

# Will activity accelerate or slow down? A few tools to answer the question

Fanny Mikol  
Matthieu Cornec

**Division Enquêtes de  
conjoncture**

One of the main questions put to economic forecasters is that of forecasted GDP growth level prior to the publication of the quarterly accounts. There has been an abundance of literature on the subject of point forecast spanning several decades, proposing a wide diversity of techniques to answer the question.

However, few studies have examined growth “profile” forecasts, i.e. the simple prediction of whether the growth rate in the quarter under consideration will be higher or lower than that of the last known quarter. And yet, apart from the exact figure itself, this growth rate trend is probably the information that users of short-term economic forecasts value most. Additionally, economic analysis is very often expressed in terms of GDP upturns and downturns, without necessarily referring to a given level of growth.

This report examines the various methods used to predict the GDP growth profile. Based on business tendency surveys, the out-of-sample simulations carried out show that it is in fact possible to provide pertinent information for forecasting the growth profile.

This analysis also serves to build a profile indicator which measures the chances of GDP accelerating or decelerating in the quarter to be forecasted. Built from the balances of opinion in business tendency surveys, this indicator is a useful tool for economic forecasters and is designed to be used in tandem with the existing composite indicators (business climate, turning-point indicator, etc.).

The indicator turns out to be very effective in forecasting the ups and downs of economic activity observed since the end of the recession. When applied to Q4 2011, this indicator points to a strong risk of a slowdown in activity. ■

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### Answering a simple question: will activity accelerate or decelerate?

*Short-term economic analysis is strongly focused on the ideas of acceleration and deceleration of the variables modelled...*

In the discourse of economic forecasters, the forecast scenario is very often described in terms of acceleration and deceleration: “output is picking up”, “activity is slowing”, etc. On the one hand, a qualitative assessment illustrates the direction given by economic growth stimuli without focusing on the growth figure itself: in a sense, it allows the forecaster to distance himself from the errors that may arise in forecasting this figure. On the other hand, predicting the growth profile of certain macroeconomic variables may be essential in certain fields: Sinclair et al. (2010), for example, consider that this would be the case for GDP and inflation forecasts, with the aim, among other things, of optimising monetary policy decisions.

*...but this question is not directly analysed*

However, this question is often eclipsed by that of predicting the growth figure, as witnessed by the vast literature on the subject covering both French data (Dubois and Michaux, 2006, Erkel-Rousse and Minodier, 2009, Bessec, 2010) and foreign data (Moore, 1983, Wallis, 1989, Sédillot and Pain, 2003).

Very few economic studies have looked at predictions of the growth profile. Instead, the methodology has been used for certain macroeconomic variables in fields such as finance (Merton, 1981, Henriksson and Merton, 1981). In macroeconomics itself, it only appeared relatively recently, and has mainly been used to provide a criterion in ex-post validation of growth prediction models (Stekler, 1994, Sédillot and Pain, 2003, Bessec, 2010).

*Building a direct forecast of the “acceleration” or “deceleration” of GDP*

Outside the domain of economic analysis, numerous fields use methods which consist in categorising observations into two (or more) groups, then using these classifications to make forecasts. In medicine, notably, patients can be categorised according to their characteristics (individual attributes and/or clinical measures) into an “at-risk” group and a “healthy” group. Once this classification has been made, the physician can assign patients to the group they belong to, observing only their characteristics, and thus determine a suitable treatment.

This is the logic adopted here for forecasting the growth profile: in particular, the as-yet-unknown growth profile can be placed in two categories, “acceleration of GDP” and “deceleration of GDP”. By means of a sequential reproduction of the framework in which the forecaster’s predictions are made each quarter, and using a number of economic indicators - here, the business tendency surveys - methods can be used to predict the GDP growth profile for the following quarter.

The originality of this work also lies in the variety of methods used. Indeed, as well as the usual econometric forecasting models, a wide range of classification methods can also be implemented; here we will detail only one of them. Ultimately, a profile indicator is presented, summarising in probabilistic terms the “risk” of a future deceleration (or acceleration) of GDP.

