The contribution of a macroeconomic model to short-term analysis of the economic situation in the euro zone

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A macro-econometric model for the euro zone (MZE-2003) has been developed in collaboration between Insee and the Direction de la Prévision in the Ministry of Finance. This model, which is traditional in its approach, makes it possible to throw additional light on the forecasts contained in this Note de conjoncture obtained using Insee's habitual instruments (calibrations based on business surveys, time-series models).
For example, using this model, it can be estimated that the recent 20% rise in the price of oil will have depressed domestic demand and, at the same time, exports, but with a very small impact on GDP in the short term. As regards the impact of an appreciation of the euro against the USD amounting to 10%, as recently observed, the negative impact on GDP is seen to be more substantial in the short term, failing a vigorous reaction in terms of monetary policy. These results make it possible to understand part of the reason for the downward revision in growth for the early part of 2003 between the previous Note de conjoncture (issued in December 2002) and the present one.

For the purpose of predicting the evolutions in the components of GDP in the euro zone, INSEE has for several years provided itself with various instruments linking the components of GDP to the variables emanating from business surveys (calibrations): cf. Buffeteau and Mora (2000). For example, GDP growth has been calibrated on that of the common factor calculated at INSEE from the balances of opinion of the industrial survey for the euro zone.

INSEE also uses purely statistical models, at detailed level, to predict evolutions in the retail price index (HICP) for the euro zone. For each heading in the index, an ARIMA [(1)] model is estimated, sometimes incorporating exogenous explanatory variables (such as the price of oil).

The aim of this special article is to show how a macro-econometric model for the euro zone, based on the estimated relations of agents' behaviour in a balanced accounting framework, can provide supplementary aid to the economic forecaster in his work, as is already the case for the exercise carried out for France (*see box in the previous special article, only available in the French version*). It is also an opportunity to describe once again the data which the economist has available for examining the euro zone.

A macro-econometric model providing a safety net at several levels

The MZE-2003 model respects the Eurostat national accounts framework

The aim of the model is to provide an instrument for taking a fresh look at, or even predicting, GDP in the euro zone, together with its components, prices, employment, unemployment, etc.. In the past, many people have attempted to reconstruct these data on the basis of national accounts for countries in the zone [(2)]. This is no longer necessary, since Eurostat provides the data in the case of the resource/use balance, in both volume and value. While these data are sometimes the subject of criticism, they are now accepted as having authority.

One of the major gaps as regards economic analysis remains trade in goods and services. These data are

(1) "Auto Regressive Integrated Moving Average". This type of model represents the dynamics of a time series, without recourse to information other than what is included in itself.
(2) For example, the ECB reconstructs its data in terms of geometric means, in order to preserve the property that the growth rate of the zone is the weighted sum of the growth rates. The disadvantage of this method is that the resulting accounts are not in balance.
The OECD reconstructs data by means of aggregation of national series, using as weightings GDP on a purchasing power parity basis.
Eurostat simply aggregates the data, converting them into euros since 1999, into ECU previously. This possible disadvantage as regards the past is seen to be reduced when it is remembered that the model is used mainly to re-examine the recent past and forecasts.

the simple aggregation of the trade figures for each country, the result being that in the Eurostat national accounts data, the trade of the zone is represented by the sum of intra-zone and extra-zone trade. This can be detrimental for economic analysis, and even for the measurement of the zone's GDP, since the intra-zone flows are not statistically in balance [3].

In addition, certain crucial data for economic analysis are lacking. This means that, in addition to the extra-zone trade, data have been reconstructed for disposable income, productive capital, employment and public finances (*see box 1*).

The MZE-2003 model reproduces the regularities observed in the past

Unlike the results of calibration, the macro-econometric model estimates behavioural relationships, in conformity with economic theory. For example, consumption is related to income, which is itself related to the total wage bill, whose evolution is broken down between that of wages and that of employment, and so on. These theoretical relationships are then compared with data for the past in order to estimate the elasticities (structural parameters) of the various magnitudes concerned. It is in fact verified that the elasticity of consumption to income can be regarded as being equal to unity over the long term. In other words, a lasting 1% addition to income leads to a lasting increase of 1% in consumption. *Box 2* provides the theoretical framework adopted for the model and *box 3* describes its estimation.

The MZE-2003 model provides additional material for the economic interpretation of recent and predicted variations in the present Note.

The use of the MZE-2003 model makes it possible to compare the predictions made using calibrations and judgements by experts with those obtained in the framework of a model on the assumption of unchanged behaviour on the part of economic agents. It also makes it possible to flesh out forecasts using those for variables not covered by these methods.

For the forecasts obtained by means of calibration, involving components of GDP and consumer prices, the subject of interest is the gap between these forecasts and those obtained using the equations in the model. This makes it possible to relate the forecasts not just to the survey variables but to the determinants that are usually found in economic reasoning (for example, the relationship of consumption to income).

The other variables, those not covered by calibration, are deduced from the model. In practice, they result either from accounting identities or from econometric equations describing agents' behaviour [4]. For example, employment stems from the demand for labour on the part of firms that set themselves a productivity target. In this way it is possible to supplement the present diagnosis by forecasts concerning employment, the unemployment rate or earnings, for example.

The forecasts of the components of GDP are fairly reasonably reproduced by those of the economic determinants (see graphs)

In the model, household consumption is determined by real gross disposable income (real GDI), by the unemployment rate and by the real interest rate (*see box 3*). Until Q3 2002, the growth in the purchasing power of GDI enabled consumption to be maintained at a high level despite the rise in unemployment that was prompting households to increase their precautionary saving. On the other hand, the falls in the real interest-rate led households to reduce their saving, although the impact was more limited. In 2003, the model relates the decline in consumption growth to the slowdown in purchasing power and the rise in the unemployment rate. Consumption growth, on this basis, is expected to amount to 0.25% in H1 (0.15% in Q1 and 0.1% in Q2). The purchasing power of GDI would in fact contribute 0.3 of a point, the real interest rate 0.1 of a point. In the other direction, the unemployment rate would make a negative contribution of 0.15 of a point.

