NOTES D'ÉTUDES

ET DE RECHERCHE

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Delphine Irac and Franck Sédillot

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Short run assessment of French economic activity using OPTIM

Delphine Irac and Franck Sédillot[1],
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Summary

This paper describes a short-term projection model for French economic activity, OPTIM, the aim of which is twofold. First it gives an early estimate of real GDP growth for the previous quarter, when no figure has yet been released by Insee, the French National Statistical Institute, along with flash estimates for main GDP components (consumption, investment, inventories and external trade) together with a breakdown by sectors (services, manufacturing, construction, equipment, agri-food). This appears particularly useful for the short-run analysis. In this respect OPTIM may be considered as a traditional bridge equation model since it links a particular indicator available generally ahead of the release of the quarterly national accounts with a quarterly aggregate like GDP, consumption…. Second, this tool supplies also estimates for GDP growth and its main components for the current quarter and for the next quarter (i.e two and three quarters respectively following the latest reference period of Insee's GDP data release). A pool of (mainly) monthly variables is used, which are, sometimes, directly introduced in the specification but, more often, summarised by the implementation of a principal component analysis (PCA). The largest part of the set of indicators comprises survey data together with monthly traditional indicators (industrial production, consumption in manufactured goods…). But other data (in particular financial data) are also introduced. The outcomes of OPTIM rely on a relatively complex procedure involving about twenty equations and mixing two alternative approaches: a supply approach consisting in a direct modelling of GDP and a demand approach where GDP is the sum of consumption, investment, changes in stocks and net trade (exports minus imports). The discrepancy between these two estimates is distributed according to an original method, yielding a unique GDP estimation. The paper is organised as follows. Section 1 presents the main features of OPTIM. Section 2 deals with data description while section 3 addresses the data assessment's issue. In section 4, the main equations are described. Section 5 presents a general assessment of OPTIM in terms of forecasting record. Finally section 6 concludes and proposes some avenues for further developments.

Résumé

Ce document décrit un modèle de prévision de court-terme pour l'activité française, OPTIM, répondant à un double objectif. Premièrement, pour le trimestre qui vient de s'écouler, il donne une estimation de la croissance du PIB en volume et de ses principales composantes (consommation, investissement, stocks, commerce extérieur) alors que les comptes trimestriels n'ont pas encore été publiés par l'Insee. Deuxièmement, OPTIM propose aussi une prévision du PIB et de ses composantes pour le trimestre en cours et le trimestre suivant. La décomposition par secteur qui est aussi fournie pour les trois trimestres de l'estimation apparaît particulièrement utile pour l'analyse de court terme. Les estimations se fondent sur un ensemble de données, essentiellement trimestrielles, qui sont parfois directement introduites dans la spécification mais le plus souvent résumées au moyen d'une analyse en composante principale. La plus grande part de l'ensemble d'indicateurs mensuels mobilisés est composée de données d'enquête (issues de la Banque de France et de l'INSEE) et d'informations chiffrées mensuelles (indice de production industriel, consommation en biens manufacturés). D'autres données sont aussi introduites, notamment de nature financière. Les résultats d'OPTIM reposent sur une procédure assez complexe comprenant une vingtaine d'équations et combinant deux approches parallèles : une approche par l'offre consistant en une modélisation directe du PIB et une approche par la demande selon laquelle le PIB est évalué comme la somme de la consommation, de l'investissement, des variations de stocks et du commerce extérieur (exportations moins importations). La différence entre les deux estimations est ensuite ventilée selon une méthode originale, aboutissant à une estimation unique du PIB. Le papier est organisé de la manière suivante. La section 1 présente les principales caractéristiques d'OPTIM. Les données mobilisées sont décrites dans la section 2 alors que la section 3 traite du problème de l'évaluation des données (pouvoirs prédictifs). Les principales équations sont décrites en section 4. La section 5 présente une évaluation générale des performances d'OPTIM. La section conclut et propose certains développements possibles.

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1. An overview of OPTIM

OPTIM is implemented four times a year, about 40 days after the end of each quarter. As the first release of the French quarterly national accounts relative to a given quarter is available around 70 days after, OPTIM supplies an early GDP estimates about four weeks before the publication of the official quarterly figures by Insee, the French National Statistical Institute, allowing therefore a first analysis of the ongoing conjunctural developments. Along with this flash estimate, the model also provides projections for both real GDP growth and its main components for the next two quarters[2]. They may not be interpreted strictly as leading indicators but as a benchmark, the aim of which is to give a reasonable starting point for the model based forecast.

The main purpose of OPTIM is not only to provide a forecast for real GDP growth, but also a forecast for all its components. Therefore it helps determine which part of demand (consumption, investment, net external demand or stock buildings) drives activity. The tool relies on a quantitative summary of the maximum number of high-frequency indicators containing information about current and future activity and relies on a model-based approach, seeking to reduce the scope of the judgmental analysis as much as possible.

1.1. A large data set[3]

OPTIM is based on a wide set of information, which gathers three sub-sets. The first is survey data. In France, two main institutes, the Banque de France and INSEE, carry out business and consumer surveys. These surveys contain standard questions about past and future activity, level of stocks, level of prices and staff development, etc. Interestingly, answers to the different questions appear very correlated to each other and it seems difficult to establish a clear economic distinction between the different series. Particularly, as shown in section 3, questions about future activity do not appear to have a predictive power significantly higher than the principal component extracted from the whole survey given that its weight in the axis is similar to that of other components. The approach undertaken considers that surveys reflect the general impression of employers (or households) with respect to activity, without trying to focus on one specific question. Thus, to summarize the first subset of information encapsulated in the survey, the factor analysis appears as a natural method. The methodology undertaken in this paper is therefore in line with the main recommendations of Watson (2000) that show that models based on factors outperform models based on a small set of well-chosen indicators. More generally, according to the author, "an index of real activity constructed from a large number of variables performs better than any single series representing real activity". The second subset includes monthly macroeconomic data (industrial production index and manufacturing consumption) and one quarterly series, foreign demand addressed to France. This variable is introduced in the export equation in addition to survey data because as OPTIM is used within the European System of Central Banks's broad macroeconomic projection exercise[4], it has to rely on jointly shared international assumptions. Finally, the third subset comprises financial data (slope of the yield curve, loans to households).

1.2. Data selection and modelling strategy

Given the large number of high frequency indicators that are likely to bring information about current and future activity, it is necessary to define a few numbers of selection criteria. First, particular attention is paid to the availability of data since the design of OPTIM is to yield "real time" forecasts.

[2] Thereafter, denoted zero, one and two quarters ahead forecasts.

[3] Annex A describes the mnemonics used in OPTIM.

[4] For further details, see « Report on projection methods » available on the ECB website.

Second, most of the equations contained in OPTIM are not behavioral. They just rely on an empirical correlation between a short-term indicator and a quarterly national account aggregate. The construction of the model and particularly the specification of its equations is based much more on the notion of correlation than on causality. The issue of causality is addressed in the last part of this document where the forecast accuracy of OPTIM is compared with that of a simple autoregressive model. OPTIM provides an early estimate of a macroeconomic variable in the time interval between the release of the indicator and that of the national accounts, taking advantage of the predictive content of some of the short-term indicator and the fact that some others are directly used by quarterly national accounts. In particular, future consumption is modeled on the basis of business surveys and not linked to data relative to households situation (wages, unemployment rate, inflation…). This is attributable to the fact that in France, contrary to other countries (for instance Italy, see Parigi and Schitzler (1995)), high-frequency information about household disposable income is not available.

Deliberately, the set of OPTIM's equations is estimated on the single equation basis, not derived from a theoretical model, in order to reduce the interdependence between the different endogenous variables. More precisely, apart from one equation (imports), endogenous variables are never used as explanatory variables of other equations. For instance, production growth rate could have been used as a determinant of the contemporary growth rate of investment in the spirit of a standard accelerator equation. However, it has been chosen to regress investment on business survey data. The reason underlined this choice is twofold. First, OPTIM is not a small-scale replicate of the Banque de France structural macro-economic model but rather a complement of this model devoted to the short-run analysis. Second, introducing macro-economic feedback is likely to give rise to cumulative errors and therefore to blur significantly the interpretation of the results. The only exception to this 'no-feedback' rule is the introduction of a weighted average of domestic demand components in import equations. Moreover, it is worth noting that the distribution of the discrepancy (see section 5) mechanically generates inter-relationships between the different endogenous variables.

1.3. OPTIM is performed according to a two-steps procedure

In the first step, two GDP forecasts are simultaneously provided. In the first, production by sectors is directly modeled according to a sectoral decomposition using mainly business surveys ("supply side approach"). Summing these different components straightforwardly yields an assessment of the overall production, which then is linked to GDP by means of a simple bridge equation. In the second, all GDP components (consumption, investment, inventories, exports and imports) are estimated and GDP is obtained on the basis of the standard accounting identity. In a second step, the discrepancy between these two assessments is split between the different GDP components proportionally to the uncertainty surrounding their estimation - the result of the simulation is modified proportionally to the mean of the residuals over the last two years -. Overall, this method enables the automatic introduction of add-factors in OPTIM, bringing a mechanical correction to equations which temporary present bad properties.

1.4. An aggregated equation to check the consistency of each forecasting exercise

The output of OPTIM cannot be reduced to the estimation of GDP growth, since it provides also a breakdown by sectors and by components. Nevertheless, it appears valuable to compare OPTIM's results with outputs of a single GDP equation. This comparison facilitates the identification of simulation pitfalls linked for instance with the temporary failure of one specific equation. This smaller-scale model is presented in the last section and a forecast comparison - in terms of root means square errors - is implemented.

2. The Data set

OPTIM is based on a wide data set, which comprises usual monthly economic indicators, survey data and financial variables.

2.1. Monthly macroeconomic data

As most of them are used as indicators when quarterly national accounts are elaborated, these variables are exclusively used to perform the zero-quarter ahead projection. Therefore taking them into account is likely to improve the quality of the GDP flash estimate. As shown in Figures 1 to 3, industrial production along with its sub-components exhibit a good correlation with its national accounts counterpart. This is also the case for quarterly and monthly data for manufacturing consumption as can be seen from Figure 4. Overall, as detailed in section 4, the aggregation of these monthly data is directly regressed on the quarterly national account series.

Figure 1
Manufacturing output
(quarter-on-quarter, %)

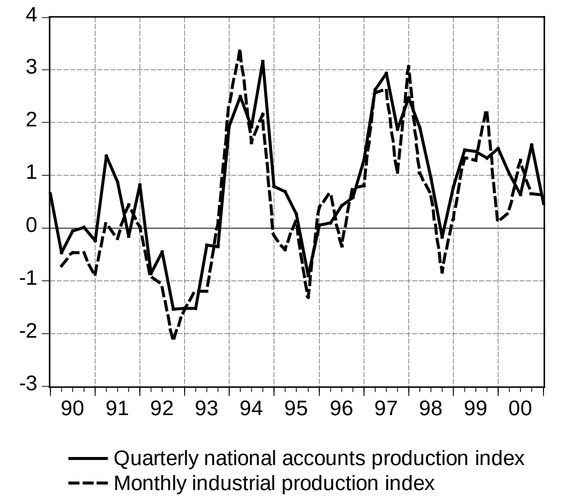


Figure 2
Agri-food output
(quarter-on-quarter, %)

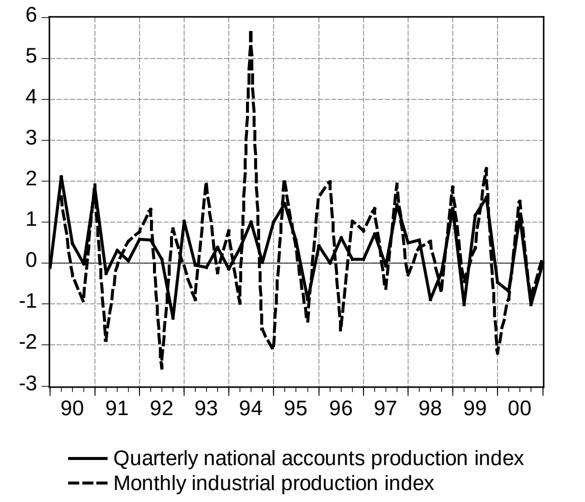


Figure 3
Energy output
(quarter-on-quarter, %)

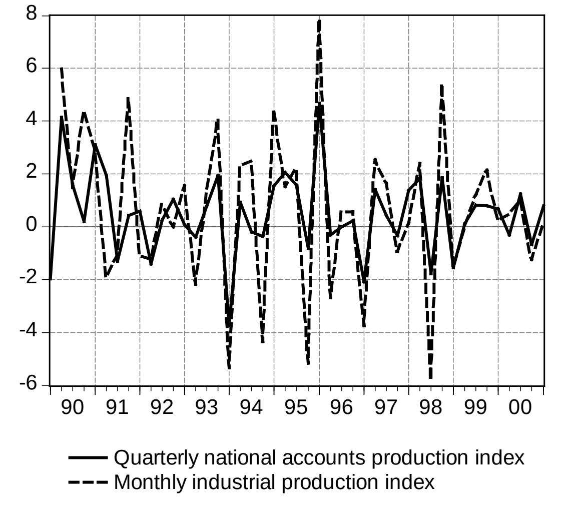
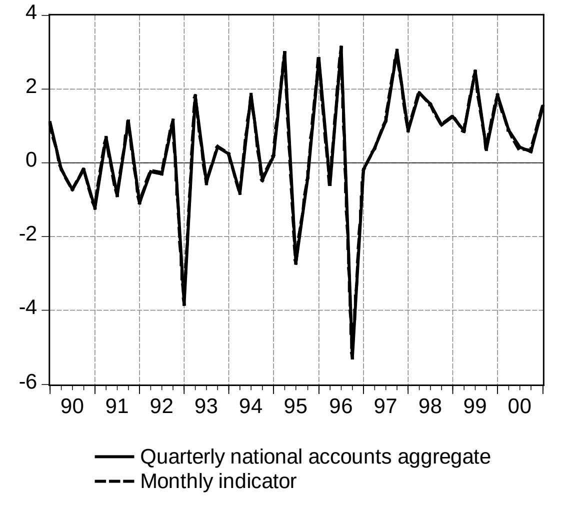


Figure 4
Manufacturing consumption
(quarter-on-quarter, %)



2.2. Survey data

Most surveys used in OPTIM are available on a monthly basis and are carried out sector by sector: for instance the surveys in manufacturing sector includes a part exclusively devoted to equipment goods. The main exception concerns surveys in the services sector that are conducted on a quarterly basis by INSEE and on a bi-monthly basis by the Banque de France.