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### Predicting the growth profile from one quarter to the next: data and method

*Variable of interest: the first  
GDP results...*

Under the conditions in which *Conjoncture in France* is produced, the aim is to predict the profile of GDP growth between the previous quarter (where growth is known) and the current quarter (where it is still unknown). GDP growth in the previous quarter at the moment when *Conjoncture in France* is published corresponds to the first publication of the results of the previous quarter. These results are published 45 days after the end of the quarter. It is upon this publication that the short-term economic forecast is based at the INSEE, whose objective is to predict the following quarter and one or two quarters beyond.

*...and more specifically their profile*

Therefore, denoting as  $y_t$  the growth rate in quarter  $t$  published in the first results of quarter  $t$ , that is, at  $t + 45$  days, the problem is a matter of predicting the profile of the series of  $(y_t)$ : will  $(y_t)$  be higher or lower than  $(y_{t-1})$ ? For example, the first results relating to Q3 2011, published in mid-November 2011, give GDP growth of 0.4%:  $y_{2011T3} = 0.4\%$ . The challenge is thus to predict whether GDP growth in Q4, which will be published in the first results of the quarterly accounts in mid-February 2012, will be higher or lower than 0.4% ( $y_{2011T4} \geq y_{2011T3}$  or  $y_{2011T4} < y_{2011T3}$ ).

For each quarter since 1997, the variable of interest is thus defined, namely the direction of the variation in growth between  $t - 1$  and  $t$ , by:

$$\varepsilon_t = 1 \{ y_t \geq y_{t-1} \}$$

With this denotation there is an acceleration in quarter  $t$  (resp. deceleration) if  $\varepsilon_t = 1$  (resp.  $\varepsilon_t = 0$ ). The series of profiles covering the past, for the period [2000Q1; 2011Q3], is illustrated in *Table 1*<sup>(1)</sup>.

You can see for example that  $\varepsilon_t = 0$  for Q4 2010, which means that the first result of GDP growth in Q4 2010 (+0.4%) was lower than that recorded in Q4 2010 (+0.5%). In what follows, we will attempt to predict whether, for the current quarter, variable  $\varepsilon_t$  has a value of 1 or 0.

(1) In practice, it is observed that the values of the profiles at the dates under consideration are very stable: they change very little over time, between the first result and the successive revisions of the quarterly accounts.

**Table 1**

#### GDP acceleration and deceleration profile

	Q1	Q2	Q3	Q4
2000	0	0	0	1
2001	0	0	1	0
2002	1	1	0	1
2003	1	0	1	1
2004	1	1	0	1
2005	0	0	1	0
2006	1	1	0	1
2007	0	0	1	0
2008	1	0	1	0
2009	1	1	1	1
2010	0	1	0	0
2011	1	0	1	

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### *Economic data used to make this forecast: the business tendency surveys*

To make this forecast, the business tendency surveys conducted by the INSEE on companies in the main sectors of the economy offer numerous advantages. First, they give reliable information about recent trends in activity and about the expectations of business leaders. Next, they are very rapidly available, and on a monthly basis. In this respect they correspond to the most recent data and can be used to draw up a short-term diagnostic. Last, they only undergo minimal revisions.

The responses given by business leaders are generally qualitative in nature: for example, regarding the activity being forecasted, the questions elicit three possible responses: “increasing”, “stable”, and “decreasing”. In this report we make use of two types of information from the business tendency surveys. On the one hand the balances of opinion, which serve to quantify responses: this is, for any given question, the difference between the percentage of positive replies and the percentage of negative replies. On the other hand, the composite indicator published by the INSEE each month, which synthesises the data from all the sectors; the “business climate” in France.

### *A forecast in a sequential framework*

When the forecast for quarter  $t$  is elaborated, we have the data from the first results of GDP growth - and hence also the growth profiles - up to quarter  $t-1$ :

$$\varepsilon_{t-1} = (\varepsilon_1, \dots, \varepsilon_{t-1})$$

The data from the business tendency surveys are already available for the first two months of the quarter: we denote as  $x_t$  the information relating to the second month of quarter  $t$ . Forecasters also have the past data from the business tendency surveys  $x_1, \dots, x_{t-1}$  and can thus eventually observe:

$$x_t = (x_1, \dots, x_{t-1}, x_t)$$

Forecasters therefore have to predict the next  $\varepsilon_t$  occurrence in the sequence of profiles  $(\varepsilon_1, \dots, \varepsilon_{t-1})$ , and they also know the economic data  $(x_1, \dots, x_t)$ .

