New leading and coincident indicators for French manufacturing output

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On the basis of information from business tendency surveys, the INSEE publishes composite indicators, also known as "business climate" indicators, for various different sectors of the economy (industry, services, construction, wholesale, retail and automobiles) as well as general figures for the economy as a whole. These indicators are published monthly, providing a summary of the different balances of opinion found in the survey. They are coincident, in that they are closely correlated with the real output of the current quarter. In this respect, and since they are available very quickly, these figures are a good early indicator of the current state of affairs in a given sector.

On the other hand, while these tendency surveys do include questions concerning future business (expected output, general perspectives etc.), business climate indicators often prove to have little correlation with the reality of future quarters.

This report contains details of the composite indicators which rely on the same techniques of factor analysis used to produce the business climate indicators, but with two important modifications: firstly, they are constructed explicitly with manufacturing output in mind, and secondly they are adapted to fit a given forecasting horizon. These indicators have been calculated quarterly since 2000, on the basis of data taken from the second month's tendency surveys and the quarterly accounts available in that quarter, providing the "real-time" context from which the "Conjoncture in France" short-term economic report is produced.

These indicators are highly effective: for all forecasting horizons covered, they yield predictions which are more precise than those obtained from classical regression methods or from composite indicators derived purely from survey data. The chosen method thus seems to represent a good compromise in terms of conserving and using sparingly the information contained in the business tendency surveys. These indicators lead us to expect a less-than-dynamic performance from the manufacturing sector in the first few months of 2012. ■

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The business climate indicators currently available are above all coincident indicators

These "business climate" figures act as a condensed summary of the information contained in the business tendency surveys

Business tendency surveys, conducted monthly in the key sectors of the economy, provide information which is essential to analysing the state of confidence in the economy. They are available almost in real time, several weeks before the production data or quarterly accounts are published.

Every month, for every sector and the economy in general, the INSEE calculates a "business climate" indicator which summarises the current state of confidence in a given sector, as seen by business leaders (see *Graph 1*). Based on factor analysis methods [(1)], this indicator summarises the results of several opinion surveys conducted as part of the broader monthly tendency survey. This aggregated indicator is easier to use than the data from individual opinion surveys, as it is less volatile.

The "business climate" indicator is a coincident indicator which reflects the current conditions...

In all sectors, the business climate figures show strong correlation with the actual production trends for the quarter in question (see *Table 1 and Graph 2*) [(2)]. In the industrial sector, for example, the quarterly business climate indicator shows a 54% correlation with the quarterly growth rate of industrial output.

This is not necessarily a logical consequence of the structure of the indicator: the composite business climate indicator for a given sector is designed to include as much corresponding information as possible from across the different opinion surveys. It is not necessarily designed for maximum correlation with the output figures for the sector.

...but it is not a composite leading indicator.

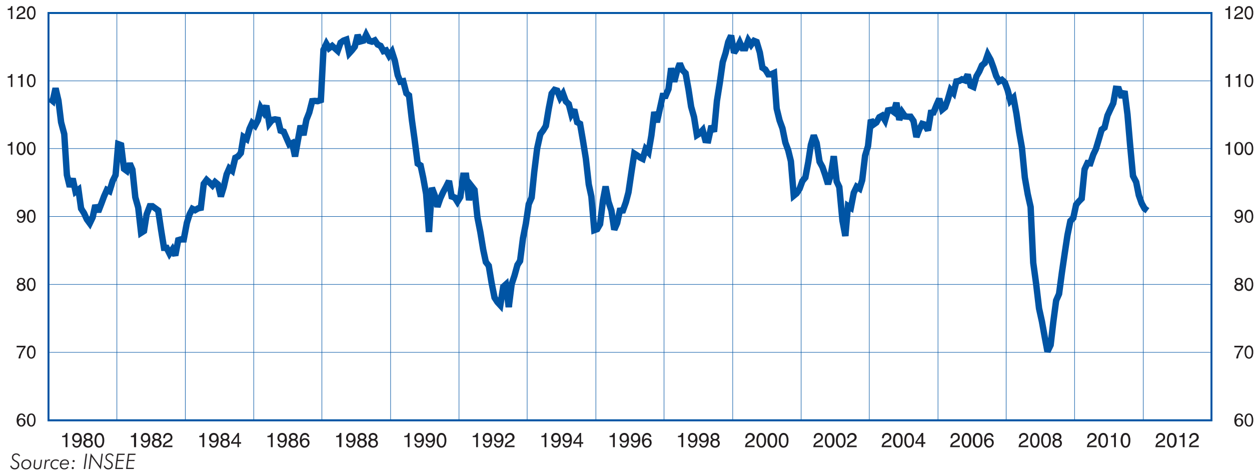
Nonetheless, there are two major restrictions which limit the utility of the "business climate" indicator as an indicator of current output trends.