Basically, six surveys are included:

1- The INSEE manufacturing survey;
2- The INSEE construction survey;
3- The INSEE survey for the services sector;
4- The INSEE retail trade survey;
5- The Banque de France manufacturing survey;
6- The Banque de France survey for the service sector.

It is worth noticing that consumer confidence has not been explicitly taken into account in OPTIM since it is difficult to identify what this index exactly captures. As pointed out by Braun-Lemaire and Gautier (2001), the link between consumer confidence and real disposable income has somewhat weakened since 1999 implying that this is not a sufficient and reliable indicator to properly estimate households' subjective perception of their purchasing power. Furthermore, interest rates, which are known to play an important role in the determination of housing investment, have probably also an impact on the fluctuations of the indicator. However, the relationship between interest rates and consumption is not straightforward. Carnezza and Pariggi (2001) shows that the French consumer confidence index can be explained by the unemployment rate, the inflation rate and the exchange rate but interest rates do not have a significant effect. This result is not surprising since the link between interest rate and household confidence is actually twofold with substitution and income effects. A high level of interest rates can impact negatively on household expenditures, particularly housing investment, and therefore can deteriorate the consumer psychological state of mind. Conversely, a rise in interest rates leads to an increase in the saving's remuneration. For instance, at the beginning of 1990, answers relative to households financial situation have probably been positively influenced by the increase in interest rate. The third variable, which is likely to influence the evolution of the consumer confidence index is the unemployment rate. In particular, the upward trend exhibited by the index is likely explained by the French labour market improvement. Finally, Braun-Lemaire and Gautier (2001) shows that introducing this index improves the econometric quality of a standard consumption equation. However the authors acknowledge that the relation between this index and standard macroeconomic variables (real disposable income, interest rate, unemployment rate) is not fully stable. According to their conclusions, confidence index remains a secondary determinant of consumption.

Overall, The relation between consumers confidence index and macroeconomic variables appears therefore subject to several breaks and can not be robust enough to be used appropriately in the model.

2.3. Financial variables convey a mixed predictive content

Estrella and Mishkin (1998) have stressed the importance for policy maker and market participants of relying their analysis on a few well-chosen indicators (such as the slope of the yield curve or stock prices). Looking at financial indicators – when they turn to be informative – is indeed quick and simple and provides a tool to check other forecasts. For the United-States for instance, Estrella and Mishkin (1998) show that asset prices are useful indicators one and two quarters ahead. Beyond, the slope of the yield curve outperforms other indicators.

2.3.1. The slope of the yield curve seems to be a useful indicator

Three theoretical reasons are generally put forward to explain the link between the long-short yield spread and economic activity. The first explanation focuses on the dynamics of the long-term-interest rates. According to the expectation theory long-term interest rates are a weighted average of expected short-term interest rates, which contain information about expected activity. Therefore, a slowdown in real growth translates into an anticipated monetary easing which in turns imply now a decline in long-term interest rates and a tightening of the yield spread. The second explanation puts the emphasis on the short-term interest rate and on the impact of current monetary policy on future activity. Estrella and Mishkin (1997) observe that, when short-term interest rates rise, the extent of the rise in long-term interest rates will be in inverse proportion of the degree of monetary policy credibility. Assuming that long-term interest rates are constant (perfect credibility), the spread between long-term and short-term interest rates only captures changes in short-term rates and the impact of these changes on future activity. The last underpinning relates to the smoothing out of consumption initially described by Harvey (1988). Overall, as evidenced in Figures 5 to 7, the yield spread lagged by two quarters is strongly correlated with output growth in various sectors, although the correlation appears tighter in the manufacturing industry than in the services. Therefore in contrast with CDC (1996) the short-term and the long-term interest rates are not separately introduced, and the yield spread enters directly (see Section 4).

2.3.2. Household loans appears to be useful for assessing consumption in services

Faced with the relative failure of standard consumption function, several authors (see Sicsic and Villetelle (1993), Charpin (1998)) have stressed the importance of financial variables for the analysis of household behaviour. The links between net loans and consumption are complex and characterized by a high degree of simultaneousness. In this respect, Charpin (1998) chose to model these relationships using a multivariate approach with no a priori about the channels of interdependance.

Consumption depends on net loans in two different ways. First, debt reimbursement, reflected by a decrease in net loans, has a dampening effect on consumption. Secondly, for a fraction of households the budget constraint is effectively binding. An increase in their opportunity to borrow directly feeds into higher consumption. A standard keynesian consumption equation can be written as follows (see for instance the long-term of the consumption equation used in the Banque de France macro-economic model (Banque de France (1995)):

$$\ln(consumption)=a\ln(income+g*net\_loans)+b(inflation)+c$$

The growth rate of net loans appears therefore as a potential determinant of the growth rate of consumption. Two monthly variables can be introduced to take net loans developments into account. First, data relative to net loans (*hloans)* are available on a monthly basis. Secondly, the Banque de France carries out a survey relative to households behaviour containing information about future developments of the demand for loans (*c53d*). According to Figure 8, surveys (c53d) appear to be correlated with the developments of loans to households. Nevertheless, data are available only on a short sample. Moreover the correlation is very weak in 1998 characterized by a sharp increase in the survey whereas loans are quite stable. Given the short observation sample, the Banque de France survey is not introduced in OPTIM. Only net loans data are used to forecast households consumption in the services sector (see section 4.2.1).

Figure 5
Total production-interest rates
(normalised data)

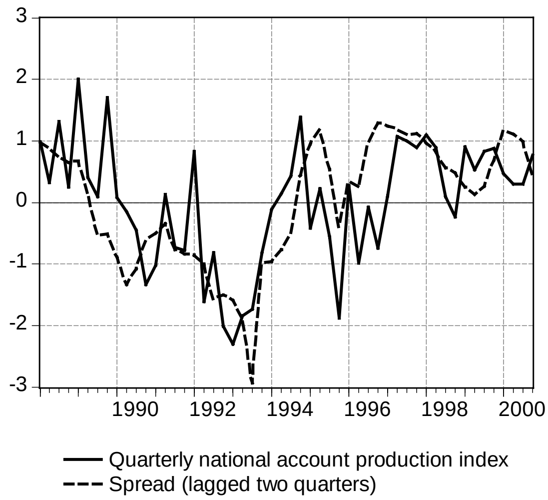


Figure 6
Manufacturing production-Interest rates
(normalised data)

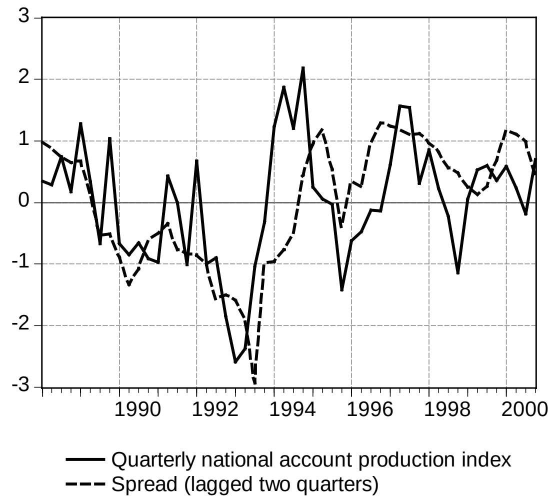


Figure 7
Services production-Interest rates
(normalised data)

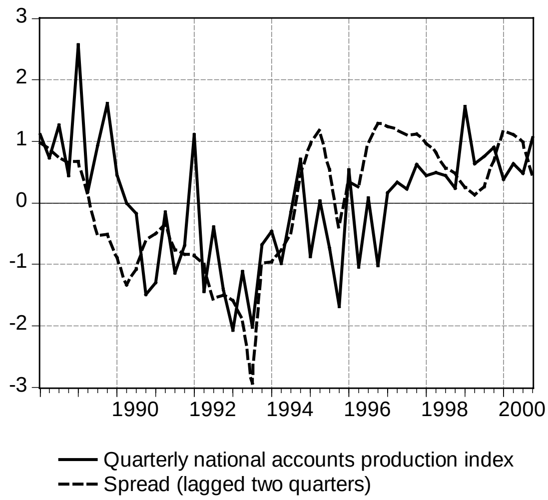
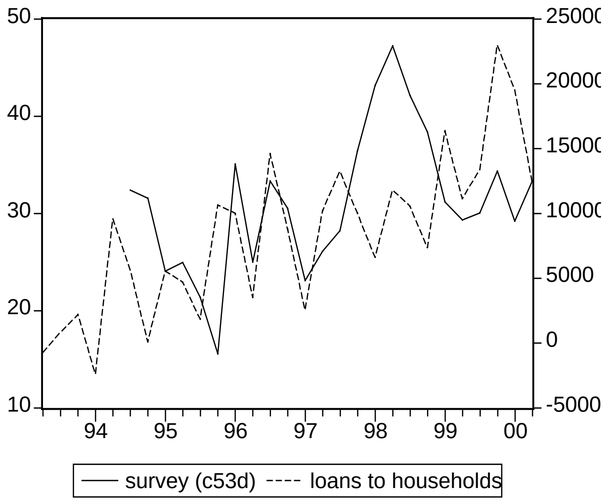


Figure 8
Surveys and loans



2.3.3. Stock prices are not relevant to project GDP growth

Stock market data can be divided in two different groups: equity and property prices. Concerning asset prices, their link with current and future output growth is twofold. First, under the assumption of deep and well-informed markets, asset prices include expectations about future dividend growth and therefore incorporate information about the future path of economic growth. Secondly, asset prices have an impact on both consumption and investment decisions. Beyond the well-known wealth effect, asset prices may also influence consumption by providing consumers with signals concerning future wages. Investment is influenced by asset prices through, at least two channels. First, an increase in asset prices is likely to bring about a general improvement in firms balance sheets, lowering risk premium on loans and therefore fostering investment. The second channel corresponds to the well-known Tobin's q effect according to which a firm should issue new shares and carry out new investment plans until the ratio between the market valuation of its projects relatively to their costs is driven to one. Concerning property prices, intuitively, the relation between property prices and the current state of economy appears quite straightforward: in a context of a rigid supply of land and of a slow adjustment of building capital, the equilibrium is achieved only by price fluctuations.

For the United-States, several studies have outlined the leading property of equity and property prices. Blanchard *et alii* (1993) point out a significant relation between the accumulation rate and the market value of equity. IMF (2000) have found leading properties of equity and property prices in the US and the UK. Results are mixed in the case of Germany and France. Some recent studies (Charpin and Peleraux (2000)) endeavor to put in evidence a stronger effect of equity prices on real activity during a recent period. But this kind of results suffers from the small number of observations. AS the IMF (2000), the following regression (for growth domestic product, total production, private services production, building production and manufacturing production for France) have been carried out:

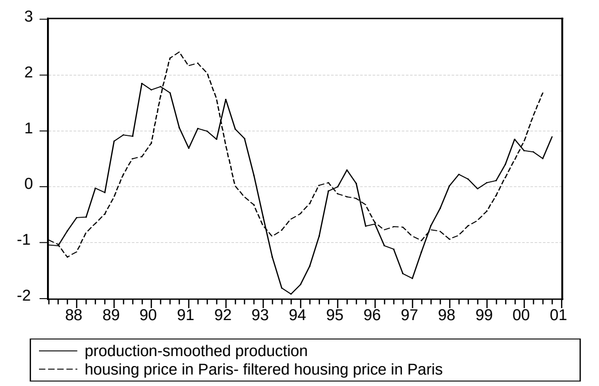
$$qg\_prod = \rho qg\_prod(-1) + c + \beta\Delta(equity(-i))$$

where qg_X is the quarterly growth rate of variable *X*.

Estimations are performed on the sample 1988-2000 and we take the cac40 index for equity price. In line with IMF (2000), the coefficient β is not significant whatever the sector and the number of lags considered. Working with other indexes, such as sbf120 and sbf250 (available only since the beginning if the 1990s) does not improve the econometric properties of the equation. Direct inspection of Figures 9 and 10 corroborates this lack of correlation. Consequently, equity prices have been excluded from OPTIM.

Figure 9
CAC 40 and production

Figure 10
Housing prices and production



3. Data assessment strategy

The high frequency data that are exploited in OPTIM are expected to provide an early estimate of real GDP growth and its components as well as a benchmark for the two upcoming quarters. Whereas the relationship between these data and current activity appears well-established and intuitive, it appears crucial to thoroughly explore the link between the data and future economic developments. Two questions are addressed in this section: first to what extent survey data contain information about future activity? Second which kind of data, in particular axis or specific questions, are the most correlated with future activity? The strategy we choose is first, to uncover direct relationships between high frequency indicators and the variable that we forecast, then to look for principal components from survey data. However, in order to avoid giving too much weight to possibly noisy observations we attempted to give more weight to factors from principal component analysis for one- or two-quarter ahead forecasts. High frequency indicators have a larger role for the assessment of GDP growth in the previous quarter ("zero-quarter ahead" estimate) .

3.1. Testing the predictive power of high-frequency indicators

However a closer look to the predictive power of survey data seems necessary, since a simple regression of the one-period ahead growth rate of e.g. production on survey indicators is not sufficient to verify that these indicators contain information about future activity. Indeed, if the survey indicator contain information about current activity (e.g. production) and if the production growth rate exhibits auto-correlation, thus, mechanically, the survey indicator will appear to be correlated with the one period ahead production growth rate[5]. Consequently, to determine whether survey indicators include information about future activity it is necessary to correct this variable from the information it contains about past activity. Two methods have been implemented to perform this correction: the first is based on a preliminary regression of survey indicators on the series they are supposed to forecast; the second consists in working with the innovations of the indicators.