### **Multiple forecasting strategies are possible, with varying performances**

Numerous strategies can be envisaged to predict the growth profile. To compare them, we use a criterion that quantifies their efficiency “in real time”, that is, under the conditions of the forecasting exercise (see Appendix 1).

### *Strategies with varying degrees of complexity*

The first set comprises strategies known as “naïve” because they do not use the information available in the business tendency surveys (see Appendix 2). The simplest among them consists in randomly picking the value of  $\varepsilon_t$  (equal to 1 or 0). There are slightly more complex strategies consisting, for example, in systematically predicting the direction of variation in the growth rate as being the opposite of its value in the previous quarter.

A second family of strategies is based on the usual quantitative methods for forecasting growth. For example, “thresholded” calibration (see Appendix 2) consists in using the usual models for forecasting the growth rate of activity via the business tendency surveys, then deducing a forecast of growth profile if the model indicates an acceleration or a slowdown. This approach has so far been de facto one of the only ones used by forecasters in the literature because, as we stated in the introduction, the question of acceleration or deceleration has very rarely been explored in itself.

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However, more complex strategies, based on classification methods and developed most notably in the financial analysis and medical fields, can give a direct estimate of  $\varepsilon_t$  (equal to 1 or 0). They are presented in detail in Cornec and Mikol (2011) and are summarised in *Appendix 2*. Among these direct methods, the probit model explained in *Box 1* is commonly used in economics.

*The best-performing methods are the direct ones*

Quite logically, the naive strategies offer low performance levels, with error rates in the order of 35%, i.e. the forecast is inaccurate in 35% of cases. Those based on the usual forecasting tools (calibrations) show better performances, with an error rate in the order of 18% over the period 1997Q1-2011Q4. This shows that the business tendency surveys provide highly pertinent information allowing forecasters to predict the GDP growth profile from one quarter to the next. Lastly, the direct classification strategies give even lower error rates, in the order of 12% (see *Table 2*).

**Table 2**

**Performances of the various forecasting strategies**

Strategies	Error rates
Naive strategies	In the order of 35 %
Usual tools	In the order of 18 %
Direct methods	In the order of 12 %

### A high-performing indicator for the quarterly profile over the recent period

*Building an indicator with a value of 1 (respectively -1) when the likelihood of acceleration (respectively deceleration) is very strong...*

As well as the average performance of the selected strategy, it may be of interest to estimate, for a given quarter, the chances of getting the profile forecast wrong, depending on the short-term economic variables observed. Indeed, the ease with which the profile can be predicted may vary depending on the economic context in which a given quarter finds itself.<sup>(2)</sup>

By using the statistical characteristics of the estimate of  $\varepsilon_t$ , we then build an indicator taking values between -1 and 1 which is directly exploitable for forecasting the growth profile (see *Box 2*): the closer the indicator is to 1, the higher the probability of observing an acceleration. Symmetrically, the closer the indicator is to -1, the higher the probability of observing a slowdown.

Among the best-performing methods, i.e. the classification methods, the probit model has properties enabling the construction of this indicator in a simple manner. This is therefore the method that will be used here (see *Box 1*).

*...with an area of uncertainty when the indicator is close to 0*

When the indicator is close to 0, its sign continues to indicate a forecast for the activity profile: an acceleration if the indicator's sign is positive, and a slowdown otherwise. But the risk of error is higher around 0. By convention, we therefore define an area of uncertainty when the indicator takes values of between -0.5 and +0.5.

*When the indicator is outside the area of uncertainty, the error rate is very low*

Over the period 1997Q1-2011Q1, this profile indicator is outside the area of uncertainty around 61% of the time (see *Graph*). Inside this confidence interval, the average error rate is lower than 4%: over the entire period 1997-2011, only two quarters are inaccurately forecasted. The profile forecasts therefore appear to be reliable when the associated profile indicator is within the confidence interval.

<sup>(2)</sup> See Cornec (2011) for an application of this theory to a forecast of the GDP growth level.

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### Box 1 - Forecast using a probit model

Here we detail the probit model, which is commonly used in economics and is one of the classification methods mentioned in *Appendix 2*.