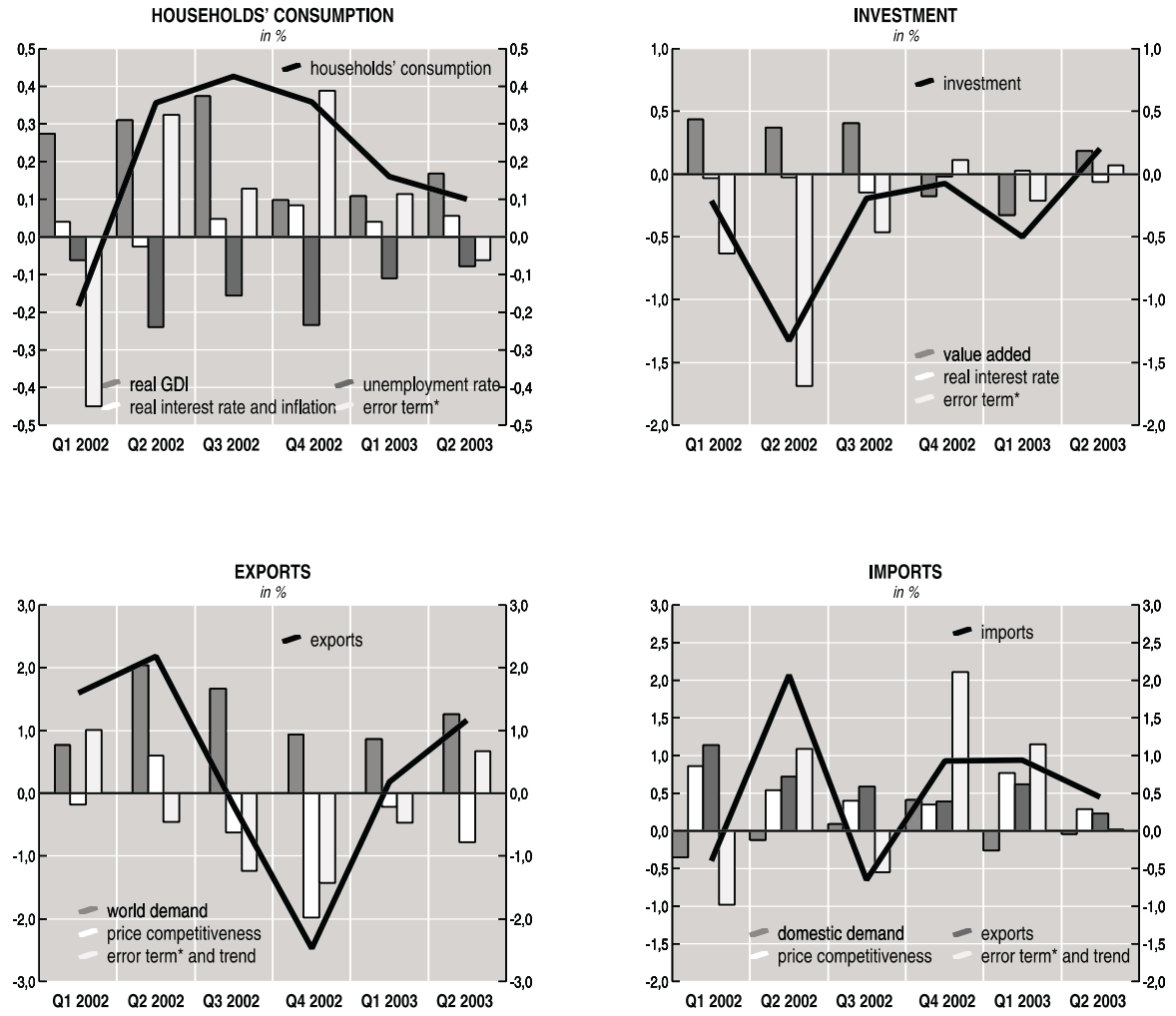
The model relates investment to demand and to the cost of capital, measured by a real interest rate increased by the rate of depreciation of capital. In relation to these determinants, investment distinctly over-reacted downwards in the early part of last year, thus correcting for an over accumulation in previous years. In Q1 2003, the slowdown in investment to -0.5% is to be related to that of demand. In Q2, the upturn in demand is expected to encourage a small rise in investment (+0.2%).

Foreign trade is represented in the model by three equations, two specific to exports and imports with the rest of the world in goods, and one relating to the balance on goods and services. The forecasts announced and obtained on the basis of calibration are not strictly comparable since they have a different coverage, namely that of total trade (goods and services) both within and outside the zone (*see box 2*). Even so, we have taken care to be sure that the contribution of external trade to GDP growth is the same in both methods.

Following a very depressed final quarter, exports of goods are expected to pick up in H1 2003. The equations in the model show in fact that the impact of competitiveness shocks on exports has a time lag of

(3) In practice, it can be seen, in particular, that the recorded exports of country A to country B are generally higher than the imports of country B from country A. This is due especially to VAT fraud.
(4) For the econometric equations, there exists an observed error with respect to the past. For forecasting purposes, it is generally assumed that this error makes no contribution to the evolution of the variable.

EVOLUTION OF THE PRINCIPAL VARIABLES AND CONTRIBUTIONS



How to read the table :
The error term is the contribution to the variable of all past errors.

at least one quarter. This means that the appreciation of the euro in the early part of 2002 (taking real effective exchange rates) has had a considerable effect at the end of the year. In Q1 2003, conversely, exports are likely to benefit from the pause in the appreciation of the euro seen last summer, before again being affected in Q2 by the more recent appreciation. The upturn in world demand in Q2 would nevertheless provide a fresh start for exports.