1) First method: systematic preliminary regression of survey indicators on quarterly series they are supposed to forecast.

Let us define *indicprod* as a synthetic survey indicator relative to production and *qg_p* the quarterly growth rate of production. We construct the variable *indicprod_c* as the residual of the following equation:

$$indicprod = \alpha(L)qg\_p + \varepsilon$$

To test if *indicprod_c* contains information about future production we run the following regression:

$$qg\_p = \rho(L)qg\_p(-1) + \alpha + \beta indicprod\_c(-i)$$

The same kind of analysis is performed for investment, consumption and inventories. The three main axis extracted from the principal component analysis are systematically tested. The results of the regression are given in Annex B (Tables B1 to B4). Concerning the one step ahead forecast (i=1 in the following tables), at least one conjunctural indicator conveys significant information about future activity, whether we consider production, investment, consumption or changes in stock (see Table B2 to B5 in Annex B, blocks corresponding to i=1: t_β >1.8). Concerning the two-step ahead forecast information relative to production in the services sector and investment in equipment appear rather scarce (see Table B1 in Annex B, second block and Table B2, fourth block: i=2).

2) Second method: working with the innovations of survey indicators

What may appear interesting in terms of activity forecast is not the absolute level of a survey indicator but rather the difference between the actual and the expected level of this indicator. The more relevant information may therefore appear as the residual of the spontaneous dynamic of the indicator. This residual reflects information firms want to deliver about their assessment of the future state of economy. Gregoir and Lenglart (1998) and Reynaud and Scherrer (1997) follow this approach. Focusing on production, a two-steps procedure is implemented. First the innovations relative to the multivariate time series process followed by the indicators linked with production are computed. These innovations are then tested as explanatory variables or the growth rate of GDP.

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[5] Formally, let us assume for instance that we have the following relationship:

$$qg\_prod = \alpha ind + \beta$$

$$qg\_prod_{+1} = \rho qg\_prod + u$$

Hence, $qg\_prod_{+1} = \rho\alpha ind + \rho\beta + u$

Concentrating on the three main sectors, namely manufacturing, building and services, we define:

$$Z\_manu = \begin{pmatrix} axe\_manu1 \\ axe\_manu2 \\ axe\_manu3 \end{pmatrix};\ Z\_build = \begin{pmatrix} axe\_build1 \\ axe\_build2 \\ axe\_build3 \end{pmatrix};\ Z\_ser = \begin{pmatrix} axe\_ser1 \\ axe\_ser2 \\ axe\_ser3 \end{pmatrix}.$$

The following VAR system is estimated for each Z:

$$Z_t = A(L)Z_{t-1} + e_t$$

The residuals of these three VAR give the three innovation vectors:

$$\begin{pmatrix} inno\_manu1 \\ inno\_manu2 \\ inno\_manu3 \end{pmatrix};\ \begin{pmatrix} inno\_build1 \\ inno\_build2 \\ inno\_build3 \end{pmatrix};\ \begin{pmatrix} inno\_ser1 \\ inno\_ser2 \\ inno\_ser3 \end{pmatrix}$$

The lag length of each VAR is estimated using the Schwarz criteria[6].

Similarly to the previous subsection, our purpose is to test whether these innovations contain information about future activity. We therefore implement the following regression:

$$qg\_p = \rho(L)qg\_p(-i) + \beta inno(-i) + \alpha$$

As shown in Table B5 in Annex B, innovations relative to the building survey, and to a lesser extent to the manufacturing survey, seem to be efficient in terms of future activity forecast. Services survey does present a predictive power but only over a one-quarter ahead horizon. The conclusions drawn from the former analysis are therefore confirmed. Conjunctural indicators do contain information about future activity even if this information can be scarce for certain sectors/horizons (particularly service sectors, two-quarters ahead horizon). One must however keep in mind that predictions in OPTIM are not only based on conjunctural information but also on other types of data (loans…).

3.2. Survey data: working with factors rather than specific series

Survey data are used in OPTIM to build coincident but also leading indicators of activity. It is true that most surveys include questions that concern specifically future developments of activity. Nevertheless, as the correlation matrices show (see Table B6 and B7 in Annex B), it is worth noting that answers to these questions do not appear significantly more correlated with future activity than other answers, particularly when the series are corrected for their component relative to past activity.

When designing an equation that is supposed to be simulated mechanically, it appears quite dangerous to over-weight one specific answer: if this latter is temporary affected by noisy perturbations, it implies to bring arbitrary correction when simulating the model which is cumbersome and not satisfactory. Working with axis enables to smooth the evolution of the series used to perform our short-term mechanical estimates. That is the reason why principal components are in general used to perform one and two-quarter ahead estimations.

Overall surveys convey useful information for forecasting variables one and two quarters ahead. Therefore these variables will be used mainly for these horizons. However, it is worth mentioning

[6] The lags are two, one and one quarter for manufacturing, construction and services respectively.

some exceptions. As no monthly indicators are available for consumption in services and external trade, survey data enter in the zero quarter ahead equation[7]

4. Presentation of OPTIM equations

This section describes the main equations used in OPTIM. As indicated before, the zero quarter ahead equations rely as much as possible on monthly variables whereas one and two step ahead equations are based upon survey data and financial variables.

4.1. A sectoral estimation of GDP growth

4.1.1. Sectoral production estimations

The estimation of GDP growth is performed by sectors (agri-food, energy, public services, construction, private services, manufacturing sector). In terms of pure GDP forecasting, it is interesting to evaluate the efficiency of this approach compared with a fully aggregated model based on a direct GDP modeling. Indeed, one of the main drawbacks of OPTIM is the lack of information concerning agri-food, energy and public services developments. These three sectors account for more than 25% of total production. The methodology implemented follows three steps. In step 1, all the infra-quarterly indicators (survey data, financial variables, etc.) are converted in quarterly series[8]. In step 2, results from step 1 are summarized into different axes by implementing a principal component analysis ($axis_k$). In step 3, the quarterly regression below is carried out:

$$\dot{X} = \sum_k \alpha_k (L) axis_k + \sum_i \beta_i indic_i + c ,$$

where $\dot{X}$ denotes the quarter-on-quarter growth rate of the variable X, X being the aggregate from the quarterly national accounts (in volume). $Indic_i$ represents some other conjunctural indicators (eg loans, slope of the yield curve) that are likely to be also correlated with $\dot{X}$.

The endogenous variables, $\dot{X}$ are the following:

- Production: agri-food, private services, public services, energy, manufacturing;
- Consumption: agri-food, private services, public services, energy, manufacturing;
- Investment in equipment and construction;
- Imports of good and services;
- Exports of goods and services;
- Changes in stocks (total).

The zero quarter ahead equations are presented in Table 1 below. As expected, aggregated monthly industrial production are taken as explanatory variables.

[7] Information contained in manufacturing surveys is summarized with a principal component analysis (yielding axe_manul, axe_manul2, axe_manul3). Information contained in construction survey is summarized with an principal component analysis (yielding axe_build1, axe_build2, axe_build3). axe_ser1, axe_2, axe_ser3 are extracted from information contained in surveys relative to services sector and axe_retail from information contained in surveys covering the retail trade sector.

[8] The conversion method consists in most cases (except for loans in particular) in taking the average of the series for the quarter.

Table 1[9]

Zero-quarter ahead output equations[10]

	qg_pmanu *Equation 1 #*	qg_pener *Equation 2 #*	qg_pali *Equation 3 #*
Constant	0.35 (4.2)	0.25 (1.6)	0.09 (1.4)
qg_ipi_manu95	0.65 (7.3)		
qg_ipi_manu95(-1)	0.27 (3.0)		
qg_ipi_pener95		0.40 (7.9)	
qg_pali(-1)			0.30 (2.1)
qg_ipi_agrifood95			0.30 (4.8)
Adjusted R-squared	0.82	0.6	0.3
S.E. of regression	0.5	1.0	0.5
DW	2.0	2.0	

However, when the zero-quarter ahead projection is performed, approximately 3 or 4 weeks after the end of the quarter, only two months of IPI and its component are available. Concerning the manufacturing component of IPI, the method implemented to project the third month exploits the correlation between IPI and manufacturing survey. Table 2 displays the result of this regression. This method is hindered by two major problems. First, the monthly growth rate of IPI exhibits a very high level of volatility (see Figure 11). Second, a break in the elasticity between the two variables is noticeable from the beginning of 1999 to the second half of 2000. For the time being, it is difficult to determine whether this is to be short-lived or long-lasting (see Figure 12).

Figure 11

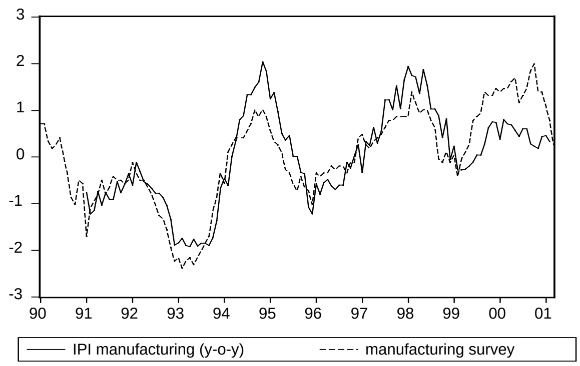


Figure 12

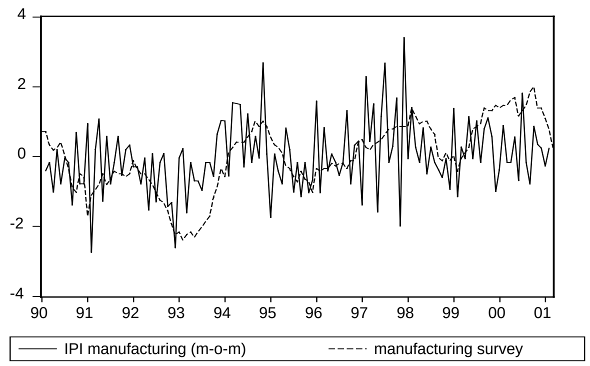


Table 2

Monthly equation used to forecast manufacturing production[11]

	Mg_ipi_manu95 *Equation 4 #*
Constant	0.12 (1.8)
Mg_ipi_manu95(-1)	-0.34 (-4.2)
Mantendrec	0.05 (3.0)
Mantendrec(-1)	0.03 (1.3)
Mantendrec(-2)	-0.06 (-4.1)
Adjusted R-squared	0.3
S.E. of regression	0.7
DW	2.2

[9] The equations included in OPTIM are designated with # and are described in a grey frame.

[10] All the equations passes the usual test (LM, Arch, normality). For sake of conveniency they are not reported in the table and are available upon request.

[11] Mnemonics are documented in Annex A. Mantendrec denotes the answer to the question relative to current activity (survey in manufacturing sector), ipi_sectorZ the industrial production index of sectorZ, mg_X and qg_X respectively the monthly and the quarterly growth rates of X.

The one and two quarter ahead equations are based upon survey data and the yield spread (see Table 3). The introduction of the latter variable is in line with Sédillot (2001), who shows that the slope of the yield curve of the current quarter contains information on future activity two-quarter ahead. Furthermore, this relationship exhibits a certain degree of regularity on the 1960-1997 sample, at least in European countries. It is worth noting that the coefficient of the slope of the yield curve is not significant in the two-step ahead equation for the production of private services and barely significant in the one-quarter ahead equation.

Table 3

One and two quarters ahead output equations

	qg_pserpr (1-quarter ahead) ***Equation 5 #***	qg_pmanu (1-quarter ahead) ***Equation 6 #***	qg_pmanu (2-quarter ahead) ***Equation 7 #***
Constant	0.8 (6.1)	0.6 (2.4)	
Qg_pserpr(-1)	-0.1 (-1.0)		
Axis_ser1(-1)	0.4 (4.2)		
Axis_ser3(-1)	0.1 (1.5)		
Axis_ser3(-3)	0.2 (2.8)		
Axis_manu1(-1)		1.5 (4.6)	
Axis_manu1(-2)		-1.2 (-4.2)	1.2 (3.6)
Axis_manu1(-3)			-1.3 (-4.0)
LTIR(-2)-STIR(-2)	0.08 (1.7)	0.2 (2.4)	0.3 (3.2)
Adjusted R-squared	0.6	0.5	0.5
S.E. of regression	0.4	0.8	0.8
DW		1.9	1.4

4.1.2. A simple bridge equation links production to real GDP growth

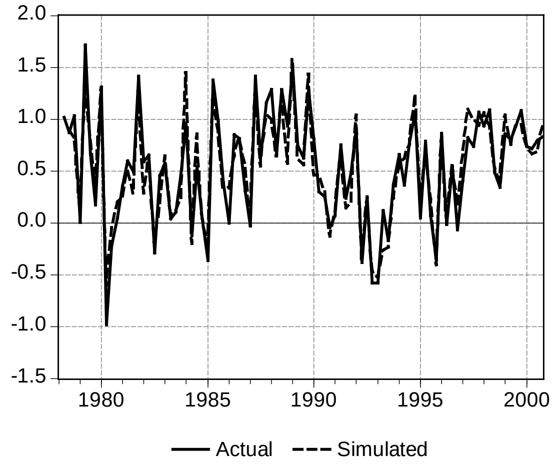
Production is forecast according to a decomposition by sectors, on the basis of the industrial production index (coincident estimation) and three main surveys: building (INSEE), industry (INSEE and BDF) and services (INSEE and BDF). For the sake of simplicity and to avoid introducing a trend in the long run equation due to the fact that the ratio of total production to GDP increases steadily since the beginning of the eighties[12], real GDP growth is derived from output growth with the following equation:

$$qg\_GDP = \alpha_1 qg\_prod + \alpha_2 qg\_prod_{-1} + \alpha_3$$

[12] This is likely due to the relative decrease in intermediate consumption related to the increasing share of services in GDP.

As shown in Figure 13 below, the simulation appears satisfactory.

