

Composite indicators: the INSEE's experience

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The French National Statistical Institute (INSEE) has not only been producing statistics but also short-term economic analyses and forecasts since its creation in 1946. This dual mission allows INSEE to guarantee and to improve the quality of its statistics; bringing closer statistical production and studies is a way of comparing statistics to their social use and to the reality they refer to.

INSEE has been conducting business tendency surveys since 1951. Initially confined to the manufacturing industry, these surveys now also cover construction, wholesale/retail trade, and services. Six out of them belong to the Joint Harmonised EU Programme of Business and Consumer Surveys. Until the 1990's, balances of opinion were considered as the only way to quantify and combine responses of individual firms. Since then, composite indicators, such as business climate indicators have joined balances of opinion in order to analyse the short-term outlook for France.

This paper aims to present the long-time experience of INSEE in producing and disseminating composite indicators, such as business climate indicators. It will focus on a number of caveats that need to be borne in mind when using business tendency survey results and composite indicators.

Business tendency surveys represent a crucial tool for economic forecasting

INSEE surveys around 20,000 businesses on their activity each month or quarter

Increasing, decreasing or stable? The responses businesses provide to questions on their past or future output, asked in the business tendency surveys, provide us with advance information on the French economy. Each month, the forecasters use this information to obtain an early indication of the economic outlook, ahead of the publication of the first quantitative indicators, particularly the quarterly national accounts.

INSEE now conducts ten tendency surveys covering businesses in the manufacturing, service, trade and construction sectors. All in all, INSEE surveys 20,000 businesses monthly, bi-monthly or quarterly regarding their recent activity (over the past three months) and business prospects (for the three coming months). The qualitative questions contained in these surveys require respondents to select one of several possible answers : "increasing", "stable", "decreasing", or "above average", "average", "below average" (*Figure 1*). This speeds up the process and lightens the burden placed upon respondents.

Figure 1: Some qualitative questions asked in the tendency survey manufacturing sector

QUESTIONS ON YOUR ENTERPRISE'S ACTIVITY				
1. YOUR PRODUCTION				
a.	Change in past 3 months.....	↗	⇒	↘
b.	Likely change in next 3 months.....	↗	⇒	↘
2. TOTAL ORDERS (OR DEMAND)				
	For the season, do you consider your current order books (or demand) to be	above average	average	below average
		↗	⇒	↘

Businesses provide objective, well-founded responses

Businesses often use numerical information to respond to the tendency surveys

The question of the relevance of using indicators that rely on subjective information, such as a respondent's own perception may be asked. Indeed, the way in which businesses understand and respond to the questions in the surveys should determine the way in which we use their responses.

In September 2014, INSEE questioned around 2,500 businesses from the manufacturing sector who regularly respond to the tendency survey about their interpretation of the questions asked each month or quarter; 40% of them responded to this "survey of survey". The results confirmed that businesses provide objective, well-founded responses.

Seventy percent of respondents to this survey indicated that, generally speaking, their financial director or a subordinate completed the business tendency questionnaire. However, in businesses with between 20 and 99 employees the company director is more likely to be personally involved in the survey than in larger companies.

In responding to the tendency survey, more often than not businesses call upon objective numerical data relating to their activities: quantities produced, amounts invoiced or hours worked. Regarding recent variations in their output, around 80% of businesses reported using one of these three indicators.

Businesses have less numerical information to call upon when it comes to making output forecasts. As an indication, 37% report basing their response to this question on a "subjective judgement". Nevertheless, around 45% base their response on the current state of their order books.

Finally, this survey allowed us to identify the thresholds beneath which businesses consider their output to be stable, and what they consider as "normal" levels for their order books in different seasons. For more than half of businesses this threshold was below +/-5%, while for a quarter of businesses it was below +/-1%.