Firstly, forecasters seek to predict future activity for different forecasting horizons (traditionally for the current quarter, Q, and the following two quarters, Q+1 and Q+2). But the indicators currently available show little correlation with the true

(1) cf. *Clavel and Minodier (2009)* for a presentation of the whole-economy indicator, *Doz and Lenglart (1995)* for industry, *Cornec and Deperraz (2007)* for services, and the *'INSEE method'* documents available for each tendency survey and corresponding business climate indicator.

(2) This composite indicator is used to predict the evolution of output from each sector, using 'calibration' models (cf. *Dubois and Michaux, 2006*).

1 – Business climate in France



Source: INSEE

output figures for future quarters (*see table 1*): they are coincident, not leading indicators.

Secondly, the composite business climate indicator is not designed for maximum correlation with actual production in the sector it covers. If such correlation is the main objective, an indicator which is different but still founded on the balance of opinion figures from the business tendency surveys may offer a more efficient method for predicting the output of a given sector.

In this document we will demonstrate that it is possible to:

- create a suitable indicator for each forecasting horizon: Q, Q+1 and Q+2,
- improve the performance of the business climate indicator as a coincident indicator

Table 1

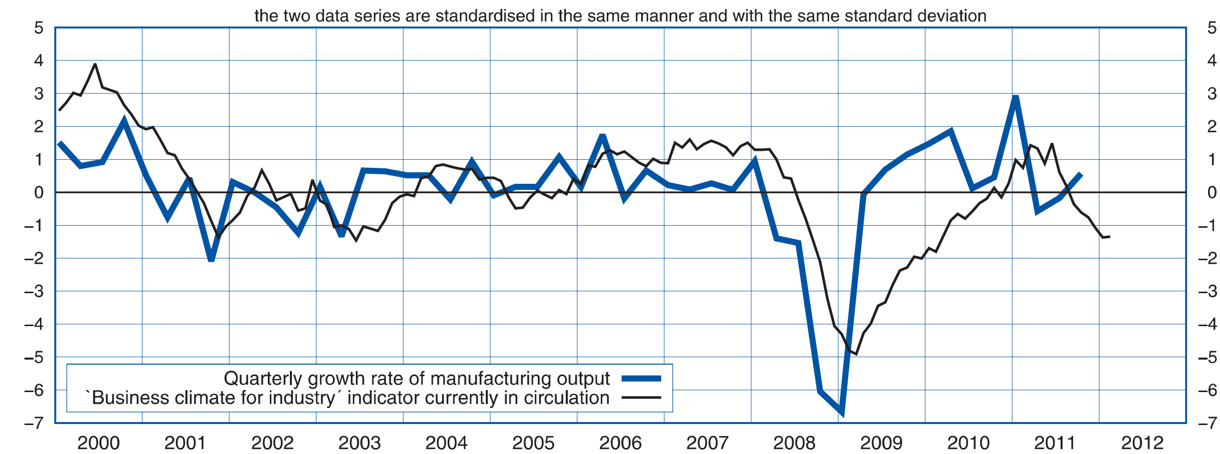
Correlations between business climate figures currently in circulation and the quarterly growth rates for manufacturing output and for all sectors

in %

Correlations calculated for the period 2000Q1 – 2011Q4	Forecast horizon		
	Current quarter Q	Quarter Q+1	Quarter Q+2
Correlation between the business climate for industry indicator currently in circulation (quarter-adjusted) (3) and the quarterly growth rate of manufacturing output for different forecast horizons.	54	20	-6
Correlation between the French business climate indicator currently in circulation (quarter-adjusted) and the quarterly growth rate of GDP for different forecast horizons.	63	33	5