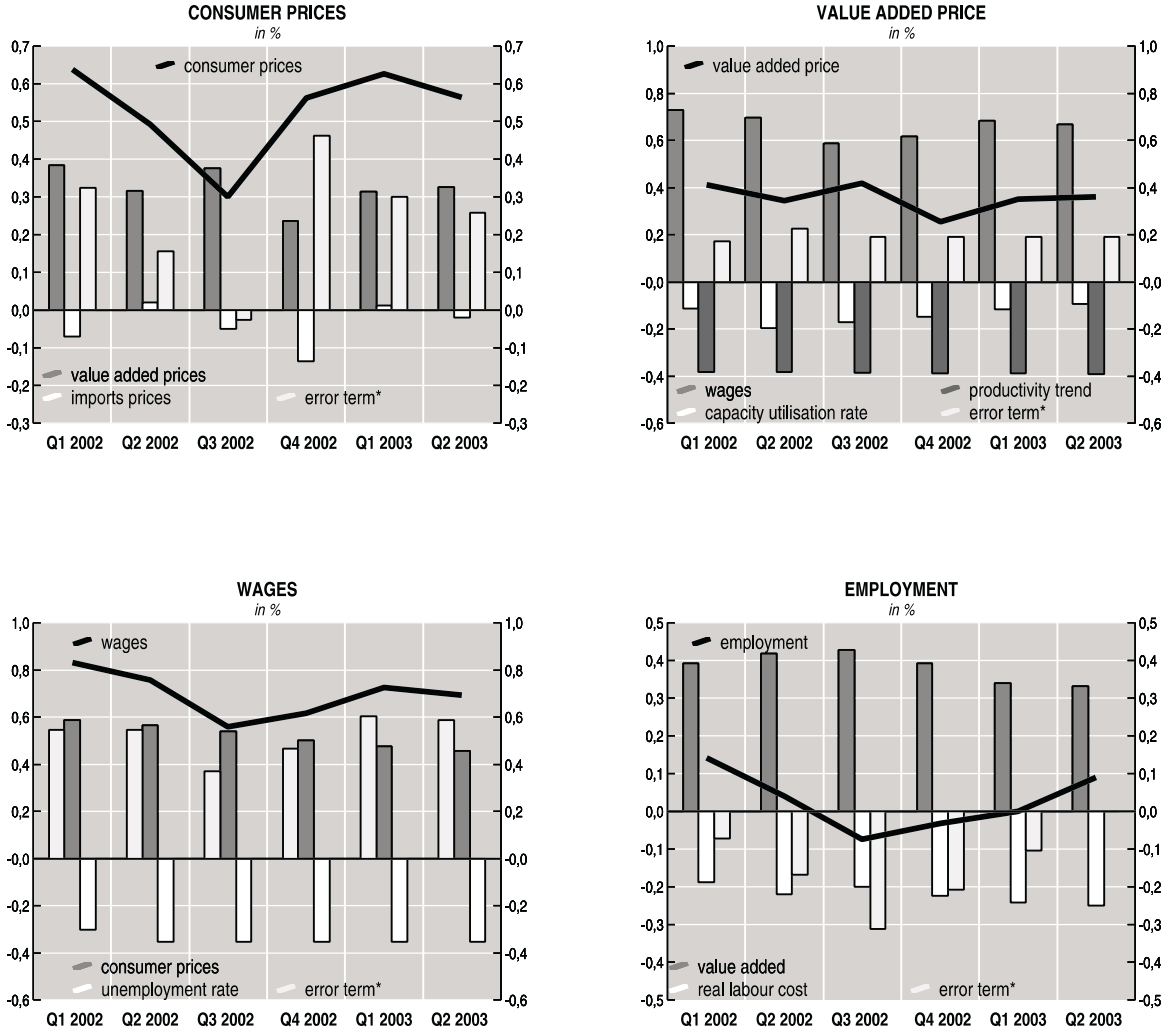
As regards imports of goods, these are likely to slow down slightly in H1 2003, in parallel with the slowdown in domestic demand. The decline in import growth would nevertheless be cushioned by the loss of competitiveness linked to the appreciation of the euro, as well as, in a smaller degree, by the recovery in exports (the effect of the import content of exports).

In the model,change in inventories are assumed to adjust to variations in final demand excluding stocks. The contribution of change in inventories to GDP growth is expected to be neutral in the first two quarters of 2003.

The forecasts for inflation can be looked at in the analytical framework of the wage-price loop contained in the model

In the model, consumer prices are measured as the deflator of household consumption and differ slightly from the indicator provided by the harmonised price index (HICP), on which comments will be found in the section "consumer prices in the euro zone". This latter index has risen more strongly in the recent past. The forecasts adopted for the year-on-year change in the consumption deflator corresponds to

EVOLUTION OF THE PRINCIPAL VARIABLES AND CONTRIBUTIONS



How to read the table :
The error term is the contribution to the variable of all past errors.

that of the HICP adjusted for the recently-observed differential. The model also makes it possible to provide forecasts for the prices of value added and for wage-earnings. The prices of value added, consumption and wage-earnings are determined simultaneously as part of the wage-price loop.

In H1 2003, the rise in wage-earnings is not expected to weaken. The equations in the model take the form of a Phillips curve, with the evolution in wage-earnings depending positively on that of consumer prices and negatively on the unemployment rate. The steady increase in the unemployment rate leads to a smaller contribution to the evolution in wages for the first two quarters of 2003 than previously. Conversely, the acceleration in consumer prices in 2003 leads to a larger contribution. As regards the prices of value added, their growth is expected to stabilise at 0.4% per quarter, at a time when there is no pressure on productive capacity.

Consumer prices are accelerating slightly, by 0.6% per quarter. The contribution of import prices, which was negative in Q4 2002, has in fact been turning slightly positive in Q1 2003 because of the rise in the oil price and despite the appreciation of the euro.

The MZE-2003 model also supplements the diagnoses through numerical forecasts of employment and the unemployment rate

In the model, the unemployment rate is calculated directly from the figures for employment and the labour force, whose evolutions are

Table 1 : Forecasts for the euro zone

(quaterly growth rate, in % - unless otherwise indicated)

	2002				2003	
	Q1	Q2	Q3	Q4	Q1	Q2
Volumes						
GDP	0.4	0.3	0.4	0.2	0.0	0.2
Domestic demand	0.2	0.2	0.2	0.4	0.1	0.2
Household consumption	-0.2	0.4	0.4	0.4	0.2	0.1
General government consumption	0.7	0.9	0.3	0.5	0.4	0.4
Investment	-0.2	-1.3	-0.2	-0.1	-0.5	0.2
Merchandise exports	1.6	2.2	-0.2	-2.4	0.2	1.2
Merchandise imports	-0.4	2.1	-0.6	0.9	0.9	0.5
Prices						
Value added prices	0.4	0.3	0.4	0.3	0.4	0.4
Consumer prices	0.6	0.5	0.3	0.6	0.6	0.6
Investment prices	0.6	0.0	0.4	0.2	0.4	0.3
Merchandise export prices	-0.7	-0.2	0.1	-0.1	-0.9	-0.3
Merchandise import prices	-0.3	0.7	-1.0	-1.8	1.2	-0.8
Wages and salaries	0.8	0.8	0.6	0.6	0.7	0.7
Employment and unemployment						
Unemployment rate (points)	8.1	8.2	8.3	8.5	8.6	8.6
Employment	0.1	0.0	-0.1	0.0	0.0	0.1
Labour force	0.1	0.1	0.0	0.1	0.1	0.2
Unit wage costs	0.6	0.4	0.1	0.4	0.7	0.5
Labour productivity	0.3	0.4	0.5	0.2	0.0	0.2
Miscellaneous						
World demand	0.9	2.5	1.4	0.8	0.9	1.4
Trade balance (points of GDP)	2.5	2.6	2.9	2.6	2.1	2.3
3-month interest rates (points)	3.36	3.44	3.36	3.10	2.95	2.60
10-year interest rates (points)	5.14	5.25	4.76	4.54	4.66	4.66
Capacity utilisation rate (%)	80.8	80.8	80.9	81.0	81.1	81.0
GDI in value	0.9	0.8	0.8	0.4	0.4	0.6
Contribution of gross operating surplus	0.2	0.3	0.3	0.0	0.0	0.1
Contribution of wages and salaries	0.7	0.6	0.4	0.4	0.6	0.6
Other contributions	-0.1	0.0	0.1	-0.1	-0.1	-0.1