Responses to the monthly business tendency survey for industry are consistent with the quantitative indicators

In order to monitor industrial output from a quantitative perspective, INSEE conducts branch-specific surveys which yield results that are then used to calculate the monthly industrial Production Index (IPI). Businesses respond after the end of the month in question. The results of these surveys are available two months after those derived from the business tendency surveys. Comparing businesses responses to these two types of survey, at an individual level, allows us to test the reliability of the responses given in the qualitative tendency surveys. The opinion of each business regarding their recent activity, measured by the tendency survey, does indeed prove to be generally consistent with the variation in their invoiced volumes as declared in the monthly branch surveys over the previous three months (Villaume, 2014).

Around 60% of businesses predict the future variations in their output correctly

An other way of evaluating the "quality" of responses is to compare the answers on past and predicted activity. For example, in a monthly survey conducted in March a business will be asked to judge whether its output over the next three months (i.e. Q2) will increase, remain stable or decrease. In the survey in June, the same business will answer questions on its actual output over the previous three months (i.e. Q2). If businesses have a clear idea of their upcoming output, their responses in June should therefore corroborate the responses they gave in March with regard to their activity in Q2. Since 1990, around 60% of businesses have correctly predicted the variations in their output: 35% correctly predicted it would remain stable, 15% correctly predicted an increase and 10% correctly predicted a decrease.

Businesses rarely get it wrong twice in a row when it comes to predicting output

Moreover, a business that has poorly predicted its output for one quarter rarely makes the same mistake for the following period: in two-thirds of cases the company will then accurately predict its output for the ensuing quarter. No individual optimistic or pessimistic bias was observed in the businesses surveyed. This confirms that the majority of companies make their predictions on the basis of objective data, resulting in consistent forecasts. The differences observed between the responses can be considered as forecasting errors, and thus indicative of surprise in the short-term conditions (Gorin and al., 2015).

The balance of opinion: an aggregate indicator with a solid theoretical grounding

The specificity of business tendency surveys is attached to their non-intrinsic utility; the interest of business tendency surveys is based on their ability to forecast macroeconomic evolutions, hence the question of how responses of the individual firms should be quantified and combined.

Balances of opinion allow us to summarise the responses of businesses

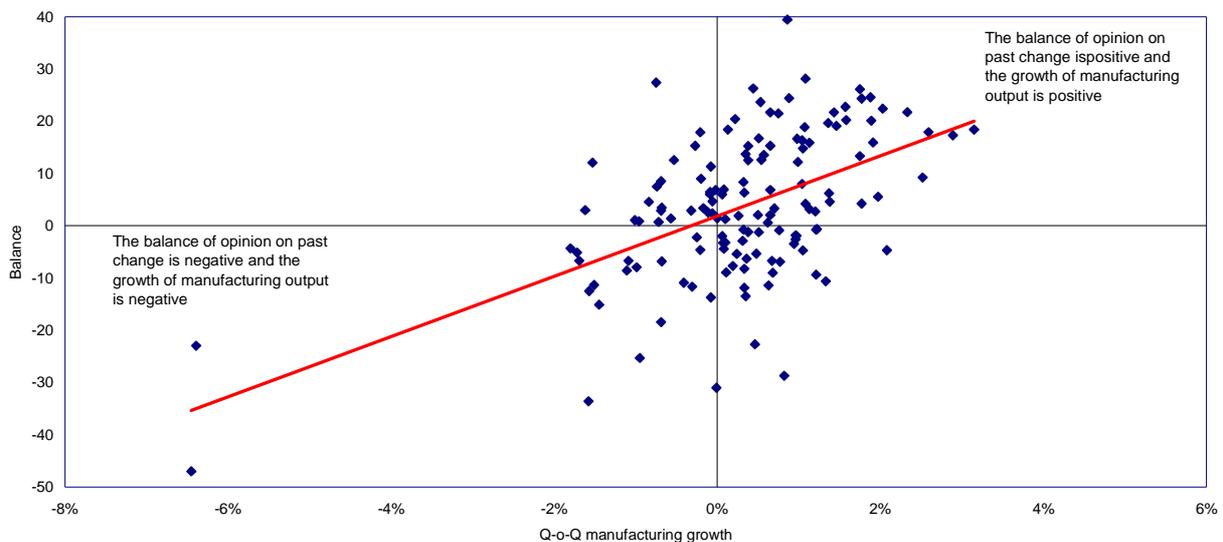
A debate on the best way to aggregate individual answers has occurred from the beginning of 50's. A consensus seemed to be found in the 70's by economic forecasters; balances of opinion were then considered as the most efficient way to quantify and combine responses of individual firms.