The direction of variation in activity ( $\epsilon_t$ ) can be estimated directly from a probit classification model, in which GDP growth acts as an endogenous variable, and the variables from the business tendency surveys are exogenous ( $x_t$ ). With this model the probability of observing a GDP acceleration profile is written as follows:

$$P(\epsilon_t = 1 | X_t = x_t) = F(\beta x_t)$$

where  $F$  is the normal distribution function. Coefficients  $\beta$  are estimated with the maximum likelihood method. The series of profiles ( $\epsilon_t$ ) is thus predicted as follows:

$$\hat{\epsilon}_t = \Phi_t^{probit}(x_t, \epsilon_{t-1}) = 1 \left\{ F_t(\hat{\beta} x_t) \geq 0,5 \right\}$$

Two specifications were selected for the choice of variables  $x_t$  from the business tendency surveys. They are the same two subsets as those used for thresholded calibration:

- One based on the France composite indicator

$$\hat{\beta} x_t = 1,99 - 4,54 y_{t-1} + 0,19 F_t + 0,27 \Delta F_t |\Delta F_t|$$

- And the other based on the balances of opinion in the business tendency in industry survey (see above):

$$\begin{aligned} \hat{\beta} x_t = & 1,95 - 4,79 y_{t-1} - 0,37 y_{t-4} + 0,06.manuf.apa_{t,2} \\ & + 0,06.(manuf.apa_{t,2} - manuf.apa_{t,1}) \\ & + 0,04.(manuf.apre_{t,2} - manuf.apre_{t,1}) \\ & + 0,04.(manuf.apre_{t,1} - manuf.apre_{t-1,3}) \end{aligned}$$

The average forecasting error rate since 1997 is around 14% for the first specification (resp. 16% for the second). The results appear to be slightly better than those obtained with the thresholded calibration strategy. This shows that a classification method may perform significantly better than a quantitative method in predicting the direction of variation in growth. Classification methods other than the probit model also confirm these good results (see *Appendix 2*). ■

### Box 2 - Estimating a profile indicator using the probit model

#### Building a profile indicator: general principle

Using this probit model, we build a profile indicator: to do so, we associate the profile forecast with a conditional likelihood, which depends on the business tendency survey data observed at the same time. The objective of the profile indicator is to determine each quarter the chance of success (or failure) associated with a profile forecast, conditionally upon the values observed in the business tendency surveys. More specifically, it supplies the probability of a given quarter being in a state of GDP acceleration ( $\epsilon_t = 1$ ) or GDP deceleration ( $\epsilon_t = 0$ ). For reasons of symmetry, this profile indicator is between -1 (deceleration) and +1 (acceleration). Formally, the profile indicator is defined as:

$$I_t = 2 \left[ \hat{P}(\epsilon_t = +1 | x_t) - 1/2 \right]$$

The probabilistic term in the definition of the indicator is interpreted as the estimated probability of being in a state of GDP acceleration conditionally upon values  $x_t$  of the business tendency surveys in quarter  $t$ .

An "area of uncertainty" may be associated with this profile indicator, corresponding to a "risky" profile forecast (i.e. the risk of error is high) which should be treated with caution. By convention, this area of uncertainty corresponds to the interval  $[-0.5; +0.5]$  of values taken by the profile indicator. Additionally, the "confidence interval" corresponds to the profile indicator values between the intervals  $[-1; -0.5[$  et  $]0.5; +1]$ .

#### Building a profile indicator: application to the probit model

With the probit model, the assumptions associated with this strategy do indeed show the conditional probability of each quarter being in a state of GDP acceleration (see above):

$$P(\epsilon_t = 1 | X_t = x_t) = F(\beta x_t)$$

By reusing the previous denotations, it is easy to define the profile indicator as:

$$I_t = 2 \left[ F(\hat{\beta} x_t) - 1/2 \right]$$

■

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*An indicator that very often sends an unequivocal signal...*

*...useful for forecasting the ups and down of activity since 2008, during the recession and afterwards*

*For Q4, the likelihood of a slowdown looks strong*

The profile indicator is particularly effective in detecting variations in the direction taken by activity in times of turmoil (see Table 3). For example, of the 14 quarters observed since Q1 2008, the profile indicator lies within the confidence interval for 12 quarters. In these 12 quarters, it systematically signals the correct direction of variation: acceleration or deceleration of GDP. For the two quarters where the indicator was in the area of uncertainty (2009Q3 and 2010Q4), the acceleration or slowdown in activity observed when the first results were published was, de facto, particularly low.