Figure 13
Simulation of real GDP growth (q-o-q, %)



4.2. GDP component estimations

4.2.1. Household consumption

Household consumption forecasts rely on two types of data: estimates of monthly expenditures (manufacturing sector) and surveys in retail trade sector (*axe_retail*). Finally, as no monthly indicators covers services, consumption in services has been modelled using the survey in services and as explained in section 2.3.2 loans.

Table 4
Current consumption equation in services

	qg_cserpr ***Equation 8 #***	qg_cserpr ***Equation 9***	qg_cmanu ***Equation 10***
Constant	0.6 (12)	0.6 (10)	0.8 (2.1)
D(hloans(-2))	$1.04\ 10^{-5}$ (1.7)		
Axis_ser1	0.3 (6.5)	0.5 (4.7)	
D(c53d)		0.02 (2.3)	
D(c53d(-2))			0.1 (2.4)
Adjusted R-squared	0.5	0.6	0.2
S.E. of regression	0.3	0.3	0.2
DW	2.0	1.5	1.7

Note: As explained in 2.3.2, c53d is a seasonally adjusted series constructed from the Banque de France's survey. EMC, "Comportement des particuliers", Evolution prevue de la demande de credits de tresorerie.

4.2.2. Investment

Investment is split into two main components: equipment (*inveq*) and building. Forecasts of building investment are based on the INSEE construction survey. Concerning short-term investment modelling, two alternative approaches are possible. First, the specification of the equation can be inspired by a standard accelerator equation including demand addressed to firms and possibly interest rate and/or capacity utilization rate. A short-term proxy of expected demand addressed to firms is directly given by the business survey in the industrial sector. Secondly, investment in equipment can also be directly estimated using survey relative to the equipment goods sector (see Figures 14 and 15). Whereas the first method introduces a partial explanation of firm behaviour (through a proxy of expected demand, see for instance Parigi and Schlitzer (1995)), the second one just exploits sectoral information.

As evidenced in Table 5, it is interesting to notice that a better fit is achieved with the principal component extracted from the survey covering the whole manufacturing sector (*axe_manu1*) than with the answers concerning the specific sector of equipment goods (*axebdfeqprev*). The variable *Axe_manu1* captures a demand effect. In this respect the first investment equation can be interpreted as a behavioural equation. Introducing the capacity utilization rate (*cur_bdf*) yields non significant coefficient. A mixed equation is adopted including a demand term (*axe_manu1*) as well as information specifically relative to equipments (*d(axebdfeqprev$_{-1}$)*) (see Table 5).

Figure 14
Growth in investment in equipment and survey
(q-o-q, level, normalised data)

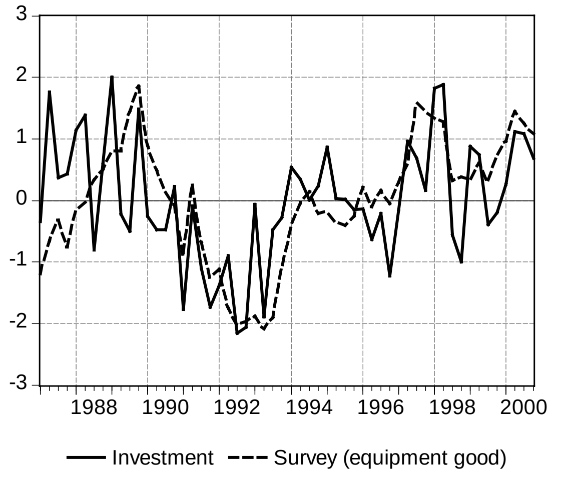


Figure 15
Growth in investment in equipment and survey
(q-o-q, level, normalised data)

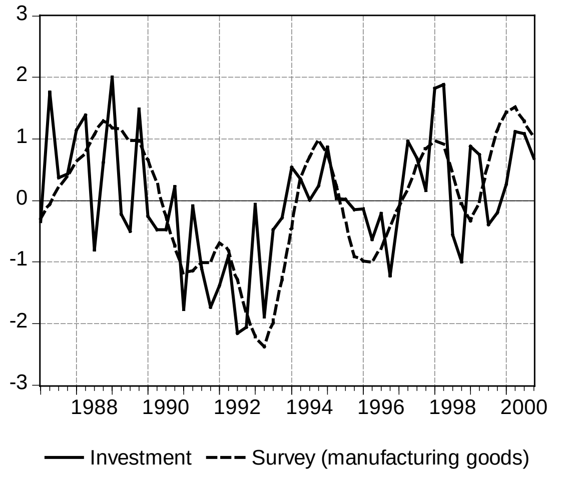


Table 5
Investment equations

	qg_inveq *Equation 11*	qg_inveq *Equation 12*	qg_inveq *Equation 13*	qg_inveq *Equation 14 #*	qg_inveq *Equation 15*
Sample	1986-2000	1986-2000	1986-2000	1986-2000	1986-2000
Constant	1.0 (3.8)	1.3 (7.5)	14.7 (1.7)	1.1 (6.7)	-5.7 (-0.7)
Qg_inveq(-1)	0.2 (1.6)				
Axebdfeqprev	0.9 (3.5)				1.0 (3.8)
Axe_manu1		1.2 (7.3)	1.5 (5.9)	1.2 (7.4)	
Cur_bdf			-0.2 (-1.5)		0.08 (0.8)
D(axebdfeqprev$_{-1}$)				0.6 (1.5)	
Adjusted R-squared	0.4	0.6	0.5	0.6	0.4
S.E. of regression	1.5	1.3	1.3	1.2	1.5
DW		1.5	1.9	1.9	1.5

4.2.3. External trade

Custom data are available on a monthly basis. Although these indicators are those used by the quarterly national accounts to estimate exports and imports of goods, we have prefered not to rely on these data. First, they are available with a two month delay. Second they are only available in value and the unit value indexes are not sufficient reliable estimates of trade deflators to adequately derive trade volumes consistent with national accounts data. Finally, the working day adjustement is different from the one used in quarterly national accounts. The input data used in OPTIM are taken from various business surveys, which generally include a few questions relative to external trade, focusing mainly on exports. These different answers are summarized with a principal component analysis (*axe_gdexp1)*) (see Figure 16). We model separately the exports of goods (*qg_xgoods*) and the exports of services (*qg_xser*). The first variable exhibits a negative autocorrelation and a high degree of volatility (see Figure 17).

Figure 16
Balances of opinions of questions related to external trade
(normalised data)

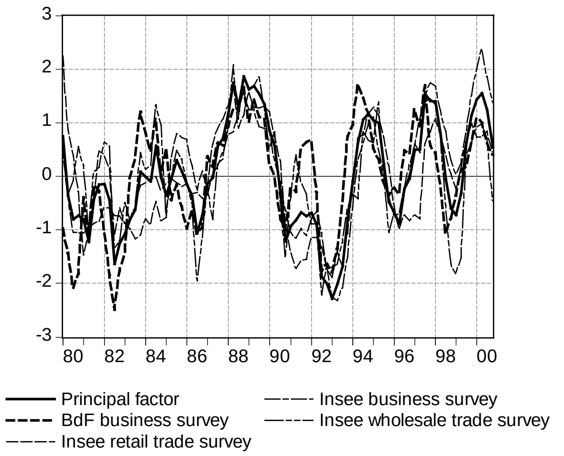


Figure 17
Exports growth and external trade principal factor
(q-o-q, level, normalised data)

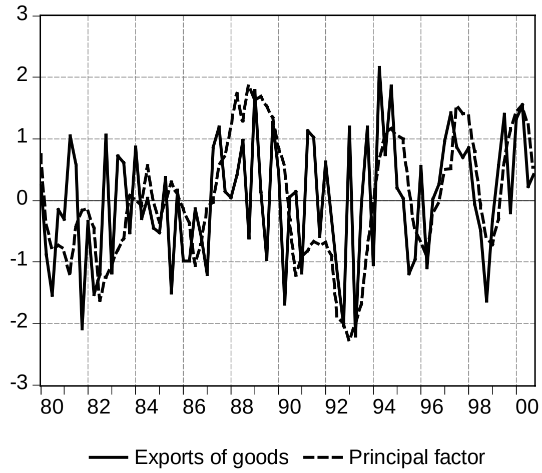


Table 6
Current quarter trade equations

	qg_xgoods ***Equation 16***	qg_xgoods ***Equation 17 #***	qg_xser ***Equation 18 #***
Sample	1980-2000	1980-2000	1988-2000
Constant	1.8 (6.6)	1.2 (3.1)	0.6 (1.3)
qg_xgoods			0.5 (2.8)
qg_xgoods(-1)	-0.2 (-2.1)	-0.4 (-3.4)	
qg_xgoods(-2)		-0.2 (-1.9)	
Axe_gdexp1	2.1 (4.3)	1.4 (2.7)	
Axe_gdexp1(-1)	-1.1 (-2.4)	-0.6 (-1.2)	
Qg_fraddmdb		0.5 (3.3)	
Qg_fraddmdb(-1)		0.3 (2.1)	
D(servtpassetr)			0.1 (1.7)
Adjusted R-squared	0.2	0.4	0.1
S.E. of regression	2.0	1.9	2.7
DW			2.3

External trade activity appears very difficult to model using high-frequency indicators. The leading indicator model of CDC (1996) uses an indicator based on foreign inflation, exchange rate and other foreign activity indicators, which is supposed to track world demand. The correlation between this factor and effective world demand appears rather weak (see Figure 1D of the CDC working paper) but it may appear helpful when focusing exclusively on GDP forecasting. Our purpose being to forecast exports, this kind of estimate is clearly not sufficient. External activity is therefore captured through the introduction of the foreign demand used in the Banque de France macro-economic model (*fraddmdb*), which is a weighted average of French imports by other countries. Taking this variable improves the econometric properties of the equation (see Table 6) and enables to be consistent with the two-year economic projection exercise (SEBC Broad macroeconomic projection exercise).

As far as the exports of services are concerned, the INSEE survey in service sectors contains question about external activity. But the correlation between the answers to these questions and exports in services appears rather poor. In addition, exports of services seem also driven by exports of goods. To model exports of services we construct an equation exploiting this double correlation but the poor quality of its fit must be underlined (see Figures 18 and 19).

Figure 18
Exports growth of services and survey
(q-o-q, level, normalised data)

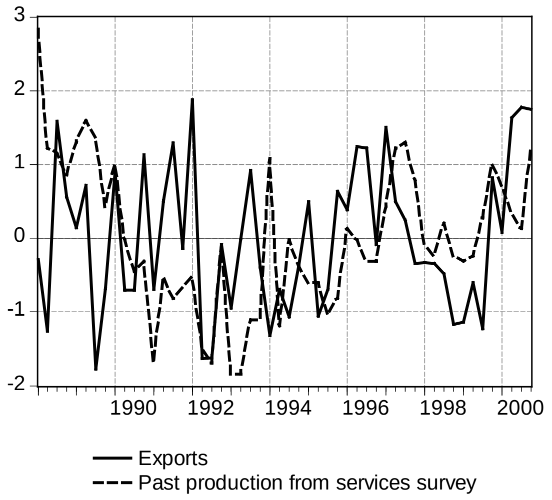
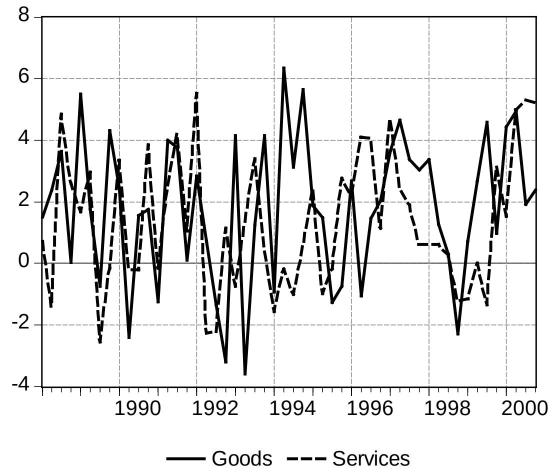


Figure 19
Exports growth of goods and services
(quarter-on-quarter, %)



Concerning imports, our first approach was to consider the same breakdown as exports between goods (*mgoods*) and services (*mser*). Nevertheless, imports of services are well-known to be difficult to model. The first method is to take advantage of the (loose) correlation between exports in services and imports in services. It is worth noting that the coefficients of exports of services is very significant (see equation 21). All in all, the fit of the equation is nonetheless very poor and we therefore chose to work on total imports (*mtot*).

The INSEE survey dealing with the wholesale trade sector and including two questions relative to deliveries expected from foreign countries is summarized with a PCA (*axe_gdimp1*). This survey is carried out 6 times per year and an interpolation is therefore performed to cast the bi-monthly series into a monthly one and, subsequently, into a quarterly series. The series we use is thus mechanically smoothed. The equation regressing the quarterly growth rate of imports on the axis summarizing this survey (see figure 21 for its residuals) exhibits two drawbacks. First, it does not capture the high negative autocorrelation that characterizes the quarterly growth rate of imports in goods. Second, the equation fails to take properly into account of two episodes of acceleration of imports in 1997 and in 2000. Given the lack of data concerning imports of goods and to mirror the model for exports, we encroach upon our principle of no macro-economic feedback between the different endogenous variables, by computing an internal demand (*dimp*) as a weighted average of the (endogenously determined) demand components.

*dimp=0.54*conso_households+0.12*conso_pubsector+1.56*invtot+1.74*stockbuilding+0.9*xtot*

Introducing domestic demand significantly improves the fit of the equation. In particular, the positive residuals at the end of the sample are still observed but are less pronounced than with the survey-based equation. In the end, the OPTIM equation (equation 23, table 9) involves our indicator of internal demand, together with the axis summarizing the INSEE surveys and the quarterly growth rate of exports of services.