Forecast

Table 2 : Analytical variant assuming a 20% rise in the oil price

(in %)

	Number of quarters			
	1	2	3	4
GDP	-0.04	-0.06	-0.08	-0.12
Consumption	-0.08	-0.16	-0.28	-0.40
Investment	-0.12	-0.12	-0.20	-0.30
Exports	0.00	0.00	-0.02	-0.06
Imports	-0.08	-0.36	-0.66	-1.00
Inventories (GDP points)	0.00	0.00	-0.02	-0.02
Inflation (year-on-year change)	0.24	0.48	0.64	0.72
Wage inflation (year-on-year change)	0.16	0.40	0.58	0.66
Unemployment rate (points)	0.00	0.02	0.04	0.06
Employment	-0.02	-0.04	-0.08	-0.12
Balance of goods and services in value (GDP points)	-0.64	-0.54	-0.44	-0.36

How to read tables 2 to 6 :
The figures shown are the differences from the reference scenario generated by the analytical shock. In table 2, GDP is reduced by 0.04% in the first period ; inflation is raised by 0.24 of a point ; the balance on goods and services is reduced by 0.64 GDP points.

derived using econometric equations. Employment is dependent on the real cost of labour and demand for goods addressed to firms; the labour force depends on the population of working age but also on the level of unemployment, since an improvement on the labour market incites certain people to return to the labour market.

For the first two quarters of 2003, growth in employment is expected to remain close to zero, with the past deceleration in value added not favouring an upturn. Taking into account the growth of the labour force — albeit slightly depressed because of the slackness of employment — the unemployment rate is expected to rise to 8.6% in H1 2003.

The MZE-2003 model makes it possible to analyse the impact of exogenous shocks taken in isolation

For more than one quarter the economy of the euro zone has been subjected to the appreciation of the euro and the rise in the oil price. The MZE-2003 model makes it possible to analyse the extent to which these exogenous shocks affect growth, unemployment, prices, etc.. More generally, other exogenous shocks can be examined, such as a fluctuation in world demand, variations in interest rates or an expansionary fiscal policy.

This section describes so-called "analytical" variants, in the sense that they portray the consequences of an exogenous shock for the economy, in isolation from any possible interaction with other shocks. For example, in the variant illustrating the rise in the price of oil, this rise has no consequences for the strength of demand in the euro zone's overseas markets. This variant describes the direct effect of the rise in the oil price on the economy in the euro zone, everything else remaining equal. This approach makes it easier to assess the macroeconomic consequences of the various shocks envisaged,

shedding light on the relative importance of the current short-term economic phenomenon.

A 20% rise in the oil price raises inflation by 0.7 of a point at the end of one year and depresses household consumption (see table 2).

A 20% oil-price shock, as seen between mid-December and mid-March, initially leads automatically to a rise in consumer prices. These are increased by more than 0.2% in each of the first two quarters following the shock. Thereafter, the rise in inflation leads households to negotiate higher wages, thus fuelling the inflationary spiral in the short term. In the end, the rise in the oil price adds 0.7 of a point to annual inflation.

The rise in wage costs in the euro zone leads to decline in demand for the labour factor on the part of firms and, as result, adds 0.1 of a point to the unemployment rate over a one-year time horizon. The fall in employment, combined with the erosion of household purchasing power, leads to a deterioration in consumption. In the first year, consumption is reduced by 0.4 of a point. In addition, the rise in the price of oil increases import prices, thus weakening the euro zone's trade balance, despite the fall in import volumes. All in all, at the end of one year, activity is reduced slightly (annual growth falls by 0.1 of a point), but the addition to inflation is substantial.

An appreciation of the euro has a major impact both on prices and on growth (see table 3)

In the short term, the appreciation of the euro impairs the price-competitiveness of European producers on both domestic and export markets. The trade balance in volume terms worsens immediately. However, the trade balance in value improves temporarily, since the fall in import prices has a positive effect which wins out during the first three quarters: the trade balance therefore moves along an inverted J-curve, *as in graph 1*.

During the first few quarters, production falls because of the deterioration of the trade balance in volume. The depressive impact of the appreciation of the euro then leads to a rise in unemployment and a fall in real earnings. In this way, despite the imported disinflation, household consumption is reduced. The recessionary impact on growth is amplified by changes in corporate investment.

The decline of 1% in world demand leads to contraction in activity: at the end of one year, growth is reduced by 0.25 of a point (see table 4)

The fall of 1% in world demand constitutes a "pure" demand shock since it affects demand for goods and services from the euro zone. In the short term, the fall in world demand leads to a decline in exports, thus curbing activity. The euro-zone growth rate falls by 0.25 of a point at the end of one year.

Table 3 : Analytical variant assuming a 10% appreciation of the euro versus the USD (1) (i.e. a 2.5% increase in the effective exchange-rate)

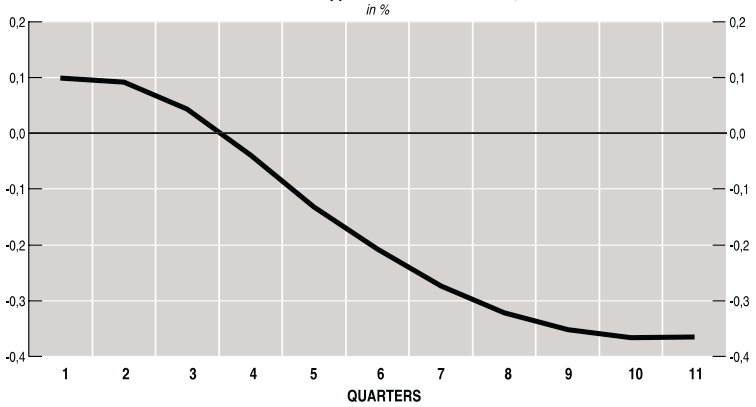
(in %)

	Number of quarters			
	1	2	3	4
GDP	-0.16	-0.27	-0.25	-0.23
Consumption	-0.04	-0.06	-0.06	-0.03
Investment	-0.38	-0.60	-0.47	-0.37
Exports	0.00	-0.46	-0.43	-0.35
Imports	0.28	-0.05	-0.02	0.24
Inventories (en point de PIB)	0.00	-0.02	-0.03	-0.01
Inflation (year-on-year change)	-0.10	-0.24	-0.37	-0.50
Inflation salariale (glissement annuel)	-0.07	-0.20	-0.34	-0.48
Unemployment rate (points)	0.01	0.02	0.04	0.06
Employment	-0.02	-0.06	-0.09	-0.09
Balance of goods and services in value (GDP points)	0.10	0.09	0.04	-0.04

(1) We assume in this case that the appreciation of the euro versus the USD brings with is that of the euro versus the CAD, but no other currencies.