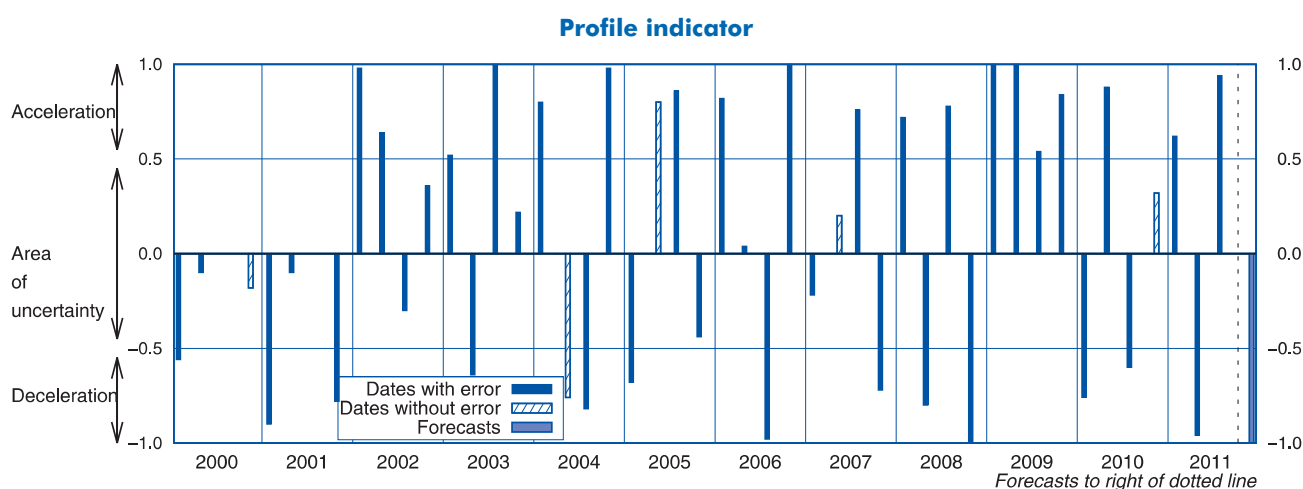
At the height of the crisis in late 2008 and early 2009, when forecasting GDP growth was particularly difficult, our profile indicator was clearly in the confidence interval: the values were in the region of -1 in Q4 2008 when the downturn became more pronounced, and took a value of +1 in Q1 2009 when the recession lost some of its intensity, and then when activity grew once again in Q2 2009.

Similarly, since the end of the recession, one of the key features of activity has been its "ups and downs", in other words the recovery has not been smooth, with an uneven profile which, in France, has been linked to the effects of the scrappage allowance, for example. The profile indicator reliably forecasts these ups and downs.

What about the forecast in this Conjoncture in France? Regarding the forecast of the direction of variation in activity in Q4 2011, the profile indicator stands clearly in the confidence interval and takes a value of -1. It therefore signals a high risk of a slowdown.

Table 3

<b>Profile indicator</b>		
as a % of quarters observed since 1997Q1	The indicator forecasts an acceleration and	The indicator forecasts a deceleration and ...
... an acceleration is observed	49 %	1 %
... a deceleration is observed	14 %	36 %



Source: INSEE calculations

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### Conclusion

Business tendency surveys provide highly pertinent information for predicting the GDP growth profile from one quarter to the next. On the face of things, this result is intuitive since it has long been demonstrated that business tendency surveys are among the best indicators for forecasting the GDP growth level. However, their use in forecasting the activity profile, which is thus a qualitative forecast, is original and relevant for at least two reasons.

On the one hand, it extends the range of possible forecasting methods. In particular, the classification methods give very satisfactory results, even better than those based on standard quantitative calibrations. This approach also makes it possible to compare strategies using short-term data with the naive strategies of uninformed agents. The former strategies are very clearly better than the latter.