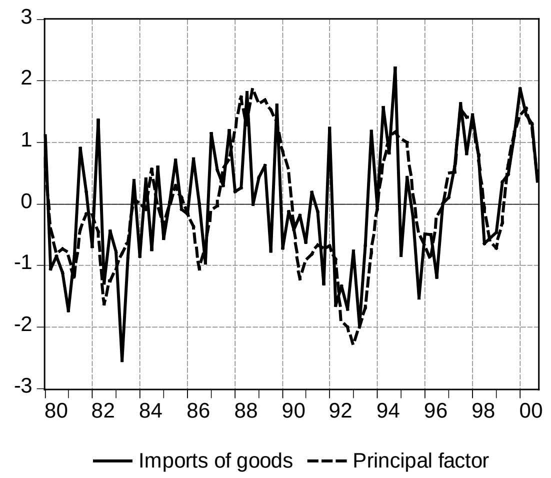
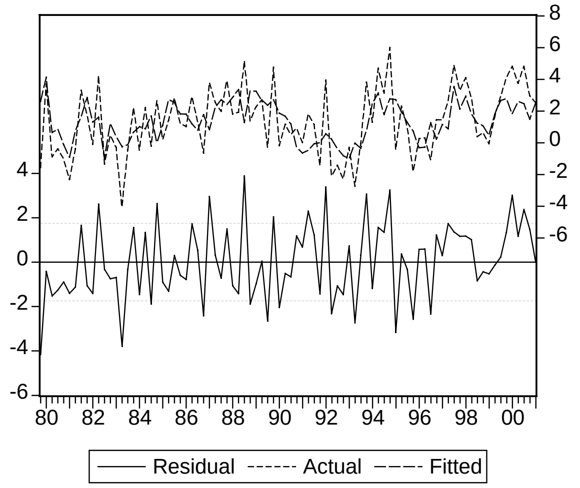
Figure 20 **Imports growth and trade principal factor** (q-o-q, level, normalised data)	Figure 21 **Residuals – equation 19**
	

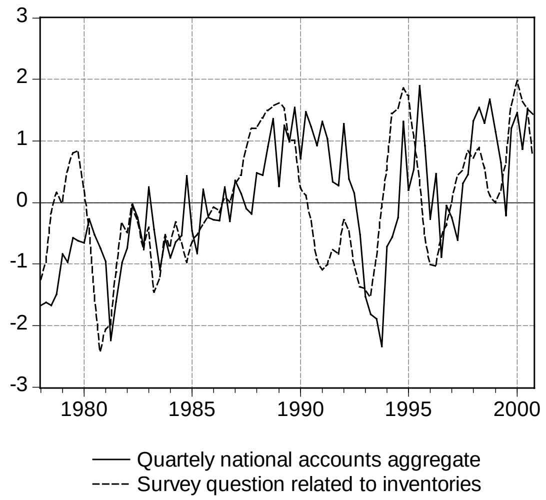
Table 7

	Qg_mgoods ***Equation 19***	qg_mgoods ***Equation 20***	Qg_mser ***Equation 21***	qg_mtot ***Equation 22***	qg_mtot ***Equation 23 #***
Sample	1979-2000	1985-2000	1985-2000	1985-2000	1985-2000
Constant	1.9 (8.8)	0.4 (2.9)	0.2 (0.6)	0.4 (2.8)	0.3 (2.3)
Axe_gdimp1	0.1 (5.4)				
Axe_gdimp1(-1)	-0.1 (-3.0				
Qg_dimp		1.4 (13)		1.3 (10.8)	1.3 (13.4)
D(axe_gdimp1$_{-1}$)		0.03 (1.6)		0.02 (1.3)	0.04 (2.1)
Qg_xser			0.5 (4.4)		0.1 (3.1)
Dum934_941					2.5 (4.1)
D(servtpassetr)					
Adjusted R-squared	0.3	0.8	0.2	0.7	0.8
S.E. of regression	1.7	0.9	2.6	1.0	0.8
DW	2.2	2.2	2.0	2.1	1.9

4.2.4. Changes in stocks

Inventories are forecast using the question related to stocks expectations contained in the INSEE business survey (*indstock*) which proved to have a good correlation with changes in inventories computed by quarterly national accounts (see Figure 22).

Figure 22
Changes in stocks and survey data
(normalised data)



5. Running and assessing the model

5.1. Dealing with the discrepancy

As already explained, OPTIM is based on a two-step procedure. The first step consists in the computation of a demand-based and a supply-based estimate of GDP growth, together with e discrepancy between the two estimates. The second step, presented in this section, provides the final estimate of GDP growth after allocating the discrepancy between the two initial estimates.

5.1.1. First step: the confrontation of a demand and a supply approach.

Even if the final output of OPTIM consists in one and only one estimation of GDP and its main components, in a first step of the forecast procedure, two forecasts of GDP ($qg\_GDPf_S^{(1)}$ and $qg\_GDPf_D^{(1)}$) are simultaneously provided by OPTIM, allowing a consistency check of the exercise:

1) A first forecast of GDP growth, $qg\_GDPf_S^{(1)}$, is provided by a "supply approach". Production is directly modeled according to a sectoral decomposition using mainly employers-oriented surveys. Regressing the growth rate of GDP on the growth rate of production provides a first forecast of the GDP growth rate.

$$qg\_GDPf_s^{(1)} = \rho(L)qg\_PRODf + c$$

2) A "demand approach" yields a second forecast of GDP growth ($qg\_GDPf_D^{(1)}$). GDP is obtained from the national income equation. Indeed, all the counterparts of GDP, consumption, investment, stock building, net external balance are estimated. An assessment of GDP, based on a demand approach, is given by:

$$GDPf_D^{(1)} = Cf^{(1)} + If^{(1)} + \Delta Sf^{(1)} + Xf^{(1)} - Mf^{(1)}$$

And therefore an estimate of GDP growth is given by:

$$qg\_GDPf_D^{(1)} = (Cf_{-1}/GDP_{-1}.)qg\_Cf^{(1)} + (If_{-1}/GDP_{-1}.)qg\_If^{(1)} + (Xf_{-1}/GDP_{-1}).qg\_Xf^{(1)} - (Mf_{-1}/GDP_{-1}).qg\_Mf^{(1)} + 100.\Delta(\Delta S)^{(1)}/GDP_{-1}$$

Since the results of these two forecasts are mechanically different, the discrepancy between the two different outcomes has to be dealt with.

3) Let define the variable *disc,* standing for discrepancy, as

$$disc = qg\_GDPf_S^{(1)} - qg\_GDP_D^{(1)}.$$

$$disc = qg\_GDPf_S^{(1)} - [(Cf_{-1}/GDP_{-1}.)qg\_Cf^{(1)} + (If_{-1}/GDP_{-1}.)qg\_If^{(1)} + (Xf_{-1}/GDP_{-1}).qg\_Xf^{(1)} - (Mf_{-1}/GDP_{-1}).qg\_Mf^{(1)} + 100.\Delta(\Delta S)^{(1)}/GDP_{-1}]$$

As already explained, *disc* measures the discrepancy between the quarterly growth rate of GDP estimated with the supply approach and the quarterly growth rate of GDP estimated with the demand approach.

5.1.2. Second step: breakdown of the discrepancy

The second step consists then in the breakdown of the discrepancy between the different terms qg_Z of the right-hand side of this equation, proportionally to the uncertainty surrounding their estimation.

A unique final estimate of GDP growth rate is derived from this procedure.. It is worth noting that this method enables the automatic introduction of add-factors in OPTIM, bringing an automatic correction to equations that temporary present bad properties: the results of the simulation of the equations are modified proportionally to the mean of the residuals during the two last years.

We will consider a very simple case, a presentation of the methodology in greater detail being provided in Annex C. Let us only concentrate on the one-step ahead horizon and let us assume that all OPTIM estimates are perfectly exact (zero uncertainty) but imports and investment. It is worth noting that imports correspond to a supply variable and investment to a demand one. Moreover, we assume that the degree of uncertainty (function of the residuals of the equation) is twice higher for investment than for exports. The first step of OPTIM provides estimates $qg\_GDP_S^{(1)}$, $qg\_I^{(1)}$, $qg\_X^{(1)}$, $qg\_M^{(1)}$ $qg\_C^{(1)}$, as well as $cont\_\Delta S^{(1)}$ (stockbuilding contribution to growth). These estimates cannot be considered as final since the corresponding levels do not satisfy the accounting equality: $GDPf_S^{(1)} + M^{(1)} = C^{(1)} + I^{(1)} + \Delta S^{(1)} + X^{(1)}$. We will suppose that the right hand side if this equation is strictly superior to the left hand side and denote λ the (positive) difference between these two quantities. In the case we consider, all the variables, except investment and imports, will remain unchanged since they are supposed to be estimated with certainty. In contrast, the estimated growth rates of investment and imports will be adjusted and the adjustment will be twice bigger for investment than for imports (*x* versus *2x*), since the uncertainty surrounding the former is supposed to be twice higher than that surrounding the latter. Moreover, since imports is a supply variable, it will be revised downwards and, conversely, investment will be revised upwards. Namely, a second set of estimates will be defined as:

$qg\_Z^{(2)} = qg\_Z^{(1)}$ for *Z=GDP, C, X*
$cont\_\Delta S^{(2)} = cont\_\Delta S^{(1)}$
$qg\_I^{(2)} = qg\_I^{(1)} + 2x$

$$qg\_M^{(2)} = qg\_M^{(1)} - x$$

Variable *x* can easily be calculated such that the demand-supply equality be satisfied. Namely, if we denote *weight_Z* the weight of Z in GDP (for instance *weight_C* for consumption) and if we suppose that these weights are constant, *x* is calculated such that:

$$weight\_M.qg\_M^{(2)}+qg\_GDP^{(2)}= weight\_I.qg\_I^{(2)}+ weight\_C.qg\_C^{(2)}+cont\_\Delta S^{(2)}+ weight\_X.qg\_X^{(2)}$$

And thus: λ=*weight_M.x-2 weight_I.x*. From this last equality, it is straightforward to calculate *x*.

This calculation can be easily generalized to the case of uncertainty surrounding all the variables and performed for each horizon. A presentation of calculation is provided in appendix 3.

5.2. Checking the consistency of each OPTIM exercise with the help of an aggregated model

OPTIM is based on a relatively complex and iterative procedure which yields coincident and leading indicators of GDP together with a breakdown of these indicators into five main sectors (agri-food, public services, energy, private services and manufacturing goods) as well as estimates of the counterparts of GDP. OPTIM relies on about twenty equations and is simulated as automatically as possible in order to give the priority to quantitative analysis. In this perspective a failure in one specific equation or a computational error are not completely unavoidable. Moreover, the one and two-step ahead forecasts of the three first sectors are only based on the assumption that production and consumption in public services, energy and agri-food come back to their long term trend with no additional survey information. Since these three sectors make up about 25% of total GDP, it appears important to check the accuracy of the output of OPTIM in terms of GDP forecast by comparing it to the output of a smaller model.

An aggregated model, presented in this section, has therefore been constructed for this purpose. According to the Harvey, Leybourne and Newbold statistics, coincident and leading indicators of GDP provided by OPTIM and by this smaller model appear equivalent in terms of forecasting performance. This result is not surprising, since both models broadly rely on the same set of information. It appears therefore very helpful to use this small-scale model as a handy device to check the consistency of an OPTIM exercise.

5.2.1. Construction of the aggregated model

The model used as a benchmark to assess the performance of OPTIM occupies a middle ground between a pure global approach and a pure sectoral approach. Indeed a pure aggregate approach – that would consists in applying a principal component analysis on the totality of high frequency data – appears purely statistical, the axis extracted being difficult to interpret.

We split indicators into nine main groups. The first group is related to household expenditure, incorporating data of retail trade survey, car registration and household loans. The second group covers firms prospects regarding economic activity (industry survey, capacity utilization rate). The next five groups concern respectively stockbuilding, construction sector, external trade, equipment expenditures and services sector. In addition, we also include in the set of information the unemployment rate (*ur*, available on a monthly basis) and the slope of the yield curve (*LTIR-STIR*).

Three equations have been constructed using these variables, yielding respectively a zero, one and two-step ahead direct assessment of GDP. These equations are similar to that estimated by Grasmann and Keereman (2001) for the euro area.

Principal factors
(normalised data)