Balances of opinion represent the percentage of businesses reporting an increase in activity and those reporting a decrease. "Stable" responses do not affect this figure. Depending on the question, the individual responses of businesses are weighted using a variable of interest: turnover, employee headcount, etc. This indicator is very simple to construct and its usefulness has been demonstrated both theoretically and empirically.

Balances of opinion allow us to give "probable" indications of future variations in the macro-economic variables...

Balances of opinion play a crucial role in the forecasting process. These balances generally present a close correlation with the corresponding macroeconomic variables, and thus yield good results when used in forecasts. For example, over time there is a relatively stable linear relationship between the quarterly growth of manufacturing output and the balances of opinion regarding past or predicted output derived from the monthly tendency surveys for industry (Graph 1).

1 - Quarterly growth of the manufacturing output and balance of opinion on past output



How to read it: for each quarter between 1981Q1 and 2015 Q2 this graph gives the value of the balance of opinion on variations in output over the preceding 3 months (y axis) and the value of quarterly growth in industrial output (x axis)
Source: INSEE

...which justifies their use in bridge models

More sophisticated tools are thus required to draw the connections between the business tendency surveys and activity. These tools include econometric models known as “bridge models”, which allow us to establish the “average” relationship between balances derived from surveys and actual activity.

The business climate indicator: a composite indicator to analyse the short-term outlook for France

The number and the diversity of questions asked every month in business tendency surveys make the results quite difficult to interpret. Indeed, the level and the volatility of the derived balances of opinion differ from one question to the other. Besides, the month-to-month evolution of balances of opinion may be apparently contradictory and difficult to comment on, hence the idea of summarizing the common information they provide by a single indicator. In France, this composite indicator is called “the business climate indicator”.

INSEE publishes six business climate indicators designed to track growth in the corresponding sectors of the economy

Since 2008 the overall business climate indicator for France has correctly reflected the growth of the French economy

The first business climate indicator was implemented in 1995 for the manufacturing industry. INSEE now publishes a business climate indicator for each of the five major sectors covered by its surveys (industry, services, construction, retail trade and wholesale trade) as well as an overall indicator (the “France indicator”) which aims to reflect the business climate across the economy as a whole (Box 1).

As a result of the way they are constructed these indicators do not have units, so they are standardised to a mean of 100 and a standard deviation of 10. The value 100 thus corresponds to a normal climate, and then to the average rate of growth in the corresponding sector or across the economy as a whole (with the “France” indicator). The fluctuations of the business climate indicators are strongly connected to the acceleration cycle of the reference variable (output, GDP): an increase (resp. decrease) of the composite indicator can be interpreted as an acceleration (resp. a deceleration) of growth rate of the reference variable. These indicators have demonstrated their ability to reflect the growth of the French economy accurately in recent years, particularly during and after the major recession of 2008-2009 (Graph 2).

Other composite indicators joined gradually the business climate indicator in order to analyse the short-term outlook for France: turning points indicators in 1997 and surprise indicators in 2015. In its own way, each of these indicators allows us to summarise the information contained in the numerous balances of opinion derived from the tendency surveys (Gorin et al., 2015).