(3) The business climate indicator for industry is part of a monthly series, as are the balance of opinion figures calculated from the results of the business tendency surveys. The variable of interest in this case, the quarterly growth rate of output, is a quarterly series. But calculating the correlation between two time series requires that both series share the same periodicity. In this case, to calculate the correlation between a monthly indicator derived from tendency surveys (such as the most recent available "business climate for industry" indicator) and a quarterly output growth rate, the monthly tendency indicator is "quarter-adjusted" by taking the figure from the second month of each quarter as representative of that quarter as a whole.

2 – Business climate for industry and quarterly growth rate of manufacturing output



Source: INSEE

Methodology for producing coincident and leading indicators for industry

Industry is a crucial sector for short-term fluctuations

The rest of this document will focus on the industrial sector. While industry may be smaller than the service sector in terms of market value-added (around 12%), the fluctuations in activity levels in this sector are more pronounced than those encountered in services, accounting for 30% of variation in market value-added. Moreover, business tendency surveys for industry are available for a longer time period.

Coincident and leading quarterly indicators are founded upon the key variable of interest: the growth rate for manufacturing output. Three different indicators are produced: one for the growth rate for production in the current quarter Q, and for the production growth rate for the next quarter (Q+1) and one for the production growth rate over the next two quarters (Q+2). These indicators can be produced quarterly, as soon as results are available for the second month's tendency surveys.

To draw up these indicators, we use the quarterly balance of opinion deduced from the industrial business tendency survey (*see Box 1*) The same six balance of opinion figures are used to calculate the business climate indicator currently published by the INSEE (*see Graph 3*).

These indicators are said to be "calculated in real time" because for each date the circumstances are the same as those in which the "*Conjoncture* in France" report was produced: the results of the business tendency surveys from the second month of the current quarter and the manufacturing output data from the last quarter are already available, but the data for the current and coming quarters are ignored. The model is thus re-assessed for each new date using the information which was actually available at this date - giving a "real time" picture.

The aim: to extract corresponding information, from the places where the balance of opinion and the manufacturing output growth rates are in alignment.

Business climate figures are produced via factor analysis, which involves extracting the "common factor" from a set of variables - summarising as accurately as possible the information of all of the variables for each date. If we use X^i_t to represent the survey balance for a given date t (this balance having already been transformed into a quarterly figure by taking the figure from the second month of every quarter to represent that quarter as a whole) and F_t for the common factor at date t, each balance of opinion indicator from the survey covers the contribution of this common factor to the various balances and a figure which is unique to

Box 1 - Tendency surveys in industry

With these tendency surveys, INSEE consults a panel of businesses and asks them to give qualitative responses to a series of questions. The INSEE's monthly business tendency survey also includes six questions directly related to the company's line of business (separate from the two questions on prices). Industrial interviewees are asked about:

- recent and probable future developments in their own output;
- the state of their order books, for exports and all orders together;
- inventory levels;
- finally, on the general outlook for output in their sector (i.e. the industrial sector as a whole).

There are several different possible qualitative responses (rising/stable/falling; above average/average/below average). The questions cover both the recent past and the near future.

For each question, we then calculate the percentage of responses in each category (situation improving, stable, deteriorating) and aggregate the scores, taking into account the size of the businesses surveyed, where necessary. The information resulting from these answers is then presented as a "balance of opinion", calculated as the difference between the percentage of companies seeing improvement and the percentage of companies who feel that the situation is getting worse. Monthly tracking of these "balances" allows us to monitor the evolution of opinion in professional circles concerning these matters. ■

the individual balance (*see Appendix*). The "business climate" composite indicator is thus arrived at by estimating the value of this common factor *(cf. Doz and Lenglart, 1999)*.

