case, to be more precise, the household consumption deflator ex food and energy) ; $\bar{\pi}$ is the credible inflation target ; u_t is unemployment ; $\bar{u}_t$ is the equilibrium unemployment rate which is not necessarily constant over the period considered ; ε_t is white noise. Since the equilibrium unemployment is unknown and potentially variable over time, we opted for the solution of introducing into the equation only the cyclical conponent of unemployment $\tilde{u}_t$ identified with the help of a Hodrick-Prescott filter.The estimated relation then becomes :

$$\pi_t = \alpha_1^0 \pi_{t-1} + \alpha_2^0 \pi_{t-2} + \alpha_3^0 \pi_{t-3} + \alpha_4^0 \pi_{t-4} + \beta^0 \tilde{u}_t + \mu^0 + \varepsilon_t$$

In the second case, the situation called state 1, when the inflation target is no longer credible, this relation then becomes :

$$\pi_t = (1-\alpha_2^1 - \alpha_3^1 - \alpha_4^1)\pi_{t-1} + \alpha_2^1 \pi_{t-2} + \alpha_3^1 \pi_{t-3} + \alpha_4^1 \pi_{t-4} + \beta^1 \tilde{u}_t + \varepsilon_t$$

If one denotes by S_t the variable indicating the state, 0 ou 1, in which one finds oneself, one makes the assumption that S_t obeys a Markov process. This is reflected in the fact that, if one is in state 0, there is then the probability p_t^{00} of remaining in the same state the following quarter and the probability p_t^{01} of moving to state 1. Symetrically, if one is in state 1, there is then the probability p_t^{11} of remaining in that state in the following quarter and the probability p_t^{10} of moving to state 0.

It is assumed that the probabilities of transition in this process are a function of variations in the oil price. Adopting Diebold et al. (1994), the following form is postulated for the transition matrix of the process followed by S_t :

	State 0 in t	State 1 in t
State 0 in t-1	$p_t^{00} = \dfrac{e^{\gamma_0 + \delta_0 \Delta brent_{t-1}}}{1+e^{\gamma_0 + \delta_0 \Delta brent_{t-1}}}$	$p_t^{01} = 1 - p_t^{00}$
State 1 in t-1	$p_t^{10} = 1 - p_t^{11}$	$p_t^{11} = \dfrac{e^{\gamma_1 + \delta_1 \Delta brent_{t-1}}}{1+e^{\gamma_1 + \delta_1 \Delta brent_{t-1}}}$

Working on quaterly data, one takes as starting point an auto-regressive form of order 4 before successively eliminating the non-significant coefficients. Since the modelling obtained can depend on the order in which these non-significant parameters are eliminated, a systematic attempt was made to reintroduce the oil variable in the final modelling. In addition, it was permitted to change all the parameters as a function of the present state. The parameters are estimated by maximising the likelihood of the model. For this purpose use was made of an EM algorithm[1].

On the basis of the coefficients estimated in this way it is possible to calculate the implicit inflation target in state 0 : this is equal to $\frac{\mu_0}{1-(\alpha_1^0+\alpha_2^0+\alpha_3^0+\alpha_4^0)}$ ■

(1) Cf. Diebold et al (1994) and Hamilton (1993) for the calcul ation of the likelihood and the description of the maximisation algotithm.

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