2 - Business climate in France and year-on-year GDP figures since 2005



Source : INSEE

Box 1 - The balances of opinion used to calculate the INSEE's business climate indicators

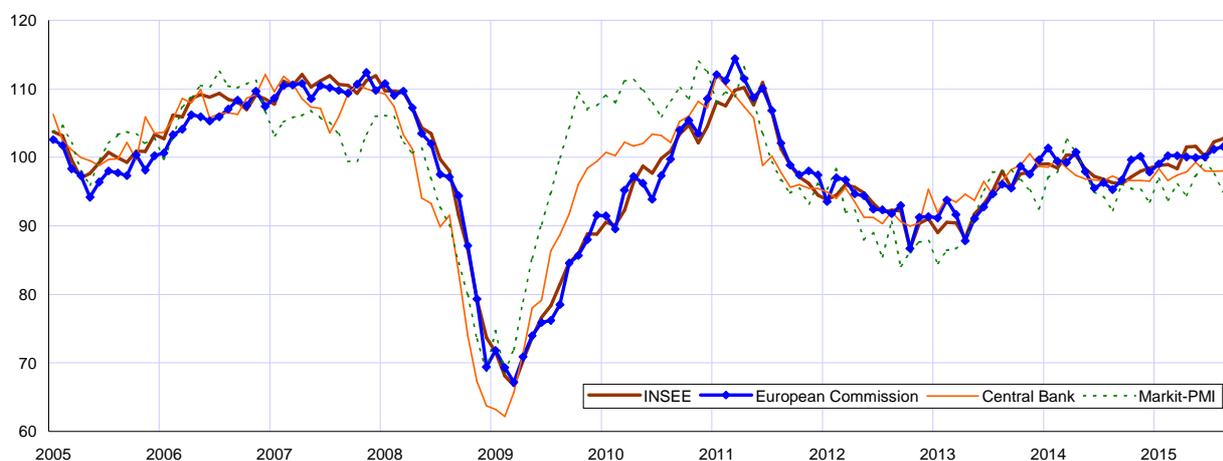
Sector	Implementation	Method used	Balances of opinion
Industry	1995	Static factor analysis	<ul style="list-style-type: none"> ▪ Past activity (M) ▪ Personal production expectations (M) ▪ General production expectations (M) ▪ Level of global order books (M) ▪ Level of export order books (M) ▪ Level of finished-goods inventory (M)
Services	2006	Dynamic factor analysis	<ul style="list-style-type: none"> ▪ Past activity (M) ▪ Expected activity (M) ▪ General outlook (M) ▪ Operating balance, past result (Q) ▪ Operating balance, expected result (Q) ▪ Expected demand (M)
Wholesale trade	2006	Static factor analysis	<ul style="list-style-type: none"> ▪ Sales (B) ▪ Export sales (B) ▪ Ordering intentions (B) ▪ Received merchandise from abroad (B) ▪ General outlook (B)
Construction	2007	Static factor analysis	<ul style="list-style-type: none"> ▪ Past activity (M) ▪ Expected activity (M) ▪ Past employment (M) ▪ Level of order books (M) ▪ Production capacity utilisation rate (M)
Retail trade	2008	Static factor analysis	<ul style="list-style-type: none"> ▪ General outlook (M) ▪ Ordering intentions (M) ▪ Expected employment (M) ▪ Past sales (M)
"France indicator"	2008	Dynamic factor analysis	<ul style="list-style-type: none"> ▪ The above 26 balances

M: monthly question, Q: quarterly question, B: bi-monthly questions

Alternative business climate indicators are produced for France by other institutes

INSEE is not the only institute to produce and disseminate business climate indicators for France. Every month, such composite indicators are published by the European Commission, the National Bank and the Markit Institute. All these indicators are conceived with different methodology. However, they all provide a timely information on the short-term outlook for France (*Graph 3*).

3 - Alternative business climate indicators for the manufacturing industry in France



Source : INSEE, DG-ECFIN, Banque de France, Markit

Despite different methodologies, the European Commission composite indicators and the INSEE business climate indicators at the sector level are in general very similar. Both are based on the INSEE tendency surveys results. Concerning the indicators produced by the National Bank and the Markit Institute, the reference period for the questions that are asked constitutes a major difference in the information delivered by these alternative indicators. Indeed, in the INSEE tendency surveys, entrepreneurs are being asked to express their opinion regarding their recent activity (over the past three months) and business prospects (for the three coming months). Markit and the National Bank, meanwhile, ask entrepreneurs to express their opinions only on the latest monthly change in their output. The information conveyed by these different types of indicators provides a comparable global trend of the past, but may sometimes give rise to contradictory interpretations from one month to the next (*“Conjoncture in France”, dec. 2010*).