Figure 23
Questions relative to households expenditure

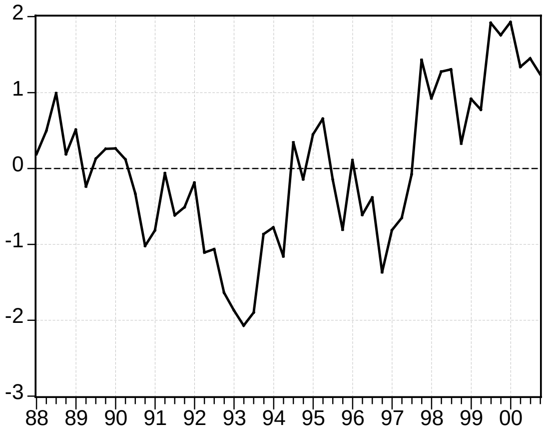


Figure 24
Manufacturing sector

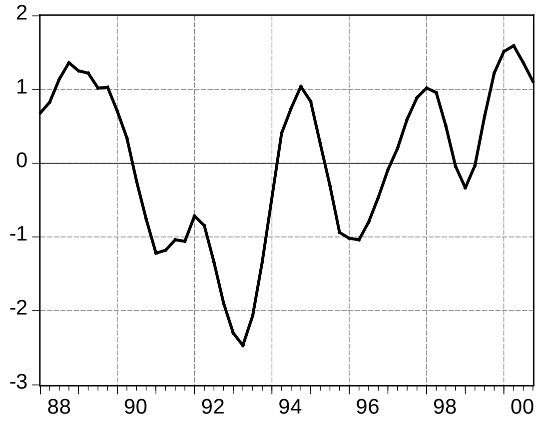


Figure 25
Questions related to inventories

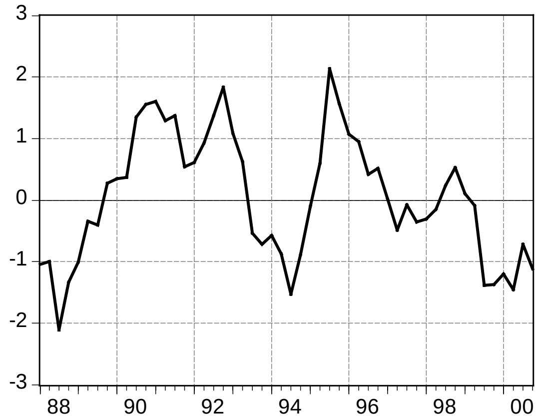


Figure 26
Construction sector

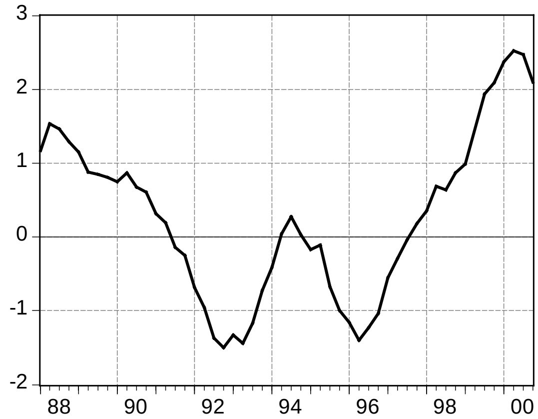


Figure 27
Questions related to foreign demand

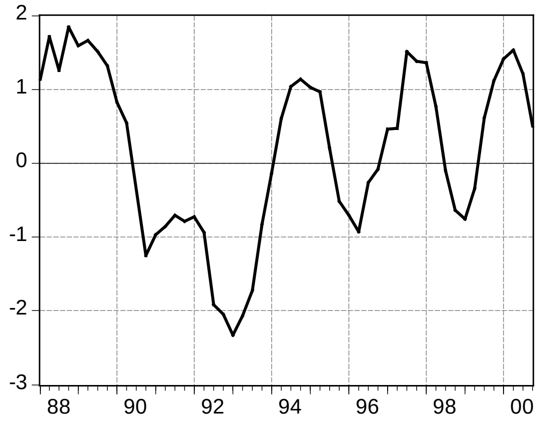


Figure 28
Services sector

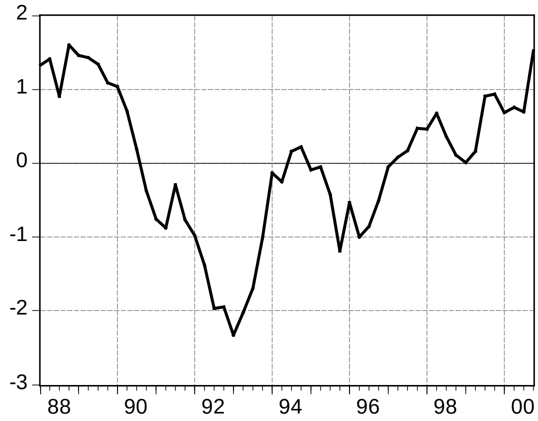


Figure 29
Equipment goods

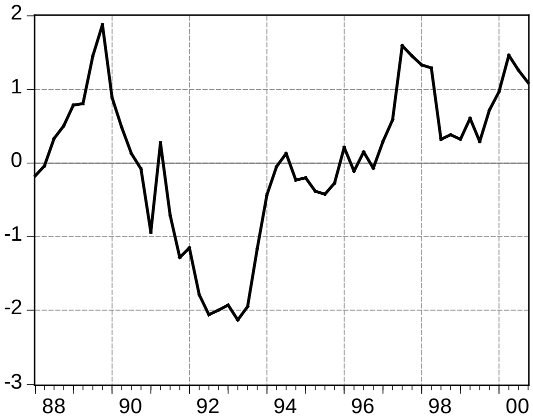


Figure 30
Unemployment rate

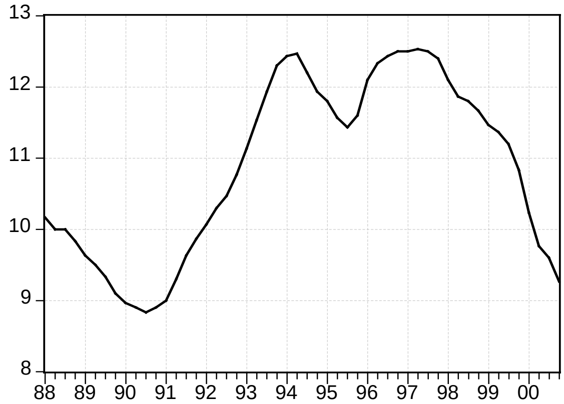


Table 8

	Coincident assessment qg_gdp	One-step quarter ahead forecast qg_gdp	Two-step quarter ahead forecast qg_gdp
Estimation sample	1988-2000	1988-2000	1988-2000
C	0.7 (9.6)		
Qg_gdp(-1)	-0.3 (-2.5)		
D(ur)	0.6 (1.6)		
Axis_dem1	0.2 (3.9)		
Axis_ser1	0.4 (3.6)		
Axis_ext1	0.1 (1.8)		
Axis_build1		0.2 (4.1)	0.2 (3.1)
D(Axis_firm1(-1))	0.3 (2.1)	0.3 (2.2)	
D(Axis_firm1(-2))			0.3 (2.2)
$LTIR_{-2}$-$STIR_{-2}$		-0.1 (-2.1)	-0.1 (-2.1)
Axis_stock1(-2)	0.1 (2.1)		
Adjusted R-squared	0.7	0.5	0.4
S.E. of regression	0.2	0.3	0.3
DW		2.1	1.6

5.2.2. Comparison of forecasting performances

The approach we adopt in this subsection is based on the computation of mean squared errors (MSE). But it is worth keeping in mind that a simple ranking of MSE of different competing models is not fully satisfactory, since the better performance of one model may only be due to chance. Diebold and Mariano (1995) stressed the importance of comparing the prediction records of two alternative models in the classical statistical hypothesis framework. In their important contribution to the literature on forecast evaluation, they proposed a statistic to test the null hypothesis of equality of prediction MSE. However, for small observation samples, the Diebold and Mariano test appears over-sized, the true null hypothesis (equivalent performance) being too often rejected. Moreover, this deficiency increases with respect to the length of the forecast horizon. The Harvey, Leybourne and Newbold (1997) statistic stems from a small sample correction of the statistic proposed by Diebold and Mariano (1995). The details of the method implemented are given in Annex D. Tables 9 and 10 below provide the results of this out of sample exercise.

Table 9
RMSE

	OPTIM	Aggregated model
Coincident assessment	0.037	0.031
One-step ahead forecast	0.079	0.085
Two-step ahead forecast	0.073	0.117

Table 10

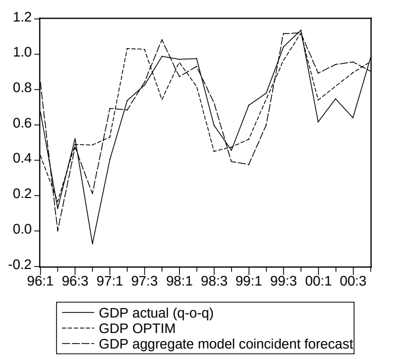
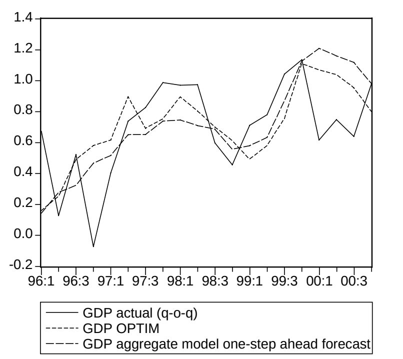
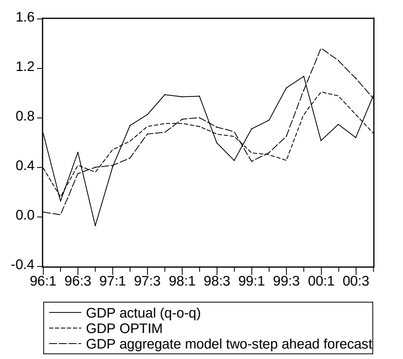
Comparison OPTIM/aggregated model

Diebold and Mariano/Harvey, Leybourne and Newbold statistics (p-value)

	$S_{k,DM}$	$S_{k,HLN}$
Coincident assessment	19.4%	17.7%
One-step ahead forecast	27.4%	29.2%
Two-step ahead forecast	26.6%	34.2%

Note: these figures represent the p-values of the statistic under the null hypothesis that the performances of the two models are equivalent.

Figures 29

Coincident forecast	**One-step ahead forecast**	**Two-step ahead forecast**
		

According to table 10, this smaller model forecasting performance is equivalent to that of OPTIM. Using the former to control the results of the latter appears therefore as a useful strategy to detect some possible forecasting issues. Of course, this small scale model cannot be considered as a substitute to OPTIM, since OPTIM produces a much larger set of consistent estimates.

5.3. Assessing the forecasting performance of OPTIM

The aggregated model we present in the previous subsection can be used as a convenient tool to check the consistency of the output of OPTIM but is too specific to offer a general benchmark to assess the forecasting performance of the model. This section is specifically devoted to prediction assessment on the basis of a standard method: the prediction record of OPTIM is compared to a general autoregressive model. Indeed, in order to test the accuracy of forecasts, a first method (see for instance Pesaran and Timmermann (1992)) consists in adressing the following issue: “the null hypothesis being that the model has no power in predicting the variable of interest, is the proportion of times that the direction of change of the endogeneous is correctly predicted high enough to reject the null hypothesis?” This kind of method is particulary relevant when the data of interest are qualitative or for forecasts produced by large non linear dynamic macroeconomic model. OPTIM does not correspond to any of these categories. Therefore in this subsection we adopt a second approach consisting in comparing the forecasts given by OPTIM to those of a simple AR model. Autoregressive equations are estimated to forecast GDP, households consumption, investment, imports, exports, and stockbuildings. The 0, 1 and 2 step ahead forecasts of these equations are compared to those of OPTIM. Since the conjonctural indicator used to predict manufacturing consumption is only available since 1991:1, the simulations are from 1995:4 onwards.

Table 11 RMSE

Sample: 1995:4 – 1999:4						
	OPTIM			AR model		
	Coincident	1 quarter ahead	2 quarter ahead	Coincident	1 quarter ahead	2 quarter ahead
GDP	0.200	0.293	0.293	0.333	0.364	0.381
Household consumption	0.508	0.667	0.679	0.695	0.681	0.706
Investment	0.911	0.690	0.831	0.888	0.958	1.026
Exports	1.172	1.317	1.437	1.633	1.663	1.645
Imports	1.202	1.400	1.517	1.396	1.423	1.532
Stock	0.327	0.380	0.400	0.343	0.375	0.374
Sample: 1995:4 – 2000:4						
	OPTIM			AR model		
	Coincident	1 quarter ahead	2 quarter ahead	Coincident	1 quarter ahead	2 quarter ahead
GDP	0.191	0.299	0.292	0.318	0.344	0.360
Household consumption	0.480	0.614	0.617	0.627	0.614	0.638
Investment	0.869	0.684	0.820	0.911	0.988	1.066
Exports	1.296	1.366	1.460	1.670	1.710	1.724
Imports	1.294	1.432	1.624	1.406	1.439	1.674
Stock	0.308	0.360	0.375	0.318	0.348	0.346