The "classical" model is as follows: (1) $X^i_t = \Lambda_i' F_t + \varepsilon^i_t$

with X^i_t representing balance of day; D the common factor; Λ_i the weight vector; ε^i_t a residual.

This model pinpoints the information which is shared by the different balances, but does not integrate one key variable of interest: manufacturing output.

The method put forward in this document is a means of expanding the model (1) so as to take into account both the balances of opinion and the growth rate of industrial output, by identifying the common factor which best sums up the information contained in the tendency surveys and the real output figures. The model (1) can be simply extended to:

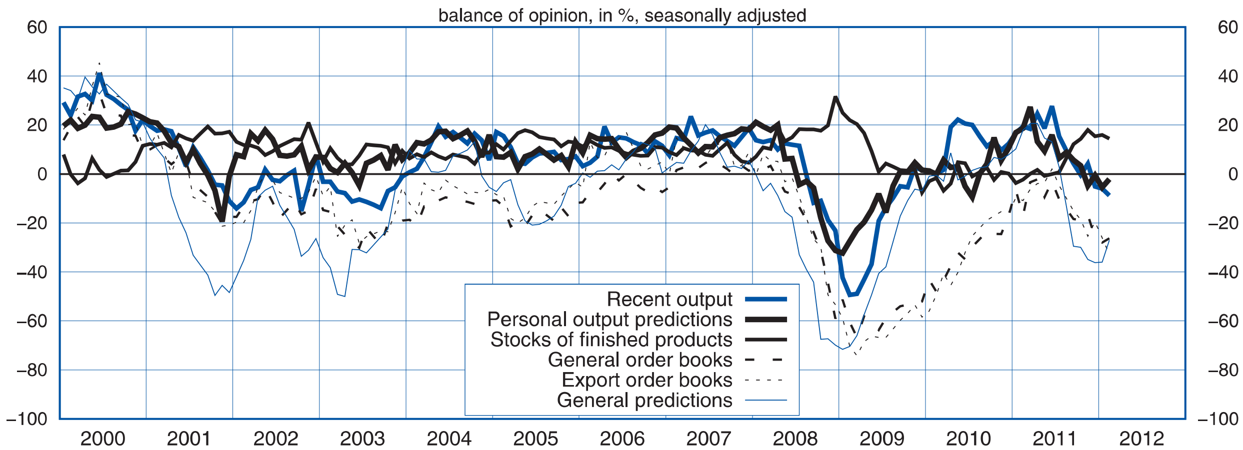
$$(2) \quad \begin{cases} X^i_t = \Lambda'_i F_t + \varepsilon^i_t \\ \widetilde{Y}_t = \Gamma' F_t + \eta_t \end{cases}$$

with $\widetilde{Y}_t$ the variable of interest; Γ the weight vector for this variable and η_t a residual

This modelling process presents three major advantages:

- very easy to adapt to the relevant timeframe. To adapt, we simply select $\widetilde{Y}_t = Y_t$ (and respectively $\widetilde{Y}_t = Y_{t+1}$, $\widetilde{Y}_t = Y_{t+2}$) for a coincident indicator (respectively brought forward to the order of 1, 2),
- capable of directly integrating the magnitude of interest $\widetilde{Y}_t$ the quarterly growth rate of output in order to optimise correlation with the composite indicator,
- can be applied "in real time" to take account of the chronological characteristics of the period for which tendency surveys have already been completed before output data is released.

3 – "Balance of opinion" data used to calculate the "business climate for industry" indicator