On the other hand, the profile indicator allows forecasters to associate, each quarter, the profile forecast with a “likelihood” which is conditional upon the business tendency surveys. This offers the possibility of defining a confidence interval in which the acceleration or deceleration forecast may be considered to be relatively reliable. This indicator thus constitutes a useful, high-performing tool which complements the existing economic analysis indicators. ■

### Appendix 1- Criteria for judging growth profile forecasting strategies

#### Out-of-sample simulations

To assess a forecasting strategy, it is first necessary to do an out-of-sample simulation of the past. For an out-of-sample simulation from 1997Q1 to 2011Q3 for example, this means that we first estimate the model over the period 1989Q1-1996Q4 and from this we deduce a growth profile forecast for 1997Q1. Next we add a point to the estimate (which therefore gives the period 1989Q1-1997Q1) and we forecast the profile of 1997Q2; and so on until the forecast for 2011Q4.

This sort of out-of-sample simulation is only valid if the variables used actually correspond, for each quarter in the past, to those that were effectively available at that moment (“real-time data”). But by definition, the series of first GDP results, and hence that of growth profiles, are indeed real-time data (see above). The balances of opinion in the business tendency surveys obey a “pseudo-real-time” logic as they are only revised once (in the month following their first publication), and only very marginally.

#### Loss function

The following stage consists in assessing the predictive capability of a forecasting strategy. For this we have to define a “loss function”. The simulated forecasts are compared with the first results of GDP growth actually published covering this same period.

The loss function assigns a certain penalty to forecasting errors; here it is simply defined as follows:

$$L_t(\phi_t) := \frac{1}{t} \sum_{i=1}^t 1\{\epsilon_i \neq \hat{\epsilon}_i\}$$

It is in fact a “combined cost” corresponding to the mean error rate of forecasts made in real time over the period  $[1, t]$ :

$$L_t(\phi_t) = \bar{\eta}_t$$

with:

$$\eta_t := 1\{\epsilon_t \neq \hat{\epsilon}_t\}$$

With this function an inaccurately forecasted acceleration in GDP “costs” as much as an incorrectly forecasted deceleration. We could have envisaged a function that gives a more severe penalty when a deceleration is incorrectly anticipated (during crisis periods, notably). However, the function used here has the merit of being relatively simple to manipulate.

Each forecasting strategy can be assigned a loss function over the period  $[1, t]$  (in this case,  $[1997Q1, 2011Q3]$  for the current exercise). The loss function naturally takes its values in  $[0, 1]$ : a value of 0 (resp. 1) means that the strategy in question has perfectly forecasted the sign of growth trends over the period (resp. has been mistaken over the period).

The forecasting errors of the various strategies studied are compared from 1997, the date on which the economic variables observed have all been available for several years. ■



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## Appendix 2 - Several forecasting strategies proposed

### 1- Examples of "naive" forecasting strategies

Naive strategies do not use the information available in business tendency surveys, merely confining themselves - at best - to replicating a certain regularity in the direction of variation. They are logically quite ineffective and thus provide a "reference point" for judging the performance of more sophisticated methods.

#### Random strategy

An uninformed agent can randomly predict the next activity sign. His forecast will simply be drawn from a 1/2 parameter Bernoulli distribution:

$$\hat{\epsilon}_t = \phi_t^{\text{random}}(\epsilon_{t-1}) = u_t$$

By definition, the mean error since 1997 would have been around 50%. More precisely, application of the central limit theorem leads to a prediction that with a higher probability (95%), the mean error over the period 1997Q1-2011Q1 would have been higher than 35%.

#### "Opposite" strategy

Since 1997, the series of activity signs ( $\epsilon_t$ ) has alternated 63% of the time. One strategy would therefore be to take, for quarter  $t$ , the exact opposite of the profile observed in  $t-1$ :

$$\hat{\epsilon}_t = \phi_t^{\text{opposite}}(\epsilon_{t-1}) = 1 - \epsilon_{t-1}$$

Over the period 1997Q1-2011Q1, the average error rate of this strategy is around 36%.