Some keys to build a business climate indicator

A composite indicator for which purpose?

The composite indicator translates the business climate as perceived by entrepreneurs

Composite indicators such as business climate indicators are usually conceived to summarise the information contained in the different questions asked every month to businesses. A simple way to do so is to calculate the mean of the different balances of opinion. This method has the advantage to be very simple, but the choice of the retained questions and the weightings attributed to each question seem to be arbitrary. Other methods are sometimes used like factor analysis methods (principle component analysis, static factor analysis,...). However, in its own way, each of the derived indicator can be considered as an *ad-hoc* average of balances of opinion. Besides, the results obtained with both methods are usually very close.

The question of the best method to use is linked to the purpose of the indicator. Usually, the composite indicator is expected to be not only a simple summary of the questions asked in the business tendency surveys but is also expected to reflect the growth of a reference variable. We'll have then to concentrate on the selection of balances and on the constraints put on the weightings.

Application to the INSEE business tendency survey in the manufacturing industry

In this section, we'll compare the INSEE business climate indicator in the manufacturing industry (conceived with a static factor analysis method) with two alternative indicators (simple average and principle component analysis).

The selected balances of opinion should be correlated to a variable of reference

With the business climate indicator in the manufacturing sector, it is not our purpose to try to approximate quantitative production measures with an indicator obtained from aggregated qualitative answers (*Doz, Lenglar, 1996*). Nevertheless, the composite indicator should give a good idea of the main short term economic movements.

The number of balances retained in the indicator must be sufficient enough to make the composite indicator readable

Hence, the idea of selecting the balances which are the most connected to the output growth, seems convenient. That's why we have retained six balances of opinion out of the seven ones published from 1990 onwards; balance on personal price expectations has not been considered correlated enough with the output (*Figure 2*). Besides, a mere look at the graphic of the balances of opinion associated to the six other questions (*Graph 4*) is sufficient to be convinced that fluctuations of the series are strongly connected. This justifies the idea of summarising the selected balances in a single index.

Regarding the close correlation between balances, the issue of the number of balances retained in the composite indicator needs to be addressed. Anyway, the more the composite indicator is based on numerous balances, the more its variations from one month to the next are smoother than those observed on the balances of opinion. Using more sophisticated methods than a simple average helps to choose the most pertinent balances.

The composite indicators derived from the three methods can be interpreted as weighted average of the balances

With the simple average of balances, each balance has the same weighting. No hypothesis is made on the composite indicator.

With the principal component analysis, the information contained into the different questions is converted in a set of variables called principal components. The first principal component is reputed to be the “best” average of the balances.

The INSEE composite indicator is estimated with a factor analysis method. This method has been preferred to the above mentioned methods because the INSEE composite indicator does not only intend to summarise the information contained into the balances, but is also supposed to be the common component of all balances. Indeed, the assumption is made that each balance of opinion can be broken down into two unobservable components: one of them, the composite indicator, is common to all the series, and the other one is specific to each of the balance of opinion. So far, the static factor analysis method has been the best method to do so *a priori*.