Source: INSEE

New leading and coincident indicators for French manufacturing output

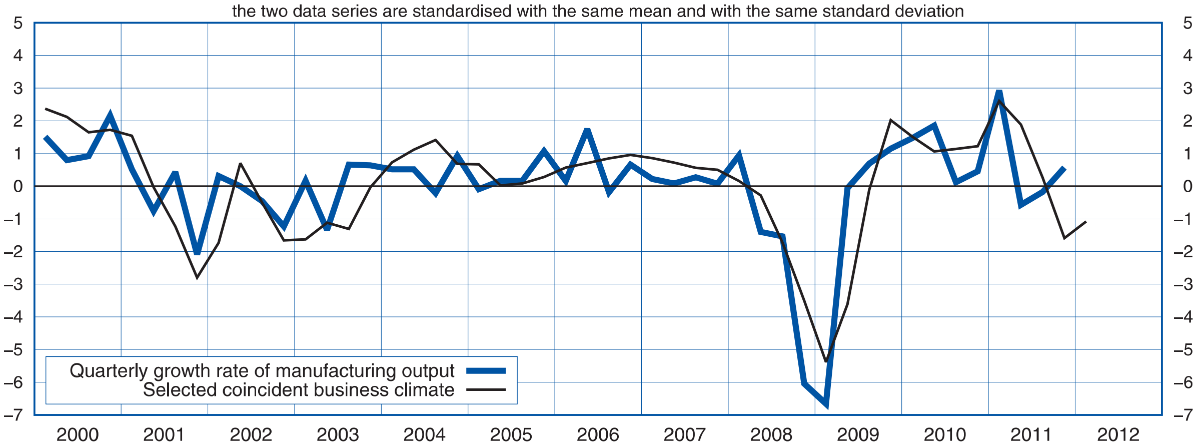
These indicators allow us to present a snapshot of industrial activity in the current quarter, and for the next two quarters

New, more efficient coincident and leading indicators

This method allows us to produce industrial indicators which cover the current quarter, the coincident indicator, and the following two quarters, the leading indicators (see *Graphs 4 and 5*).

In order to assess the accuracy of these indicators, we examine their performance by assessing their correlation with the actual development of industrial output, by comparing them with other indicators (see *Table 2*): the current "business climate" for industry indicator, the balances of opinion concerning recent output trends and the personal output predictions, along with an indicator calculated by direct linear regression of the output growth rate against the balances of opinion.

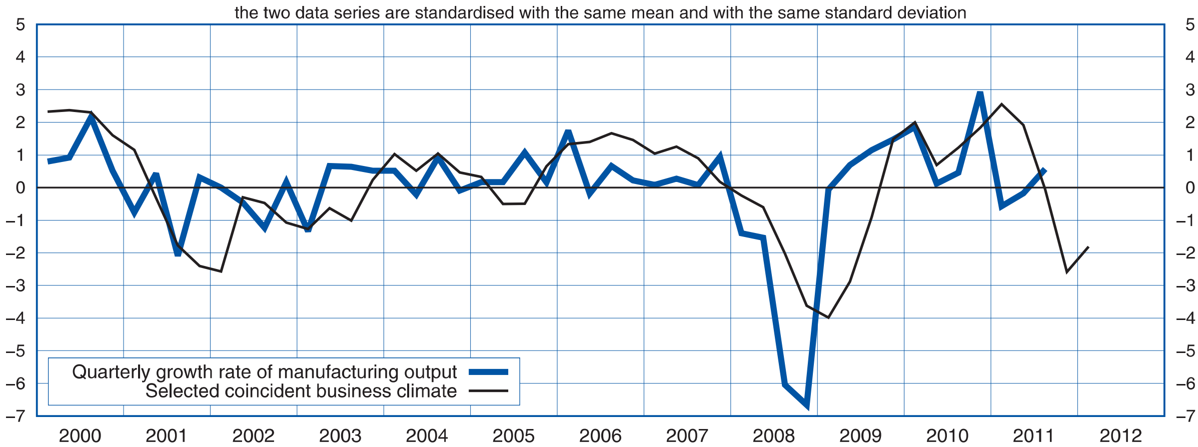
4 - Superimposing the quarterly output growth rate on the selected coincident indicator



How to read it: On the x-axis is plotted the date at which the coincident indicator was calculated. The coincident indicator calculated for the fourth quarter of 2011 predicted growth of -1.5% for this quarter, where as the monthly accounts reveal that manufacturing output actually grew by 0.6%.

Source: INSEE

5 – Superimposing the quarterly output growth rate (for the next quarter) on the selected leading indicator for the next quarter



How to read it: On the x-axis is plotted the date at which the coincident indicator was calculated. For example, in the third quarter of 2011 the leading indicator for Q4 2011 predicted negative growth of 0.1%. The actual growth rate for the fourth quarter of 2011 was in fact 0.6%.