#### Long-term average strategy

This strategy simply consists in extending the series of profiles for quarter  $t$  by its long-term average over the period observed  $[1, t-1]$  (rounded to 0 or 1):

$$\hat{\epsilon}_t = \phi_t^{\text{average}}(\epsilon_{t-1}) = 1 \left\{ \frac{1}{t-1} \sum_{i=1}^{t-1} \epsilon_i \geq 0,5 \right\}$$

The average error rate of this strategy is around 41% since 1997. ■

### 2 - "Thresholded" calibration

This strategy consists in deducing the direction of variation in activity each quarter, using a forecast of the GDP growth level. The quantitative forecast is obtained via a standard regression model in which GDP acts as an endogenous variable, and the variables from the business tendency surveys are exogenous. The activity profile for quarter  $t$  is then simply derived from a comparison between the growth forecast in  $t$ , denoted  $y_t$ , and the growth actually observed in quarter  $t-1$ :

$$\hat{\epsilon}_t = \phi_t^{\text{reg}}(x_t, \epsilon_{t-1}) = 1 \{ \hat{y}_t \geq y_{t-1} \}$$

As the variables from the business tendency surveys (balances of opinion, business climate) are potentially very numerous, we need to restrict ourselves to a limited subset in order to perform the calibrations. Several specifications were tested in order to determine the quantitative growth forecasts ( $y_t$ ), leading to profile forecasts of comparable quality.

Two specifications can be highlighted:

- The first is based on a composite indicator for France expressed as a level for quarter  $t^{(1)}$   $F_t$ , and as a "signed" acceleration bet-

ween quarters  $t-1$  and  $F_t$ ,  $\Delta F_t \times |\Delta F_t|$ . This specification also involves the growth level observed for the previous quarter,  $y_{t-1}$ :

$$\hat{y}_t = 0,60 - 0,40 y_{t-1} + 0,09 F_t + 0,09 \Delta F_t |\Delta F_t|$$

- The second specification is based on a selection of balances of opinion relating to the manufacturing industry: past activity (*manuf.apa*) and forecast activity (*manuf.apre*). The manufacturing sector contributes strongly to the variability of total market output. This specification also mobilises previous levels of GDP growth. It is eventually written as follows:<sup>(2)</sup>

$$\begin{aligned} \hat{y}_t = & 0,47 - 0,37 y_{t-1} - 0,10 y_{t-4} + 0,03 \text{manuf.apa}_{t,2} \\ & + 0,01 (\text{manuf.apa}_{t,2} - \text{manuf.apa}_{t,1}) \\ & + 0,02 (\text{manuf.apre}_{t,2} - \text{manuf.apre}_{t,1}) \\ & + 0,02 (\text{manuf.apre}_{t,1} - \text{manuf.apre}_{t-1,3}) \end{aligned}$$

Each of these specifications results in a profile forecasting strategy. The average forecasting error rate over the period 1997Q1-2011Q3 is around 18% for these two strategies. ■

(1) In fact it is the indicator's average for the last three months observed at the moment the forecast is made, i.e. the first two months of the quarter and the third month of the previous quarter.

(2) As the balances of opinion are monthly, the corresponding indexes refer to a quarter and to a month in this quarter. For example, *manuf.apa<sub>t,2</sub>* represents the balance relating to past activity for the second month of quarter  $t$ .

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### 3 - More complex classification methods to predict the direction of activity

These methods generally seem to be the best-performing. Readers will find a full presentation of these strategies in Cornec and Mikol (2011).

Machine learning techniques are used with increasing frequency in the fields of financial analysis, object recognition (faces, patterns...), medical diagnosis, etc. However, they are barely used at all in economic analysis. These techniques are based on algorithmic methods and serve to analyse and classify complex systems using empirical data ("learning" data). In our case the analysis relates to the economic data observed in the current quarter, which we want to "classify" according to the as-yet-unobserved direction of variation in growth. The learning data are thus past short-term economic observations: GDP, growth profiles and business tendency surveys. Among the algorithms most commonly used in machine learning, we will mention:

- Linear discriminant analysis
- Decision trees
- Support vector machines.

These three methods are fully and precisely documented in Hastie, Tibshirani and Friedman (2009). When applied to our problem of forecasting the direction of variation in activity, these three methods give satisfactory results (Cornec and Mikol, 2011). In particular, the linear discriminant analysis method, using as its learning variables the France business climate (as an average quarterly level and as a variation) and the first GDP growth delay, provides the best forecasting performance with only 12% of forecasting errors found over the period 1997Q1-2011Q1. ■

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