Table 12

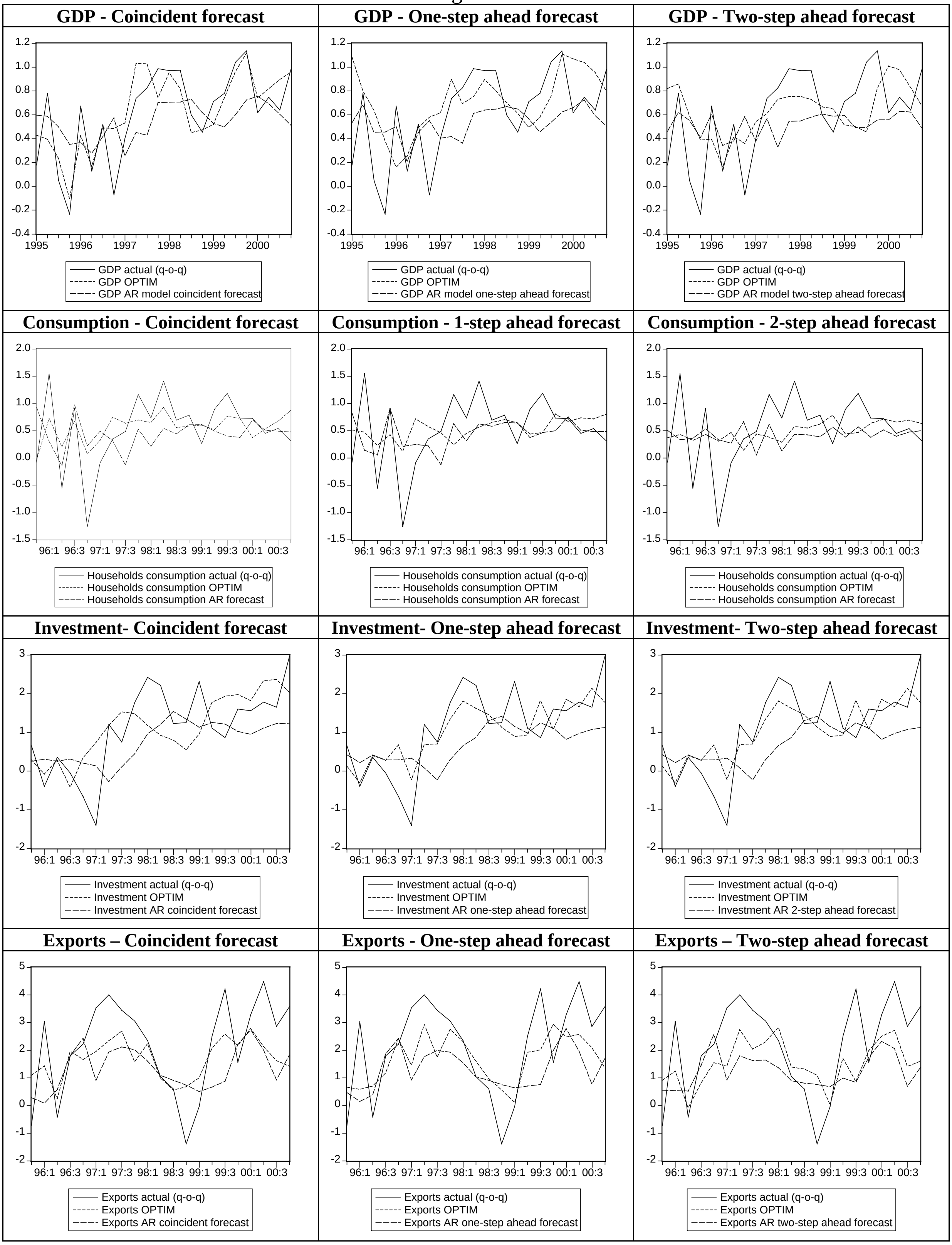
Comparison OPTIM/AR model

Diebold and Mariano/Harvey, Leybourne and Newbold statistics

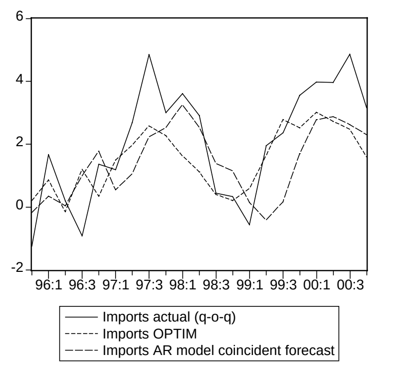
Sample: 1995:4 – 1999:4						
	$S_{k,DM}$ Diebold and Mariano			$S_{k,HLN}$ Harvey, Leybourne and Newbold		
	Coincident	1 quarter ahead	2 quarter ahead	Coincident	1 quarter ahead	2 quarter ahead
GDP	97.9%**	91.2%*	98.9%**	99.7%**	88.0%	97.9%**
Household consumption	99.4%**	60.2%	94.4%*	98.7%**	59.1%	92.8%*
Investment	42.9%	88.8%	78.2%	43.2%	85.6%	77.0%
Exports	97.2%**	98.6%**	97.3%**	95.9%**	96.8%**	95.9%**
Imports	80.8%	53.2%	52.8%	79.3%	52.9%	52.6%
Stock	61.9%	43.5%	23.5%	61.3%	44.2%	24.7%
Sample: 1995:4 – 2000:4						
	$S_{k,DM}$ Diebold and Mariano			$S_{k,HLN}$ Harvey, Leybourne and Newbold		
	Coincident	1 quarter ahead	2 quarter ahead	Coincident	1 quarter ahead	2 quarter ahead
GDP	99.9%**	83.5%	97.1%**	99.7%**	81.1%	96.0%**
Household consumption	98.2%**	50.0%	89.7%	97.2%**	50.0%	88.3%
Investment	63.3%	95.7%**	88.7%	62.8%	93.6%*	87.4%
Exports	97.5%**	99.4%**	99.7%**	96.4%**	98.3%**	99.2%**
Imports	73.4%	51.2%	60.4%	72.5%	51.1%	60.0%
Stock	59.2%	34.0%	16.5%	58.9%	35.4%	17.7%

Notes: (1) these figures represent the complementary of the p-value of the tests under the null hypothesis that the performances of the 2 models are equivalent. (2) the bad results obtained for stock are mainly due to year 1995. Working on 1996-2000 the complementary of the p-values of the Harvey, Leybourne and Newbold statistics are respectively 71,9% (coincident), 78.8% (1 quarter) and 99.4% (2 quarter). (3) **: significantly better 5% threshold ; *: 10% threshold.

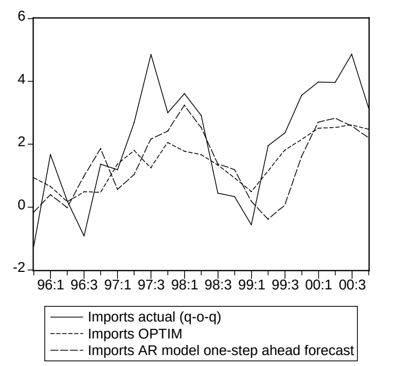
Figure 30


GDP - Coincident forecast
GDP actual (q-o-q)
GDP OPTIM
GDP AR model coincident forecast
GDP - One-step ahead forecast
GDP actual (q-o-q)
GDP OPTIM
GDP AR model one-step ahead forecast
GDP - Two-step ahead forecast
GDP actual (q-o-q)
GDP OPTIM
GDP AR model two-step ahead forecast
Consumption - Coincident forecast
Households consumption actual (q-o-q)
Households consumption OPTIM
Households consumption AR forecast
Consumption - 1-step ahead forecast
Households consumption actual (q-o-q)
Households consumption OPTIM
Households consumption AR forecast
Consumption - 2-step ahead forecast
Households consumption actual (q-o-q)
Households consumption OPTIM
Households consumption AR forecast
Investment- Coincident forecast
Investment actual (q-o-q)
Investment OPTIM
Investment AR coincident forecast
Investment- One-step ahead forecast
Investment actual (q-o-q)
Investment OPTIM
Investment AR one-step ahead forecast
Investment- Two-step ahead forecast
Investment actual (q-o-q)
Investment OPTIM
Investment AR 2-step ahead forecast
Exports – Coincident forecast
Exports actual (q-o-q)
Exports OPTIM
Exports AR coincident forecast
Exports - One-step ahead forecast
Exports actual (q-o-q)
Exports OPTIM
Exports AR one-step ahead forecast
Exports – Two-step ahead forecast
Exports actual (q-o-q)
Exports OPTIM
Exports AR two-step ahead forecast

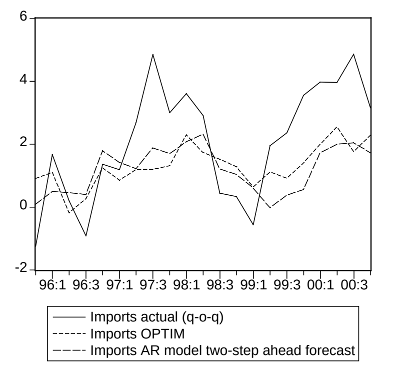
Imports – Coincident forecast



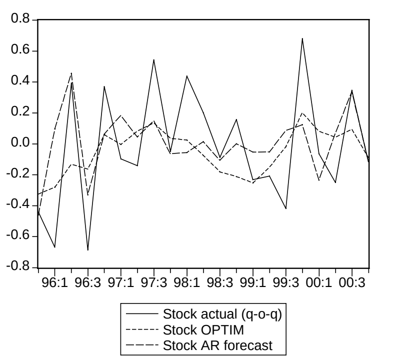
Imports - One-step ahead forecast



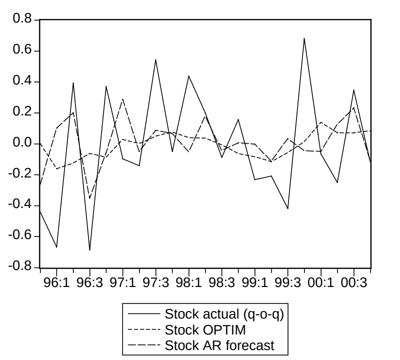
Imports - Two-step ahead forecast



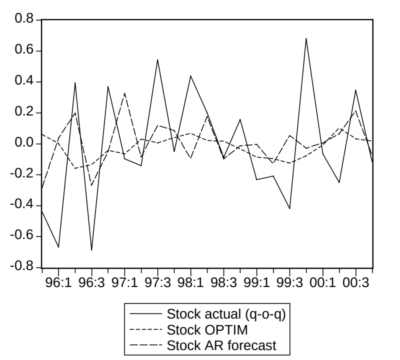
Stocks – Coincident forecast



Stocks - One-step ahead forecast



Stocks - Two-step ahead forecast



Given the small size of the simulation sample, these results must be taken with caution. Concentrating on GDP forecast, the null hypothesis can clearly be rejected for the 0 and the 2 quarter ahead horizons. The one-quarter forecast of GDP appears more disappointing. Manufacturing consumption is the main culprit. These poor performances are partially offset by the good quality of investment prediction. Including the year 2000 tends to deteriorate the results for most variables. This is not surprising since this year was characterized by a significant discrepancy between conjunctural indicators and quarterly accounts.

6. Conclusion

The method described above has shown that survey data convey useful information for projecting real GDP growth and its components up to two quarters ahead. The result for financial data is mixed. On the one hand, the yield curve and loans have proved to content some information about future conjunctural developments. On the other hand, asset prices (equity prices and property prices) do not appear to bring significant indications about current and future activity. Concentrating on GDP forecast, OPTIM clearly outperforms an AR model for the current and the two quarters head horizons. The one quarter ahead forecast appears more disappointing, manufacturing consumption estimate being by far the main culprit. These poor performances are however partially offset by the quality of investment prediction. Furthermore, the forecast accuracy of the single GDP equation model compared with that of OPTIM is equivalent, according to the statistical criterion proposed by Harvey, Leybourne and Newbold (1997). This result is not surprising since both levels use approximately the same amount of information as input. Overall, given its satisfactory statistical properties, it appears legitimate to use this smaller model as a benchmark to assess the GDP forecast obtained with OPTIM.

OPTIM has three advantages. First, this method reduces the part of discretionary judgement in the assessment of short-term activity. Second, it provides a starting point for the model-based projection for GDP and its components along with a breakdown. In this respect this method is very close to a bridge equation approach model (see Parigi and Schitzler (1995), Bovi *et alii* (2000) and Grasmann and Keereman (2001)) but departs somewhat from those elaborated by Stock and Watson (2000) or Forni *et alii* (2001). In these studies, a single factor is extracted from a wide range of conjunctural data and then used to forecast real GDP growth. This kind of approach could be used, notably in the single equation model but could also be extended to GDP components. Finally, one further extension would be to provide monthly GDP estimates by the mean of an appropriated interpolation routine. This could be easily done as relevant monthly indicators for quarterly aggregates have been highlighted in this paper. Finally this method should be complemented by a turning point approach as elaborated in Gregoir and Lenglart (1998) alos extended to the service sector.

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ANNEX A
Data description and sources

Table A1

Mnemonic	Description	Frequency	Source
Axis extracted from the implementation of principal component analysis			
Axis_manu	Principal component. Manufacturing sector	M	
Axis_ser	Principal component. Services sector	M	
Axis_build	Principal component. Building sector	Q	
Axis_retail	Principal component. Retail trade sector	M	
Axis_gdexp	Principal component. Questions relative to external demand of goods	M	
Axis_gdimp	Principal component. Questions relative to deliveries of goods from foreign countries	M	
Axis_firm	Principal component. Firms perception of the business cycle	M	
Axis_dem	Principal component. Demand	M	
Axebdfeqprev	Principal component. Equipment sector	M	
Specific answers			
Batactpas	Survey building sector. Question relative to past activity	M	INSEE
Batactprev	Survey building sector. Question relative to future activity	M	INSEE
Bdfeqprevprod	Survey equipment sector. Question relative to future activity	M	BDF
Indstock	Survey. Question relative to the level of stock	M	INSEE
Servtpassetr	Survey. Services sector Question relative to external activity	Q	INSEE
Mantendprob	Survey. Manufacturing sector Question relative to future activity (personal)	M	INSEE
Mantprobgen	Survey. Manufacturing sector Question relative to future activity (general)	M	INSEE
Mantendrec	Survey. Manufacturing sector Question relative to current activity (personal)	M	INSEE
Cur_bdf	Capacity utilization rate	M	BDF
C53d	Survey. Households Question relative to future developments in the demand of loans	M	BDF
Other data (non survey data)			
Hloans	Loans to households	M	BDF (SASM)
Ipi_manu95	Industrial production index. Manufacturing sector	M	INSEE
Ipi_pener95	Industrial production index. Energy sector	M	
Ipi_pagrifood95	Industrial production index. Agri-food sector	M	
LTIR	Long term interest rate	D	
STIR	Short term interest rate	D	
Quarterly national account data			
gdp	Gross domestic product	Q	INSEE
pagrifood	Production agri_food	Q	INSEE
pserpr	Production private services sector	Q	INSEE
cserpr	Consumption private services sector	Q	INSEE
inveq	Investment equipment	Q	INSEE
xgoods	Exports goods	Q	INSEE
mgoods	Imports goods	Q	INSEE
xser	Exports services	Q	INSEE
mser	Imports services	Q	INSEE
Mtot	Imports goods and services	Q	INSEE
Fraddmdb	External demand adressed to France	Q	BDF (Broad Forecast Exercise)

^

ANNEX B
The predictive content of survey data

Preliminary regression of survey indicators

Production: $qg\_p = \rho(L)qg\_p(-1) + \alpha + \beta indicprod\_c(-i)$

Table B1
Production

Indicprod_c	horizon	Significativity of $\beta : t_\beta$	Autocorrelation LM(2) test (p-value %)
Production – Service sectors			
First axis (*axis_ser1_c*)	i=1	2.15	56%
Second axis (*axis_ser2_c*)		-1.4	67%
Third axis (*axis_ser3_c*)		1.75	20%
First axis (*axis_ser1_c*)	i=2	0.7	67%
Second axis (*axis_ser2_c*)		0.9	94%
Third axis (*axis_ser3_c*)		1.3	9%
Production – Building sector			
First axis (*axis_build1_c*)	i=1	4.1	66%
Second axis (*axis_build2_c*)		0.2	32%
Third axis (*axis_build3_c*)		1.3	26%
First axis (*axis_build1_c*)	i=2	4.2	6.5%
Second axis (*axis_build2_c*)		-0.7	6.2%
Third axis (*axis_build3_c*)		0.7	43%
Production – Manufacturing sector			
First axis (*axis_manu1_c*)	i=1	2.2	90%
Second axis (*axis_manu2_c*)		0.8	85%
Third axis (*axis_manu3_c*)		-1.9	67%
First axis (*axis_manu1_c*)	i=2	1.3	80%
Second axis (*axis_manu2_c*)		0.8	11%
Third axis (*axis_manu3_c*)		-1.2	99%

Note: Axis are by construction uncorrelated. Regressions can be run independently.