Source: INSEE

For all forecasting horizons, composite indicators created using this method are more effective than the current indicator (calculated in the second month of the quarter underway) and all balance of opinion indicators concerning predicted future activity (particularly the quarterly balance of opinion concerning personal output predictions).

In terms of predictive power, the improvement is notable for quarter Q (76% correlation, up from 54% with the current indicator) and even more remarkable for Q+1 and Q+2. For Q+1, the indicator we currently use achieves correlation of 20%, with the new model much higher at 52%. For Q2, the correlation between the current indicator and the growth rate is next to zero (-6%), whereas the new indicator shows a correlation of 28%.

Indicators created using this method are also more effective than direct prediction methods based on linear regression of output against the balances of opinion. This superiority is a little more surprising. It is most likely due to the fact that factor analysis allows us to dramatically reduce the amount of explanatory variables while preserving, for the cases studies here, all of the information contained in the balances which can be used for predictions (*see Box 2*).

The current climate reviewed in light of these indicators

As for the current period, the coincident indicator and the leading indicators are not very strong. Although they did underestimate the rate of growth in manufacturing output for Q4 2011, the indicators still predict a less-than-dynamic performance from the manufacturing sector in H1 2012. ■

Table 2

Correlations calculated in real time between the different indicators and the quarterly growth rate in manufacturing output for the horizons Q, Q+1 and Q+2

in %

Correlations with the quarterly growth rate of manufacturing output – calculated in real time over the period 2000Q1 – 2011Q4.	Forecast horizon		
	Currently quarter Q	Quarter Q+1	Trimestre Q+2
Current industry climate indicator, quarter-adjusted	54	20	-6
Recent production trends, quarter-adjusted	62	20	-1
Personal output predictions, quarter-adjusted	71	34	-1
Linear regression of the quarterly growth rate of manufacturing output against the six balance of opinion figures used to calculate the current business climate indicator	72	40	11
Coincident indicator used	**76**		
Leading indicator for Q+1		**52**	
Leading indicator for Q+2			**28**

How to read it: The table presents the correlations obtained for each forecast horizon. The first line corresponds to the current industry climate indicator. The second and third lines correspond respectively to the balance of opinion figures for "recent production trends" and "personal output predictions". The fourth line gives the linear regression of the quarterly growth rate of manufacturing output over the six data sources used to calculate the current monthly business climate indicator. The final three lines contain three indicators which form part of our calculation method, one for each forecast horizon: Q, Q+1 and Q+2.

Source: INSEE

Box 2 - Comparing the forecasting accuracy of this indicator and the linear regression method

An obvious next step is to compare the performance of this composite indicator with that of a simple linear regression analysis of the growth rate of manufacturing output against the six balance of opinion figures. This simple comparison cannot impede the performance of the predictive calibrations established for the different forecasting horizons (*cf. Dubois É. and Michaux E. 2006*).

For all of the forecasting horizons considered, these indicators return better out-of-sample correlations than the corresponding regression calculations (*see Table 2*).

It should be recalled that the predictive power of the linear regression method can decrease as the number of explanatory variables increases: the so-called "curse of dimensionality". Indeed, with a linear model $Y = X\beta + \varepsilon$, the predictive error can be estimated by:

$$E(Y-\hat{Y})^2 \cong \sigma^2 + \frac{\sigma^2 p}{T}$$

where *p* is the number of explanatory variables and σ^2 the noise variance. The effect on the variance of the prediction error of increasing the number of explanatory variables is a result of two contradictory phenomena: firstly, the direct and detrimental effect of the presence of factor p in the second part of the equation; secondly, the positive effect on variance σ^2 . In extreme cases where all of the relevant information included in the balances of opinion can be summarised in a single variable (the estimated factor), using this factor as the sole explanatory variable can allow us to reduce the number of variables retained (term p) without affecting the noise variance (term σ^2), thus reducing the overall variance of the prediction error.

