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Forecasting Inflation in France: an update of the model used at Banque de France


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This Policy Brief presents an updated version of the reference model used at Banque de France to forecast inflation: MAPI (Model for Analysis and Projection of Inflation). While the conceptual framework of the model remains very close to its initial version, our update takes stock of (i) a change in the underlying classification of HICP components used at the European level (ECOICOP); (ii) the development at Banque de France, in 2019, of a new semi-structural model to produce macroeconomic projections (FR-BDF); (iii) economic developments related to the Covid-19 pandemic. Overall, the new model is a more parsimonious version of the initial model, entailing a stronger harmonization with FR-BDF, and maintaining a significant pass-through of wages, exchange rate and import prices to consumer prices.

Forecasting French HICP at Banque de France

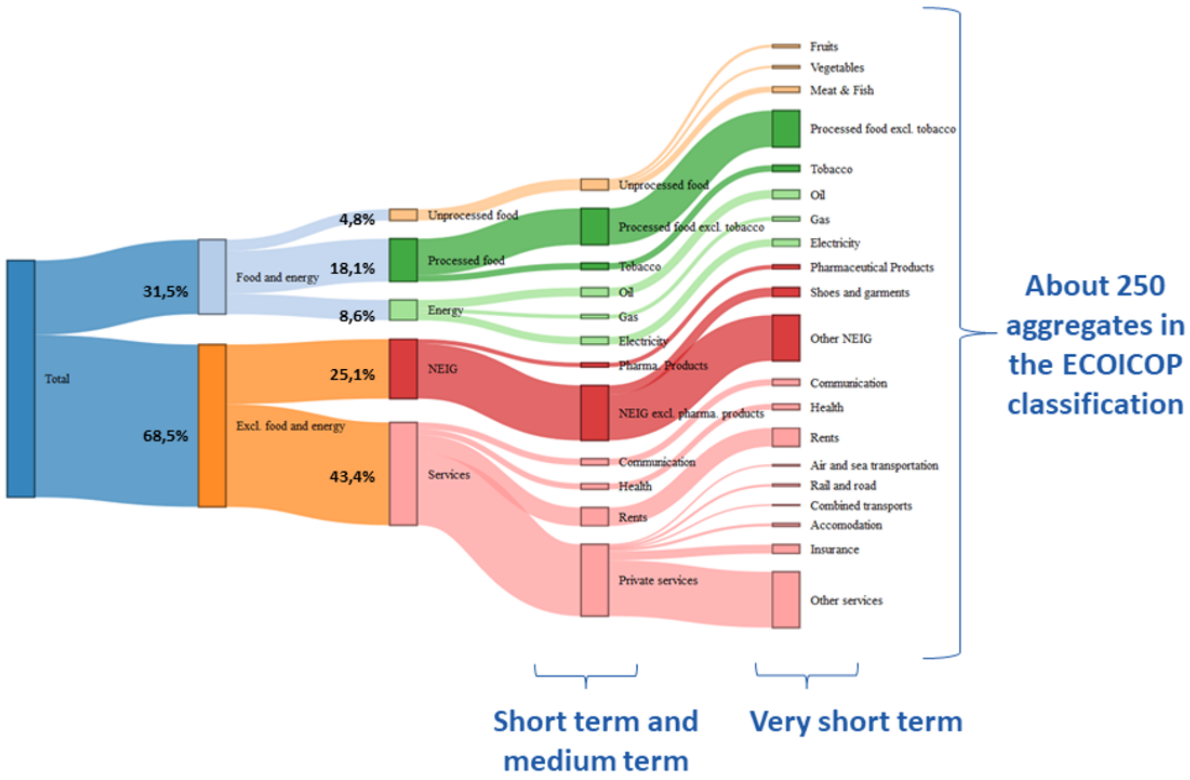
Inflation forecasts play a key role for monetary policy decisions. In practice, forecasting inflation is a stimulating, but difficult and multifaceted task. Indeed, many factors affect inflation and a good forecast implies to combine short and long term perspectives, microeconomic and macroeconomic views and a deep understanding of detailed components while keeping an eye on global assessment. For this purpose, at Banque de France, we use a rich toolbox, which includes mainly a dedicated disaggregated model for projecting HICP components (MAPI) working in interaction with our large semi-structural model (FR-BDF) and other tools such as Phillips curves to ensure consistency of our inflation forecasts.

In a recent working paper (Ulgazi & Vertier, 2022), we presented a renovated version of the main model used at Banque de France to forecast inflation: MAPI (Model for Analysis and Projection of Inflation). This model was first developed and described in 2017 (De Charsonville & al., 2017), but was gradually modified due to several factors. First, a change in the European classification used to define HICP aggregates (ECOICOP), operated in 2019. Second, the necessity to strengthen the links between MAPI and the new semi-structural macroeconomic model used at Banque de France (FR-BDF, presented in Lemoine & al. 2019), also developed in 2019. This interaction is key for the forecasting exercise: general equilibrium properties as well as (wage) Phillips effects are given by FR-BDF. Third, important variations in input data, especially regarding wage and compensation data, in the midst of the Covid-19 pandemic.