Investment: $qg\_inv = \rho qg\_inv(-1 \text{ to - n}) + \alpha + \beta indicinv\_c(-i)$

With $indicinv\_c$ defined as the residual of the following equation: $indicinv = \alpha(L)qg\_inv + \varepsilon$

Table B2
Investment

Indicinv_c		Significativity of $\beta : t_\beta$	Autocorrelation LM(2) test (p-value)
Investment – Building			
Batactpas_c	i=1	6.7	18%
Batactprev_c		6.6	61%
Batactpas_c		6.3	80%
Batactprev_c	i=2	6.0	47%
Investment – Equipment			
Bdfeqevprod_c	i=1	2.9	36%
BdfEqprevprod_c		2.0	35%
Axebdfeqprev_c		1.5	15%
Bdfeqevprod_c	i=2	0.7	31%
BdfEqprevprod_c		0.6	34%
Axebdfeqprev_c		0.6	38%

Consumption: $qg\_cons = \rho(L)qg\_cons(-1) + \alpha + \beta indiccons\_c(-i)$

With $indiccons\_c$ defined as the residual of the following equation: $indiccons = \alpha(L)qg\_cons + \varepsilon$

Table B3

Consumption

Indiccons_c	Horizon	Significativity of $\beta : t_\beta$	Autocorrelation LM test
Consumption – Manufacturing			
Axe_retail1_c	i=1	2.8	67%
Axe_retail1_c	i=2	1.5	80%
Consumption – Services sector			
Axe_ser1_c	i=1	2.1	82%
Axe_ser1_c	i=2	1.7	77%

Stockbuilding: $\Delta S = \rho(L)\Delta S(-1) + \alpha + \beta indicstock\_c(-i)$

With $indicstock\_c$ defined as the residual of the following equation : $indicstock = \alpha(L)\Delta S + \varepsilon$

Table B4

Stock

Indicstock_c		t_β	LM test
Indstock_c	i=1	-5.11	4%
Indstock_c	i=2	-4.61	0.6%

Working with innovations

Table B5

Working with innovations

		Significativity of β : t_β	Autocorrelation LM(2) test (p-value %)
Manufacturing sector			
Inno_Axe_manu1	i=1	1.1	24
Inno_Axe_manu2		0.8	86
Inno_Axe_manu3		-1.8	22
Inno_Axe_manu1	i=2	2.9	25
Inno_Axe_manu2		0.1	0.4
Inno_Axe_manu3		-1.2	35
Services sector			
Inno_Axe_ser1	i=1	1.9	52
Inno_Axe_ser2		-1.3	98
Inno_Axe_ser3		1.2	48
Inno_Axe_ser1	i=2	0.9	11
Inno_Axe_ser2		-0.6	20
Inno_Axe_ser3		0.2	15
Building sector			
Inno_Axe_bat1	i=1	2.7	8.9
Inno_Axe_bat2		2.4	59
Inno_Axe_bat3		3.5	18
Inno_Axe_bat1	i=2	2.8	12
Inno_Axe_bat2		0.9	80
Inno_Axe_bat3		2.0	24

Correlation matrices

Table B6

Correlation matrix: one quarter ahead

(sample 1986-2000)

Non corrected series						
	Quarterly accounts	Questions relative to future activity		Axis	Questions relative to current activity	
	QG_PMANU(+1)	MANTENDPROB	MANTPROBGEN	AXE_MANU1	MANTENDREC	CUR_BDF
QG_PMANU(+1)	1.00	0.57	0.49	0.48	0.47	0.17
MANTENDPROB	0.57	1.00	0.92	0.96	0.94	0.67
MANTPROBGEN	0.49	0.92	1.00	0.94	0.93	0.59
AXE_MANU1	0.48	0.96	0.94	1.00	0.99	0.77
MANTENDREC	0.47	0.94	0.93	0.99	1.00	0.74
CUR_BDF	0.17	0.67	0.59	0.77	0.74	1.00
Corrected series:						
	Quarterly accounts	Questions relative to future activity		Axis	Questions relative to current activity	
	QG_PMANU(+1)	MANTENDPROB	MANTPROBGEN	AXE_MANU1	MANTENDREC	CUR_BDF
QG_PMANU(+1)	1.00	0.28	0.10	0.23	0.22	0.00
MANTENDPROB	0.28	1.00	0.75	0.87	0.82	0.39
MANTPROBGEN	0.10	0.75	1.00	0.81	0.77	0.26
AXE_MANU1	0.23	0.87	0.81	1.00	0.96	0.57
MANTENDREC	0.22	0.82	0.77	0.96	1.00	0.51
CUR_BDF	0.00	0.39	0.26	0.57	0.51	1.00

Table B7

Correlation matrix: two quarter ahead

(sample 1986-2000)

Two-quarter ahead						
Non corrected series						
	Quarterly accounts	Questions relative to future activity		Axis	Questions relative to current activity	
	QG_PMANU(+2)	MANTENDPROB	MANTPROBGEN	AXE_MANU1	MANTENDREC	CUR_BDF
QG_PMANU(+2)	1.00	0.36	0.26	0.27	0.27	-0.02
MANTENDPROB	0.36	1.00	0.92	0.96	0.94	0.67
MANTPROBGEN	0.26	0.92	1.00	0.94	0.93	0.59
AXE_MANU1	0.27	0.96	0.94	1.00	0.99	0.77
MANTENDREC	0.27	0.94	0.93	0.99	1.00	0.74
CUR_BDF	-0.02	0.67	0.59	0.77	0.74	1.00
With corrected series:						
	Quarterly accounts	Questions relative to future activity		Axis	Questions relative to current activity	
	QG_PMANU(2)	MANTENDPROBP	MTENDPROBGP	AXE_MANU1P	MANTENDRECP	CUR_BDFP
QG_PMANU(+2)	1.00	0.27	0.08	0.23	0.26	-0.03
MANTENDPROB	0.27	1.00	0.74	0.85	0.80	0.41
MANTPROBGEN	0.08	0.74	1.00	0.80	0.76	0.26
AXE_MANU1	0.23	0.85	0.80	1.00	0.95	0.59
MANTENDRECP	0.26	0.80	0.76	0.95	1.00	0.53
CUR_BDFP	-0.03	0.41	0.26	0.59	0.53	1.00

Note: corrected series: cf section 221. Survey indicators are preliminarily regressed on the series they are supposed to forecast.

ANNEX C
Dealing with the discrepancy

Aggregating the residuals of the different sector equations with a weighted average yields the uncertainty surrounding $qg\_GDP_S^{(1)}$, $qg\_I^{(1)}$, $qg\_X^{(1)}$, $qg\_M^{(1)}$ and $qg\_C^{(1)}$ [13]. For instance, the uncertainty surrounding qg_GDP_s is computed with the following method. First a confidence interval is built for the quarterly growth rate of production, qg_P. The amplitude of this interval is given by :

$$resid\_qg\_P = \sum_j \left| resid\_qg\_P_j \right| . \frac{P_j}{P}$$

resid_Z represents the mean of the residual of the equation giving Z over the last 6 quarters. *I* represents the different sectors (agri-food, energy…) according to which production is decomposed. GDP is deduced from production using the equation :

$$qg\_GDP = \alpha_1 qg\_P + \alpha_2 qg\_P_{-1} + c$$

The uncertainty surrounding the estimation of the quarterly growth rate of GDP is therefore given by :

$$resid\_qg\_GDP = \left|\alpha_1 resid\_qg\_P\right| + \left|\alpha_2 resid\_qg\_P_{-1}\right|$$

Once an assessment of uncertainty has been performed, each variable is then corrected in the following way. Concerning supply variables, namely GDP (supply approach) and imports, their growth rate is modified according to the following equation:

$$qg\_Z_k^{(2)} = qg\_Z_k^{(1)} - \lambda_k \left| resid\_Z_k \right|$$ where *k*=0,1 or 2 represents the forecast horizon.

Concerning demand variables, namely consumption, investment, exports and stock buildings, their growth rate is modified according to the following equation:

$$qg\_Z_k^{(2)} = qg\_Z_k^{(1)} + \lambda_k \left| resid\_Z_k \right|$$

where *resid_Z* represents the uncertainty surrounding the estimation of *qg_Z* and *k*=0,1 or 2 represents the forecast horizon.

Uncertainty surrounding the first estimation of stock buildings

The weighted average method to evaluate the uncertainty surrounding the first estimation GDP and its components is implemented for consumption, investment, imports and exports. Concerning stock buildings, the method does not hold since the stock equation models directly change in stock level, namely ΔS. The variable of interest is indeed the contribution of stock buildings to GDP growth, namely $cont\_\Delta S = \frac{100\Delta(\Delta S)}{P_{-1}}$. A proxy of the uncertainty surrounding this variable (noted $resid\_cont\Delta S$ is given by:

- $100\frac{\left|resid\_\Delta S_0\right| + \left|resid\_\Delta S_{-1}\right|}{P} = 100\frac{\left|resid\_\Delta S_0\right|}{P}$, for the 0 quarter-ahead forecast.
- $100\frac{\left|resid\_\Delta S_1\right| + \left|resid\_\Delta S_0\right|}{P}$, for the 1 quarter-ahead forecast.

[13] For stockbuildings the computation is less straightforward since change in stock level is directly modeled. See infra.

- $100\frac{|resid\_\Delta S_2|+|resid\_\Delta S_1|}{P}$, for the 2 quarter-ahead forecast.

<u>Determination of lambda</u>

For ease of notation, we omit k in the equations that follow. λ is defined such that the following accounting equation be satisfied:

$$\begin{aligned}&qg\_GDP^{(2)} - weight\_I.qg\_I^{(2)} - cont\_\Delta S^{(2)} - weight\_X.qg\_X^{(2)}\\&+ weight\_M.qg\_M^{(2)} - weight\_C.qg\_C^{(2)} = 0\end{aligned}$$

With $weight\_Z = Z_{-1}/P_{-1}$ for Z=*GDP, I, X, M C.*

This last equation can be rewritten :

$$\begin{aligned}&qg\_GDP_S^{(1)} - \lambda resid\_GDP - weight\_I.qg\_I^{(1)} - \lambda weight\_I.resid\_I - cont\_\Delta S^{(1)}\\&- \lambda resid\_cont\Delta S - weight\_X.qg\_X^{(1)} - \lambda weight\_X.resid\_X - weight\_M.qg\_M^{(1)}\\&- \lambda weight\_M.resid\_M - weight\_C.qg\_C^{(1)} - \lambda weight\_C.resid\_C = 0\end{aligned}$$

This expression is equivalent to:

$$\begin{aligned}&disc - \lambda resid\_GDP - \lambda weight\_I.resid\_I - \lambda resid\_cont\Delta S - \lambda weight\_X.resid\_X\\&- \lambda weight\_M.resid\_M - \lambda weight\_C.resid\_C = 0\end{aligned}$$

Hence λ is given by :

$$\lambda = \frac{disc}{resid\_GDP + weight\_I.resid\_I + resid\_cont\Delta S + weight\_X.resid\_X}$$

ANNEX D
The Harvey, Leybourne and Newbold test

Let $\varepsilon_{0,OPTIM}$, $\varepsilon_{1,OPTIM}$ and $\varepsilon_{2,OPTIM}$ be respectively the zero, one and two step forecast errors of OPTIM[14] and $\varepsilon_{0,ag}$, $\varepsilon_{1,ag}$ and $\varepsilon_{2,ag}$ the zero, one and two step forecast errors of the above described aggregated model. The mean square errors of each model are defined as:

$MSE_{k,OPTIM} = \frac{\sum \varepsilon^2_{k,OPTIM}}{N}$ and $MSE_{k,ag} = \frac{\sum \varepsilon^2_{k,ag}}{N}$ where N represents the number of prediction that are implemented and *k* the prediction horizon (*k*=1, 2 or 3). The sequence of forecast errors is likely to be autocorrelated up to the order *k-1*. The variances of ($MSE_{k,OPTIM}$-$MSE_{k,ag}$) can be expressed:

$V_0 = \frac{1}{N}\gamma_0$ for k=1

$V_1 = \frac{1}{N}\left(\gamma_0 + 2\gamma_1\right)$ for k=2

$V_2 = \frac{1}{N}\left(\gamma_0 + 2\gamma_1 + 2\gamma_2\right)$ for k=2

With

$$d_{k,t} = \varepsilon^2_{k,t,OPTIM} - \varepsilon^2_{k,t,ag}$$

$$\overline{d}_k = \frac{1}{N}\sum_{t=1}^{N}\left(\varepsilon^2_{k,t,OPTIM} - \varepsilon^2_{k,t,ag}\right) = MSE_{k,OPTIM} - MSE_{k,ag}$$

$$\gamma_0 = \frac{1}{N}\sum_{t=1}^{N}\left(d_t - \overline{d}\right)^2 \; ; \; \gamma_1 = \frac{1}{N-1}\sum_{t=2}^{N}\left(d_t - \overline{d}\right)\left(d_{t-1} - \overline{d}\right); \gamma_2 = \frac{1}{N-2}\sum_{t=2}^{N}\left(d_t - \overline{d}\right)\left(d_{t-2} - \overline{d}\right)$$

The Diebold and Mariano ($S_{k,DM}$) statistic is given by: $S_{k,DM} = \frac{\overline{d}_k}{V_k^{1/2}}$

Diebold and Mariano (1995) show that under the null hypothesis, this statistic has an asymptotic normal distribution. Given the above mentioned drawbacks of this statistic when working on moderate sample size, Harvey, Leybourne and Newbold (1997) propose a small sample correction of this statistic. They show that the size of the test is significantly reduced by the correction. Their statistic ($S_{k,HLN}$) is deduced from the Diebold and Mariano statistic with the following formula:

$$S_{k,HLN} = \theta_k S_{k,DM}$$

With $\theta_k = \left(\frac{N + 1 - 2k + N^{-1}k(k-1)}{N}\right)^{1/2}$

[14] What we call the coincident (0 quarter ahead) estimation is actually a one step ahead estimation, hence corresponding to k=1.

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