1

TRADE BALANCE IN VALUE (in point of GDP)
for an effective appreciation of the euro of 2,5%
in %



How to read the graph :
The balance moves along an inverted J curve at the time of an effective appreciation of the euro.

This fall in activity then leads to a fall in employment and hence a rise in unemployment. Household incomes are affected by the deterioration on the labour market and household consumption diminishes. At the end of one year, household consumption is reduced by 0.2 of a point and investment by 0.5 of a point. Prices are only slightly affected by the world demand shock.

A fall in interest rates has a more rapid impact on activity than on prices (see table 5).

A fall in interest rates of 100 basis points stimulates consumption and investment in the short term, raising them by 0.6 and 1.2 of a point, respectively, at the end of one year. The growth rate in the euro zone is raised by 0.3 of a point at the end of one year. Imports are stimulated by the strength of domestic demand. The unemployment rate declines by 0.1 of a point in the first year. On the other hand, the fall in interest rates has less impact on prices within a one-year time horizon, with inflation rising by only 0.1 of a point. It should nevertheless be noted that the annual inflation rate is increased by 0.5 of a point in the second year (not shown in the table). Monetary policy therefore takes a year to start to have an impact on consumer prices.

A fiscal expansion provides a strong stimulus to activity in the short term, with the Keynesian multiplier standing at around 1 (see table 6)

A rise in public spending amounting to one point of GDP has both an expansionary and an inflationary effect in the short-term. At the end of one year, inflation is increased by 0.5 of a point and the growth rate of the economy by around 1 point. Household consumption is underpinned by the rise in employment. The strength of domestic demand leads to a sharp increase in imports. ■

Table 4 : Analytical variant assuming a 1% fall in demand in the euro zone's export markets

(in %)

	Number of quarters			
	1	2	3	4
GDP	-0.20	-0.18	-0.20	-0.25
Consumption	-0.08	-0.09	-0.14	-0.18
Investment	-0.47	-0.36	-0.39	-0.46
Exports	-0.99	-1.01	-1.01	-1.02
Imports	-0.76	-1.07	-0.99	-0.98
Inventories (GDP points)	0.00	-0.05	-0.02	-0.02
Inflation (year-on-year change)	0.00	-0.01	-0.05	-0.10
Wage inflation (year-on-year change)	0.00	-0.02	-0.05	-0.11
Unemployment rate (points)	0.01	0.03	0.05	0.07
Employment	-0.03	-0.07	-0.09	-0.12
Balance on goods and services in value (GDP points)	-0.05	0.02	0.00	-0.01

Table 5 : Analytical variant assuming a 100-basis-point fall in interest rates

(in %)

	Number of quarters			
	1	2	3	4
GDP	0.09	0.17	0.25	0.33
Consumption	0.20	0.31	0.45	0.59
Investment	0.22	0.58	0.91	1.20
Exports	0.00	0.00	0.01	0.02
Imports	0.32	0.74	1.12	1.46
Inventories (GDP points)	0.00	0.02	0.03	0.04
Inflation (year-on-year change)	0.00	0.01	0.03	0.07
Wage inflation (year-on-year change)	0.00	0.01	0.03	0.08
Unemployment rate (points)	0.00	-0.02	-0.04	-0.07
Employment	0.02	0.05	0.09	0.13
Balance on goods and services in value (GDP points)	-0.08	-0.18	-0.27	-0.35

Table 6 : Analytical variant assuming a rise of 1 GDP point in public spending

(in %)

	Number of quarters			
	1	2	3	4
GDP	0.93	0.87	0.89	1.03
Consumption	0.36	0.46	0.65	0.79
Investment	2.21	1.84	1.70	1.87
Exports	0.00	0.02	0.06	0.08
Imports	3.24	4.65	4.35	4.35
Inventories (GDP points)	0.00	0.24	0.10	0.10
Inflation (year-on-year change)	0.00	0.07	0.22	0.49
Wage inflation (year-on-year change)	0.01	0.07	0.23	0.52
Unemployment rate (points)	-0.04	-0.13	-0.23	-0.32
Employment	0.15	0.32	0.42	0.52
Balance on goods and services in value (GDP points)	-0.77	-1.11	-1.05	-1.00

BOX 1: THE RECONSTRUCTION OF MISSING DATA FOR THE PURPOSES OF ECONOMIC ANALYSIS

The reconstruction of household's gross disposable income (GDI)

Eurostat does not publish quarterly figures for gross disposable income for the euro zone. It has therefore been necessary to construct this series, while respecting the major aim of having an accounting framework that is easily integrated in the economic modelling for the euro zone. The interest of constructing an accounting framework defining GDI is to mobilise additional information for the purpose of econometric modelling (rates of tax and compulsory contributions for the euro zone, for example). The method used for constructing quarterly GDI can be divided into two stages:

creation of a complete annual accounting framework for households in different euro-zone countries from 1991 to 2000, using the maximum information available from Eurostat.

putting this accounting framework on a quarterly basis using Eurostat's quarterly indicators when these are available.

The construction of the capital stock

Data from Eurostat provide investment series, in value and in volume — all products and all agents combined — as well as the series for the consumption of fixed capital in value. Eurostat compiles this series by aggregating national series. It therefore includes information that is useful for the calculation of a series for the capital stock.

To calculate the stock of capital in volume (K_t), the following accumulation model is used:

$$K_t = (1-\delta_t).K_{t-1} + I_t$$

With information on investment and the consumption of fixed capital, deflated by the investment price, this equation makes it possible to compile the series for capital once a point in the series is chosen. This also amounts to setting the depreciation rate at a given date, for example in Q1 1991, the start of the Eurostat series.