Inflation forecasts at Banque de France are produced within the Eurosystem framework, which requires both monthly and quarterly projections at the disaggregated level. First, the levels of aggregation used in MAPI differ on the forecasting horizon (**Figure 1**). A very short-term monthly forecast for the current quarter based on 20 components: this forecast is made using univariate time-series methodologies, augmented with expert judgment. The short-term monthly projections (11 months ahead) and the medium-term quarterly forecast (2 to 3 years ahead) are then produced using a set of disaggregated equations for 12 components (representing 87% of the HICP basket in 2021), mostly relying on Error-Correction Models. Our updates to the model focus specifically this block of equations.

Compared to the initial version of MAPI, the updated version relies on the same theoretical framework (i.e. consumer prices are expected to depend in the long run on domestic factors – wages and compensations – and import prices), and the same technical features (regarding the treatment of seasonality or the aggregates considered), but proposes improvements along three dimensions. First, we update the estimating samples up to 2019 if possible. Second, we simplify the estimation process by including only input variables that are forecasted within FR-BDF or that are part of Eurosystem assumptions. Finally, we develop equations that are more parsimonious, relying on milder assumptions.

Figure 1: Main HICP aggregates used in the forecast (weights of 2021)



Main equations in the updated model

For services, we use an error-correction equation on "private services" which is the main aggregate of services, and represents 30.3% of total HICP in 2021. In the long run, as in the initial version of MAPI, the HICP of private services is assumed to closely follow compensations in the private sector, as it is mainly labor intensive. However, contrarily to the initial version of the model, the measure of labor cost we use is wages per hours worked, this choice is commanded by the strong divergence between hours worked and number of employees due to the sanitary restrictions induced by the Covid-19 pandemic (with the former decreasing much more than the latter). The long run equation is simply defined as a relation between the log seasonally adjusted private services and the log compensation per hour (contrarily to the initial version of MAPI where it was assumed that the log-ratio of prices and wages followed a trend). The result is a higher elasticity from compensations to services inflation, reinforcing the wage-price dynamics and the link between our macroeconomic model (FR-BDF) and MAPI. In the short run, the HICP of private services is assumed to be affected by variations in minimum wage and unemployment. We also include a dummy which captures a break in the ratio of private services HICP to compensations and could reflect a break in the evolution of productivity or possibly measurement issues.

For manufactured products, the forecast is made on an aggregate that excludes pharmaceutical products, which represents 23.3% of total HICP. This item is highly volatile due to seasonal sales. However, once the usual sales seasonality is stripped away, the variability and dynamics of HICP of manufactured products excluding pharmaceutical products are low, which makes it hard to reconcile with traditional macroeconomic determinants. In particular, contrarily to evidence on the Euro Area (Chatelais & Schmidt, 2017), the long-run pass-through of producer prices and import prices to non-energy industrial goods HICP is unlikely to sum to one. In the long run, following the theoretical framework, the HICP of this item is modelled as depending on the prices of imported goods and services (both including and excluding energy), on the domestic price of value-added in the whole economy and on the nominal effective exchange rate. However, contrarily to the initial model, we relax the assumption that the sum of the coefficients of import prices and domestic prices are equal to one. More specifically, we include import price of energy in the long-run relationship, in order to take into account indirect effects of oil prices on non-energy components, which have been found to be sizable in France (Kalantzis & Ouvrard, 2018). An ideal measure of import prices would have excluded services, but since FR-BDF does not produce separate forecasts for import prices excluding services, this would have required a satellite equation. Furthermore, domestic value added in the whole economy (which is forecasted in FR-BDF) is very close to the deflator of market services that was used in the initial version of MAPI (but which required a satellite equation). Secondly, we include, both in the long term and short term equation, the nominal effective exchange rate, in order to take into account potential indirect effects of change that would not be completely captured by import prices. Finally, all the input variables of the long run equation are included as a moving average over two quarters echoing several studies finding significant delay in the transmission of import prices to consumer prices of manufactured products.

For food inflation, we distinguish the unprocessed and the processed component. Unprocessed food accounts for 4.8% of the total HICP in 2021 (and includes fruits, vegetables, meat and fish). This component is highly seasonal and is particularly hard to forecast given its strong dependence on external shocks (notably meteorological). However, this variable exhibits an increasing trend of 0.2% in terms of monthly variations. The equation therefore uses an autoregressive specification, which guarantees that the forecast spontaneously converges towards its historical mean. For the processed component which represents 15.4% of total HICP in 2021 and from which we exclude tobacco, we use an error-correction equation depending on prices of raw material, on labor costs and on regulation affecting retailing margins. As for manufactured products, in the long run, processed food prices depend both on domestic and import prices. However, contrarily to the initial version of MAPI, we directly integrate Eurosystem assumptions on farm-gate prices in the equation, rather than through its effect on the production prices in the agri-food sector: this stems from the observation that the two variables are strongly correlated, and that using directly the former avoids resorting to a satellite equation.