The composite indicators derived from the alternative methods seem to be very similar

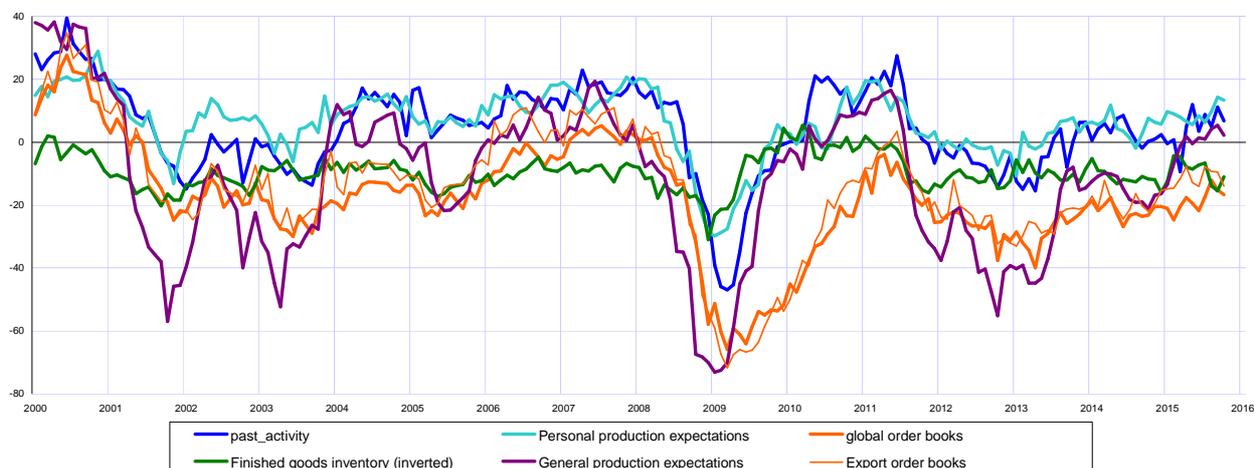
The three derived composite indicators appear to be very similar, notably those conceived with a simple average and a principle analysis component (Graph 5). The INSEE business climate indicator is quite similar too, except during the period after the major recession of 2008-2009. This can be explained by the fact that it gives more weight to the balances of opinion on past activity and level of order books which are less correlated with the output growth (Figure 3). In particular, it is well commonly admitted that the balance of opinion on level of order books gives a delayed information compared to the output growth rate, especially during an upturn period. Indeed, even if the order books are refilling, entrepreneurs will go on answering “below average” during a certain period.

Figure 2: Correlations between monthly questions and the manufacturing output

	Balances of opinion retained for the calculation of the business climate indicator						Personal prices expectations
	Past activity	Personal production expectations	General production expectations	Order books	Export order books	Finished goods inventory	
Output (y-o-y)	0.77	0.69	0.74	0.77	0.79	-0.32	0.26
Output (q-o-q)	0.54	0.61	0.61	0.45	0.48	-0.44	0.06

Source: INSEE

4 - The six balances of opinion used to calculate the INSEE business climate indicator in the manufacturing industry



Source: INSEE

Anyway, the three indicators give a good idea of the main short-term economic movements. The fact that the balances of opinion have been chosen regarding their close correlation with the output growth explains the proximity of the different composite indicators and might strengthen the idea that the selection of the balances is more important than the method used.

The composite indicators explain 80 % of the variability of the balances

The selection of the balances then needs to be validated regularly. Additional tools can be used to guarantee the quality of the indicator (Box 2).

The balances of opinion must explain a great proportion of the variability of the composite indicator. The indicator commonly used to assess the relevance of the balances is the “loading”. A balance of opinion with a very small loading (below 0.5 for example) would bring more noise than information. In the case of the three alternative composite indicators for the manufacturing sector, balances of opinion explain much more than 50 % of the variability of the composite indicator. Besides, it is important to check regularly the stability of the loadings over the time.