For this purpose, one takes the accumulation model in a stationary regime. In such a regime, the investment and the stock of capital grow with GDP, at a rate γ such that:

$$(1+\gamma).K = (1-\delta).K + (1+\gamma).I$$

The depreciation rate is then deduced as a function of the consumption of fixed capital and of investment:

$$\delta = \frac{\gamma.(\delta.K)}{(1+\gamma).I - (\delta.K)}$$

If the average growth rate of the economy is estimated to be 2.5%, it is deduced that the depreciation rate was 0.9% in Q1 1991, and showed a trend rise during the decade to reach 1.3% in Q3 2001. This corresponds to the generally accepted fact that the depreciation rate rose during the 1990s, because of the increasing use of high-tech materials that became rapidly obsolete.

The series for capital reconstructed starting from Q1 1991 preserves the property of growth in the depreciation rate during the 1990s [1].

Foreign trade

One of the principal difficulties associated with macroeconomic modelling for the euro zone is to find statistics for external trade with countries outside the zone that are compatible with the national accounts data used for estimating most types of economic behaviour used in the model. The Eurostat national accounts include, at present, statistics for trade in goods and services in value and in volume that include intra-zone trade. At the same time, there exist data for exports and imports of goods within and outside the euro zone which Eurostat reconstructs on the basis of national customs data. Unit value indices are also published on a sectoral and geographic basis.

Given the data available, two types of modelling of external trade for the euro zone could in our view be envisaged:

- reconstructing data for trade outside the zone in goods and services taking national accounts figures, at the cost of simplifying assumptions regarding trade behaviour within the zone.
- using the available trade statistics and unit value indices for the field covered by customs data and to model the service data on a somewhat mechanical basis.

The approach adopted here is the second of these, using trade statistics corresponding to the customs coverage. Admittedly these data cover only trade in goods and are not directly compatible with data in the national accounts (differences in coverage, classification, etc.). However, for the moment they constitute the best statistical information available on trade flows with outside the zone.

Employment and the unemployment rate

The gross data used for the employment series emanate from Eurostat. Seasonal adjustment using X11 has been carried out.

In the case of the unemployment rate, this is the one contained in the Eurostat database, available since 1993. For the period between 1991 and 1993, the series was back-calculated using national data.

Public finances

As regards public finances, Eurostat has annual data making it possible to reconstitute the resource-use table for general government from 1995 to 2000 [2] and the evolution of the outstanding amount of public debt from 1991

(1) The ECB in its model uses a depreciation rate of 1%, constant throughout the decade
(2) On the other hand, for the period 1991-1994, Eurostat publishes only data using the previous base, which have not been back-calculated. The construction of the account for central government before 1995 has not for the moment been undertaken but could be partly carried out using as allocation scales the corresponding items in the household account or the aggregation of statistics at OECD level.

BOX 1: THE RECONSTRUCTION OF MISSING DATA FOR THE PURPOSES OF ECONOMIC ANALYSIS

to 2001. The outstanding debt used in the database, recalculated on the basis of the evolution in government financing capacity (3), comes very close to the series provided by Eurostat. Following the construction of a consistent annual accounting framework from 1995 to 2000, we proceeded to put it on a quarterly basis using the Chow-Lin method.

In the breakdown used for the modelling, the resources of general government are divided into, on the one hand, direct taxes on production and imports, income and property taxes and, on the other, spending corresponding to social contributions, interest payments, social benefits, public consumption and investment. Some secondary headings made it possible to reconstruct the production account of general government (gross operating surplus and operating subsidies) or other headings of the income account (other transfers, other current expenditure on capital).

Other elements

The interest rates are calculated by the Direction de la Prévision on the basis of aggregated national data expressed as shares of GDP. The real effective exchange rate and world demand for goods have been supplied by the Direction de la Prévision. ■

(3) Using, for the period before 1994, the deficit/GDP ratios supplied by the European Commission.

BOX 2: THE THEORETICAL FRAMEWORK OF THE MODEL

Supply side

The production function

For reference (and as emerges from the data at the time of the estimate described in *box 3*), a production function of the Cobb-Douglas type was used:

$$y = \alpha . l + (1-\alpha) . k + \gamma . t + cte$$

(Y, value added at factor cost; L, employment; K, the stock of capital in volume; t, a deterministic linear trend; variables shown in lower case are expressed as logarithms)

In specifications of this type, the elasticity of substitution between capital and labour is equal to 1 and technical progress is neutral, being modelled simply by a deterministic linear trend.

Demand for factors

- ***Demand for labour***

Employment derives simply from the first-order condition of the maximisation of corporate profits under monopolistic competition. This means that, with a Cobb-Douglas production function, the share of wages is fixed as a function of α and of the elasticity η of the demand for goods at prices:

$$\frac{W}{P} = \alpha . \kappa . \frac{Y}{L} \qquad where \ \kappa = 1 - 1/\eta$$

(W, wages; P. the price of added value)

The above first-order condition naturally constitutes the long-term relationship of the employment equation. In the short term, the demand for labour adjusts gradually to fluctuations in activity.

- ***Investment***

As regards the stock of capital, the first-order condition of profit maximisation has been combined with the long-term relationship between capital and investment derived from the accumulation equation:

$$\frac{R}{P} = (1-\alpha) . \kappa . \frac{Y}{K}$$

$$Accumulation : \frac{I}{K} = \delta + (\dot{K})^{longterm}$$

(R, the cost of capital; I, investment)

We therefore preferred to estimate an investment equation having for the long term:

$$\frac{Y}{I} = \frac{1}{(1-\alpha) . \kappa . \left(\delta + (\dot{K})^{longterm}\right)} \cdot \frac{R}{P}$$

R/P is proxied by the long-term real interest rate with correction for the risk premium and the depreciation rate.

We also preferred to adopt the specification using investment rather than capital stock, since the specification using the latter results in an extremely slow adjustment in the capital stock. The investment equation also includes in the short term a strong accelerator effect.

BOX 2: THE THEORETICAL FRAMEWORK OF THE MODEL

The wage-price loop

• ***Prices of value added***

Prices are set by firms at the same time as their demand for factors, without immediately ensuring equilibrium on the market for goods. The usual "factor price frontier" is not explicitly the long-term relationship for prices. Rather, the assumption has been made that firms calculate their labour costs over the long term as a function of the wage rate and the long-term labour productivity and adjust their mark-ups in line with the imbalances recorded on the market for goods. The imbalance on this market is given by the capacity utilisation rate:

$$p = w - gfp \,/\, \alpha + \frac{1-\alpha}{\alpha}.cur$$

The equation for prices of value added is based on this long-term relationship and includes a short-term sub-indexing on wage inflation.