The results given in this document lead us to believe that we are probably fairly close to this extreme scenario: reducing the dimensionality of the problem while retaining as much information as possible, made possible by factor analysis, then regressing the variable of interest against the common factor obtained allows us to improve our predictive performance. ■

Appendix - Estimating coincident and leading indicators

Either $t \in N^*$ the current quarter. In this study the first quarter is Q1 of 1980.

Or (y_t) the extension of observations of the quarterly growth rate of manufacturing output. These observations are supposed to have been generated by the creation of a time series $(Y_t)_t$.

Or (X_t) with $X_t \in R^d$ the multi-variable time series of d quarter-adjusted balance of opinion figures, taking the values from the second month of each quarter to represent the business climate for that quarter: the dimension vector d then represents the t^{th} observation of the d balance of opinion figures used. The single-variable time series of the b j^{th} balance of opinion is noted (X^i_t) and the t^{th} observation of the b j^{th} balance of opinion (x^i_t) plus the information $I_t : \sigma((X_t, Y_t)_t)$

The reduced centered data are considered in advance, along with the centered variable of the output growth rate. We suppose the existence of p latent unobserved factors. Each quantity observed (balance or growth rate) is thus expressed as the sum of a combination of these shared p factors and an individually-specific term. Following *Doz and Lenglart* (1999), we would also expect to observe an ARMA-type temporal dynamic in action on the factors and residual term of each series. The specification of our model can thus be expressed as follows:

$$\begin{cases} X_t^i = \lambda_{j1} F_t^1 + \lambda_{j2} F_t^2 + \ldots + \lambda_{jp} F_t^p + \varepsilon_t^i, \text{ pour tout } j \\ Y_t = \gamma_1 F_t^1 + \gamma_2 F_t^2 + , \ldots + \gamma_p F_t^p + \eta_t \\ F_t^i = \phi_{j1} F_{t-1}^i + \phi_{j2} F_{t-2}^i + \nu_t^i \\ \varepsilon_t^i = \alpha_i \varepsilon_{t-1}^i + \chi_\tau^\iota \end{cases}$$

from starting point F1 = F2 = 0 and with the following assumptions

- $(\chi_\tau^\iota, \eta_t)$ centered Gaussian white noise with covariance $Diag(\sigma_1^2, \ldots \sigma_d^2, \sigma^2)$,
- (v_t) centered Gaussian white noise, reduced to identify the model,
- (v_t) and $(\chi_\tau^\iota, \eta_t)$, independent ,
- $\lambda_{ij}, \alpha_i, \gamma_i, \mu, \phi_1, \phi_2$ real and positive real,
- and with p the number of unobserved factors.

The parameters are estimated by maximising the probability calculated with the help of the Kalman filter *(see Hamilton, 1994)*. They are estimated in real time: that is to say they are recalculated for each date, on the basis of all information available as of this date. The number of factors retained – p – is that number which maximizes the out-of sample correlation with the growth rate of manufacturing production, it has been empirically estimated at 3 for this study.

The two main advantages of such a model are:

1.This specification takes full account of the variable of interest, the rate of growth for output, unlike the currently-used common factor. This is not a key objective in and of itself, but it should allow us to construct an indicator better correlated with the output growth rate, for more accurate predictions.

2.The second major advantage is that this model allows us to select the forecasting horizon and thus construct leading indicators. For example, for the horizon t+2, we need only to replace Y_t in the equation by $\tilde{Y}_t = Y_{t+2}$. Specificity of this level is not possible with the current factor.

Traditionally, the composite indicator for the variable of interest Y_t is calculated as an approximation of the common factor, in the quadratic risk manner:

$$IS_t = \hat{\gamma}_1 E_{\hat{\theta}}(F_t^1 / I_t) + \hat{\gamma}_2 E_{\hat{\theta}}(F_t^2 / I_t) + \hat{\gamma}_3 E_{\hat{\theta}}(F_t^3 / I_t)$$

Finally, we should note that for a quarter t, data are available from surveys x^i up until quarter t. However, the exact value of the growth rate for quarter t is unknown. We must wait until the middle of the following quarter until this rate is known. Therefore the conditional outlook is calculated with knowledge of all past results up until t-1 for surveys, but up until t for output growth rates.■

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