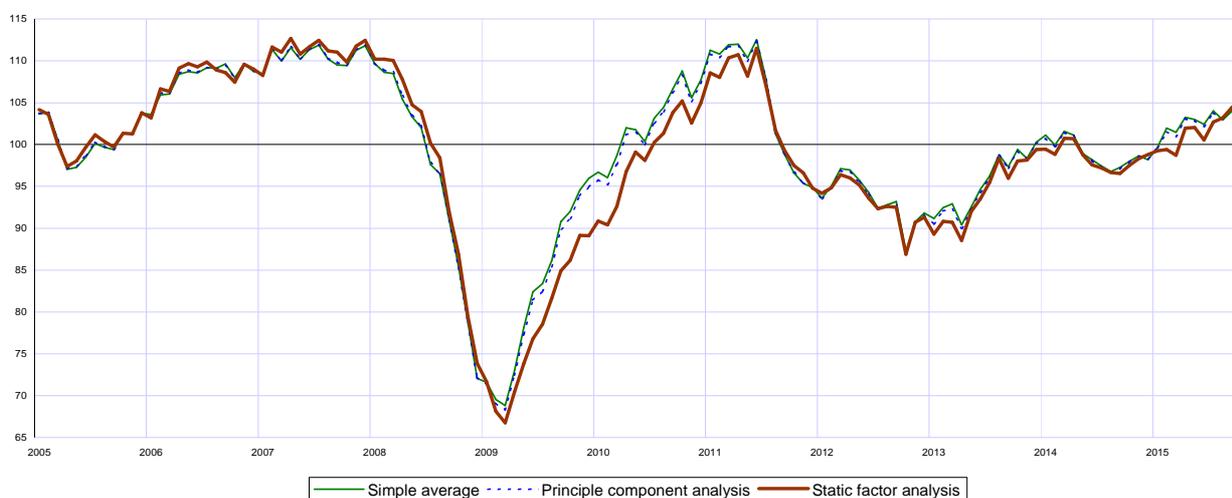
An other way of assessing the quality of the composite indicator is to check that it explains a great proportion of the variability of the balances. The three alternative composite indicators for the manufacturing sector explain 80 % of the variability of the balances.

Figure 3: Weightings attributed to balances in the three composite indicators

	Past activity	Personal production expectations	General production expectations	Order books	Export order books	Finished goods inventory (inverted)
Simple average	0.167	0.167	0.167	0.167	0.167	0.167
Principle component analysis	0.177	0.175	0.167	0.175	0.169	0.137
Static factor analysis	0.221	0.155	0.092	0.298	0.198	0.035

Note: the weightings have been normalised so that their sum be equal to 1
Source: INSEE

5 - The three composite indicators for the manufacturing industry



Source: INSEE

Box 2 - How to assess the quality of a composite indicator?

Once balances of opinion have been selected, they are usually standardised to a mean of 0 and a standard deviation of 1. This operation is made because the level and the volatility differ from one balance to an other. Whatever the method, a composite indicator is usually constructed in 3 steps.

- **Estimation of the composite indicator (F).**

In any case, a balance of opinion B_i can be interpreted as: $B_i = \lambda_i \times F + n_i$ and the composite indicator as: $F = \sum_i w_i \times B_i$, where λ_i are the loadings and w_i are the weightings.

- In the case of a simple average, F is the simple average of balances.
- In the case of a principle component analysis, F is the first principal component.
- In the case of a static factor analysis, F is the common component of all the balances and n_i is the specific component of balance B_i , so that $cov(F, n_i) = 0$

The composite indicator is in general standardised. For example, INSEE composite indicators are standardised to a mean of 100 and a standard deviation of 10.

▪ Evaluation of the quality of the composite indicator

- The loading λ_i is a good indicator to assess the **relevance** of a balance of opinion in the composite indicator. The higher its value is, the more relevant the balance of opinion is in the composite indicator. Being calculated as $\lambda_i = \frac{\text{covariance}(B_i, F)}{\text{variance}(F)}$, the loading can be interpreted as the contribution of the balance to the variability of the factor.

- The **efficiency** of the composite indicator tells us about the proportion of the variability of the

balances explained by the composite indicator. It can be estimated by $Efficiency = \frac{\sum_{i=1}^I \lambda_i^2}{I}$, where I represents the number of balances on which the composite indicator is based on.