That capacity utilisation rate is modelled in traditional manner:

$$CUR = \frac{Y}{\pi_k.K}$$

(π_K , the potential productivity of capital).

Assuming π_K to be constant, one obtains in logarithmic form the following expression from which constants are omitted:

$$cur = y - k$$

Taking into account the long-term relationship in the equation for the prices of value added, one arrives at the factor price frontier. In fact, combining the two previous equations with the first order condition for the capital stock, one obtains:

$$cur = \rho - p$$

And hence:

$$\alpha.(w-p) + (1-\alpha).(\rho - p) = gfp$$

• ***Wages***

Two options are possible for the modelling of wages.

Case 1 (Phillips): the first is that of a Phillips curve, linking over the long-term evolutions in the real wage and the rate of unemployment.

$$\Delta(w - pc) = -\beta.u + \lambda$$

In the short term, the indexing of wages on consumer prices is not immediate.

Case 2 (WS): in a second option, wages are modelled using a WS curve, as seen in models for wage bargaining, for example. The wage curve is identified (in relation to that of prices) through the introduction of "wedge" variables (terms of trade and tax wedge):

$$w - p = (pc - p) + wedge + gfp \,/\, \alpha - \beta.u$$

In the short term, the indexing of wages on consumer prices is quasi-unitary

Structural inflexions in activity

The participation rate t_a is assumed to depend negatively on the long-term unemployment rate:

$$t_a = ls - pop1564 = -\chi \,/\, (1-\chi).u$$

This can be written as the fact that the labour force is a geometric mean of employment and population of working age (pop1564):

$$ls = \chi.l + (1-\chi).pop1564$$

The NAIRU

Case 1 (Phillips): the NAIRU is derived directly from the wages equation and the price equation, taking first differences:

$$u^* = [\lambda - \dot{gfp}] \,/\, \beta = \lambda'/\beta$$

Case 2 (WS): the NAIRU is derived from the juxtaposition of the long-term equations for the factor price frontier and wages (after allowing for dynamic elements which can marginally distort the result) leading to the existence of equilibrium unemployment rate :

$$u^* = \left[(pc - p) + wedge + \frac{1-\alpha}{\alpha}.(\rho - p)\right] / \beta$$

The potential of the economy

The potential of the economy can easily be calculated on the basis of the first order condition for labour:

$$y^* = ls - u^* + (w - p)$$

Using the dependence of the labour force on the unemployment rate.

$$ls = pop1564 - \chi \,/\, (1-\chi).u$$

and that of wages on the real cost of capital.

$$\alpha.(w-p) + (1-\alpha).(\rho - p) = gfp$$

$$y^* = pop1564 - 1\,/\,(1-\chi).u^* + gfp \,/\, \alpha - \frac{1-\alpha}{\alpha}.(\rho - p)$$

This implies that possible impacts on the unemployment rate are intensified on production.

All in all, depending on the case chosen:

Case 1 (Phillips):

$$y^* = pop1564 - 1\,/\,(1-\chi).\lambda'/\beta$$

$$+ gfp \,/\, \alpha - \frac{1-\alpha}{\alpha}.(\rho - p)$$

The potential of the economy depends in this case on the population of working age, global factor productivity and the real cost of capital.

BOX 2: THE THEORETICAL FRAMEWORK OF THE MODEL

Case 2 (WS) :

$$y^* = pop1564 + pgf\ /\ \alpha - \frac{1}{\beta.(1-\chi)}.(pc - p)$$

$$- \frac{1}{\beta.(1-\chi)}.wedge - \left(\frac{1}{\beta.(1-\chi)} + 1\right).\frac{1-\alpha}{\alpha}.(\rho - p)$$

Apart from the factors already mentioned for case 1, the potential of the economy in case 2 depends also on the terms of trade and taxation.

Demand prices and balancing in value terms

For the purpose of achieving balance in terms of value, there remain to be determined consumer prices, investment prices and prices of stocks. This is done in the traditional way.

The prices for consumption and investment are in the long term a geometric mean of domestic prices (value added) and external (import) prices. For lack of data on VAT by product, it has been assumed that taxes on products concern only consumption. As a result, for the consumer prices, this tax effect was added. Not having data of this kind further back than 1996, it was difficult to estimate their impact. This is why unit elasticities for consumer prices were imposed, in both the short and the long term. In practice, the introduction of taxes leads to obtaining a reasonable equation.

In terms of values, the model is balanced by adjusting the stock change item. ■

BOX 3: THE ESTIMATION OF THE MODEL

The estimation of parameter α of the production function and the trend in total factor productivity (TFP)

In a first stage, the choice of a production function of the Cobb-Douglas type can be motivated in relation to a production function permitting an elasticity of substitution between capital and labour different from 1. The Cobb-Douglas function is a particular specification of the CES function, which takes the following form (assuming neutral technical progress):

$$CES : Y = e^{\gamma.t}.\left[\alpha.L^{-\rho} + (1-\alpha).K^{-\rho}\right]^{-1/\rho}$$

($\sigma = 1/(1+\rho)$ is the elasticity of substitution between L and K)

When δ tends towards unity, the CES tends towards the Cobb-Douglas. In fact, using a limited development of the CES specification, in the neighbourhood of the Cobb-Douglas specification (i.e. around σ=1 i.e. ρ=0), one obtains (*cf. Kmenta, 1967*):

$$Kmenta : y = \alpha.l + (1-\alpha).k - \frac{1}{2}\rho.\alpha.(1-\alpha).(l-k)^2 + \gamma.t + cte$$

It can be verified in this way that the Cobb-Douglas specification used is not rejected by the data in comparison with a less constraining specification such as a CES. In fact the coefficient $\rho(1-\alpha)\alpha$ is not significant in the following regression (1):

$$y = \underset{(c)}{(1-0.40)}.l + \underset{(4.28)}{0.40}.k + \underset{(0.28)}{0.71}(k-l)^2 + \underset{(6.91)}{0.90\%}.t + \underset{(2.91)}{0.12}.tuc - \underset{(-8.33)}{21.27} + u$$

$$u = \underset{(4.46)}{0.80}.u_{-1} - \underset{(-1.78)}{0.26}.u_{-2} + \varepsilon \qquad R^2 = 0.996 \quad \sigma_\varepsilon = 0.24\% \quad DW = 2.22 \quad 1992q1-2000q4$$

Note: in order to circumvent the dependence of the estimates obtained on the choice of estimation period, the preceding equation was estimated correcting for the auto-correlation residuals using the Cochrane-Orcutt method and the log of the capacity utilisation rate was added.

(1) In this regression, it is seen that the dimension of K (or of L) changes the estimated values of α and of the constant, but not of the other coefficients, nor of the standard deviations. In the previous regression, K was multiplied by a coefficient in order to have α = 0.40, as subsequently used.

BOX 3: THE ESTIMATION OF THE MODEL

It is therefore possible to use the Cobb-Douglas specification with $\alpha = 0.60$ and a trend growth in global factor productivity of 0.92% a year, as shown by the following estimation:

$$y = \underset{(c)}{(1-0.40)}.l + \underset{(4.40)}{0.40}.k + \underset{(9.87)}{0.92\%}.t + \underset{(2.95)}{0.12}.cur - \underset{(-13.27)}{18.70} + u$$

$$u = \underset{(4.50)}{0.80}.u_{-1} - \underset{(-1.86)}{0.25}.u_{-2} + \varepsilon \qquad R^2 = 0.996 \quad \sigma_\varepsilon = 0.23\% \quad DW = 2.21 \quad 1992q1 - 2000q4$$

With these estimates adopted, this equation does not enter the model in this form, but solely in derivative forms (first-order conditions for employment and capital stock, providing the long-term aspects of the employment equations, prices of value added and investment: (*cf. box 2*)).

The econometric equations in the model (with the usual notations)

- ***Supply:***

Investment :
$$\Delta i = \underset{(-2.33)}{-0.18}.(i-y)_{-1} - \underset{(-1.65)}{0.20}.\frac{Pi}{P}(r10 - \Delta_4 pi + txdec)_{-1} - \underset{(-2.39)}{0.25} + \underset{(4.99)}{2.35}.\Delta y$$

$$i^* = y - 111\,(r10 - \Delta_4 pi + txdex) \qquad R^2 = 69\% \quad \sigma = 0.85\% \quad DW(0) = 2.6 \quad 1992q3 - 2000q4$$

Employment :
$$\Delta l = \underset{(-3.39)}{-0.080}.\left[l - (y - (w-p))\right] + \underset{(-3.39)}{0.14} + \underset{(2.50)}{0.33}\Delta l_{-1} + \underset{(4.92)}{0.17}.\Delta y + \underset{(1.90)}{0.07}.\Delta y_{-1} - \underset{(-3.47)}{0.13}.\Delta(w-p)$$

$$l^* = y - (w-p) \qquad R^2 = 94\% \quad \sigma = 0.08\% \quad DW(0) = 189 \quad 1991q4 - 2001q3$$

Labour force :
$$\Delta ls = \underset{(-3.89)}{-0.32}.(ls-l)_{-1} + \underset{(3.72)}{0.22}.(pop1564 - l)_{-1} + \underset{(3.73)}{0.08\%}.t - \underset{(-3.73)}{176} + \underset{(4.28)}{0.52}.\Delta ls_{-1} + \underset{(6.24)}{0.72}.\Delta l - \underset{(-5.33)}{0.55}.\Delta l_{-1}$$

$$ls = 0.30.l + 0.70.pop1564 \qquad R^2 = 78\% \quad \sigma = 0.05\% \quad DW(0) = 2.42 \quad 1992q1 - 2000q4$$

Price of value added :
$$\Delta p = \underset{(-3.76)}{-0.13}.\left(p - (w - pgf\ /\ \alpha) - \frac{1-\alpha}{\alpha}.tuc\right)_{-1} + \underset{(3.76)}{3.17} + \underset{(4.97)}{0.55}.\Delta w$$

$$p^* = w - pgf\ /\ \alpha + \frac{1-\alpha}{\alpha}.tuc \qquad R^2 = 70\% \quad \sigma = 0.23\% \quad DW(0) = 171 \quad 1994q1 - 2001q3$$

- ***Demand:***

Consumption :
$$\Delta c = \underset{(-2.36)}{-0.20}.(c - (rdb - pc))_{-1} - \underset{(2.04)}{0.14}.(r10a - \Delta_4 pc)_{-1} - \underset{(-1.89)}{0.13}.\Delta_4 pc_{-1} + \underset{(2.38)}{0.90}$$

$$- \underset{(-4.24)}{0.010}.(dum93q1 - dum92q4) - \underset{(-2.26)}{0.29}.\Delta c_{-1} + \underset{(2.39)}{0.36}.\Delta(rdb - pc) - \underset{(-1.80)}{0.17}.\Delta(r10a - \Delta_4 pc) - \underset{(-2.23)}{136}.\Delta u$$

$$c^* = rdb - pc - 0.70.(r10a - \Delta_4 pc) - 0.65.\Delta_4 pc \qquad R^2 = 77\% \quad \sigma = 0.30\% \quad DW(0) = 2.23 \quad 1992q3 - 2000q4$$

BOX 3: THE ESTIMATION OF THE MODEL

Exports :

$$\Delta x = \underset{(-7.46)}{-1}04.(x - dm^*)_{-1} + \underset{(2.67)}{0.23}.(p\$^* - e - px)_{-1} + \underset{(6.96)}{54.8} + \underset{(4.46)}{0.98}.\Delta dm^* - \underset{(-6.62)}{0.023}.t + \underset{(5.22)}{0.63}.Dum_{t \geq 95q1}$$

$$x = dm^* + 0.22.(p\$^* - e - px) - 2.2\%.t \qquad R^2 = 79\% \quad \sigma = 143\% \quad DW(0) = 198 \quad 1992q1 - 2000q4$$

Imports:

$$\Delta m = \underset{(-2.36)}{-0.16}.(m - df)_{-1} - \underset{(-1.60)}{0.092}.(pm - p)_{-1} - \underset{(-2.79)}{18.17} + \underset{(4.58)}{194}.\Delta dihs + \underset{(1.68)}{0.68}.\Delta dihs_{-1} + \underset{(2.79)}{0.008}.t + \underset{(5.04)}{0.48}.\Delta x$$

$$+ \underset{(2.39)}{0.23}.\Delta x_{-1} - \underset{(-4.30)}{0.51}\Delta(pmhe - p)$$

$$m = df - 0.575.(pm - p) + 5\%.t \qquad R^2 = 77\% \quad \sigma = 146\% \quad DW(0) = 2.21 \quad 1991q4 - 2001q3$$

■

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