Loadings and efficiency associated to the three composite indicators for the manufacturing industry

	Loadings						Efficiency
	Past activity	Personal production expectations	General production expectations	Order books	Export order books	Finished goods inventory (inverted)	
Simple average	0.94	0.93	0.89	0.93	0.90	0.75	80 %
Princ. component analysis	0.95	0.93	0.89	0.93	0.90	0.73	80 %
Static factor analysis	0.95	0.92	0.86	0.96	0.94	0.66	79 %

Source: INSEE

▪ Evaluation of the ability of the composite indicator to give a good idea of the main short-term economic movements

A priori, the method used to construct the composite indicator doesn't guarantee that the indicator will be well correlated with a reference variable. Nevertheless, the fact that balances of opinion have been chosen in that way leads to composite indicators also well correlated with the reference variable. This can be verified by calculating the correlations with the reference variable or by a mere look at the graphic of the series.

Correlations between the three composite indicators and the manufacturing output

	Simple average	Principle component analysis	Static factor analysis
Output (y-o-y)	0.75	0.76	0.78
Output (q-o-q)	0.55	0.55	0.53

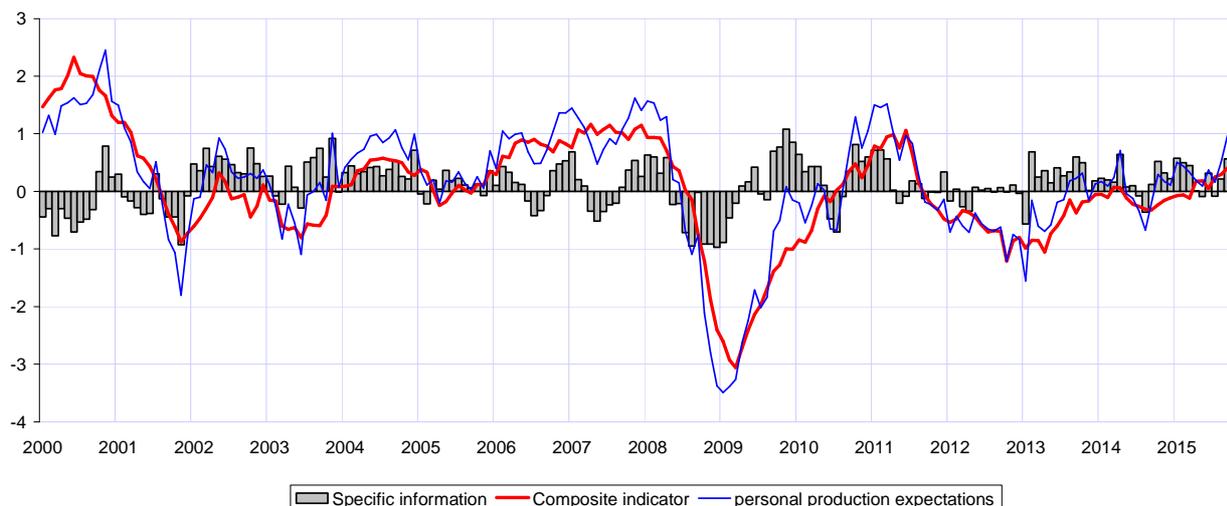
Source: INSEE

The composite indicator gives an additional information to the specific information of the balances

The composite indicator is constructed to take into account most of the information contained in the different questions. However, if one wants to consider the whole information given by the survey, one has to consider also the specific information of the balances (Doz, Lenglar, 1996). The expression "specific information" refers to the complementary information to the composite indicator brought out by a given question.

For example, the idea that the balance of opinion on personal production expectations could be a leading indicator seemed to be confirmed especially during the major recession of 2008-2009 (Graph 6). Indeed, the specific information was mainly negative during the descending period and positive during the ascending one, so that the balance of opinion seemed to be positioned below the composite indicator during the deceleration period and above it during acceleration.

6 - The specific information of the personal production expectations



How to read it: the specific information of the balance of opinion on personal production expectations (histogram in grey) corresponds to the difference between the balance of opinion (blue line) and the composite indicator weighted by the loading (thick red line).
Source: INSEE

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