Energy HICP is separated in three components: petroleum products, gas and electricity. For petroleum products (3.7% of total HICP), the logic of the initial forecasting model is unchanged. The index is made of five types of retail fuel: gasoil, domestic fuel, unleaded gasoline SP98, unleaded gasoline SP95 and unleaded gasoline SP95E10. Compared to the initial version of the model, we now have a separate equation for SP95E10, as its weight grew larger and became higher than that of SP95 as of 2019. First, we implement an equation for refined products (diesel or gasoline) linking them to the variations of *Brent* prices. In a second step, for each fuel, we forecast the before-tax price using the refined product, with different lags depending on the considered fuel. We then add the VAT and the excise tax for each fuel and the m-o-m change of petroleum products is given by a weighted average of the tax-included fuel prices. For gas (1.3% of total HICP), we build a simple model in which the final price is determined by the wholesale gas price (through *futures* on the TTF market) observed two months before. We add two dummies to capture for the first one the bearish effect of the generalization of shale gas on the world markets in 2009 and for the second the effect of an increased national tax on gas consumption. As regards electricity, the French electricity market is highly regulated, and regulated tariffs are proposed at the beginning of each year by an independent institution. We are able to replicate the formula used by the independent institution and we can estimate in December of a given year the increase that could affect the regulated tariffs at the beginning of the following year.

Other components are forecasted with more simple approaches. Communication services and tobacco follow a random walk (incorporating information on future regulations of their prices whenever relevant). Pharmaceutical products follow a downward trend, reflecting the long-run decrease in prices observed since 2010 while health services follow the average seasonal pattern of the previous 4 years.

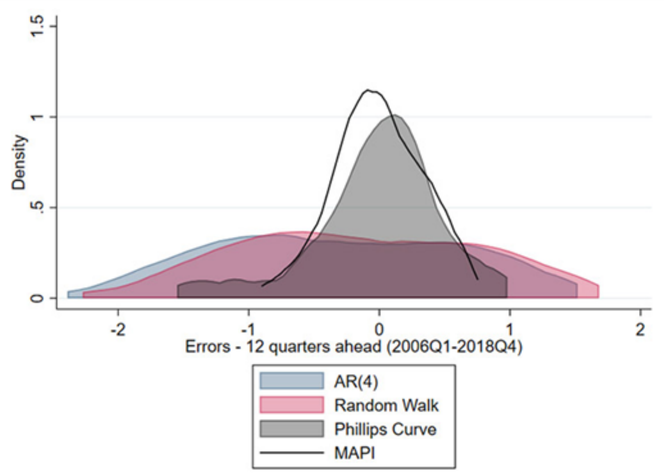
General properties of the updated model

This updated version of MAPI still entails a significant pass-through of the input variables to consumer prices as:

i) A 1% permanent shock on wages leads to an increase of 0.3 percentage point (p. p.) of HICP in the long run;
ii) A 10 euros increase in the price of the Brent barrel increases HICP by about 0.2 p. p. for an initial Brent barrel price of 55 euros;
iii) A 10% appreciation of the euro against all other currencies decreases total HICP by 0.3 pp.

Finally, we compare the in-sample predictive performance of the updated model to three benchmark models (**Figure 2**): an AR (4), a random walk and a Phillips Curve using the unemployment rate, import prices of energy and an autoregressive term for inflation. Regarding the subcomponents, MAPI systematically outperforms an AR (4) and random walks at any horizon considered. The predictive performances of MAPI are similar to those of Phillips curves for HICP excluding food and energy, but MAPI yields substantially more accurate forecasts for total HICP at any considered horizon.

Figure 2: Distribution of forecast errors on y-o-y variations of headline HICP (2006-2018) – 12 quarters ahead



This figure represents forecast errors for y-o-y variations of quarterly headline HICP for 4 types of models between 2006Q1 and 2018Q4: an AR(4), a Random Walk, a Phillips Curve (using import prices of energy, the unemployment rate and a autoregressive term of two quarters for inflation), and the renovated version of MAPI

Conclusion

The updated model we propose simplifies the initial version of MAPI. While the conceptual framework remains broadly unchanged, the specifications we implement are overall more parsimonious and less constrained. In particular, since we resort only to variables projected through FR-BDF or the Eurosystem assumptions, in particular regarding wages as well as global macroeconomic general equilibrium effects, no satellite equation is needed to project inputs. Furthermore, previous specifications that relied upon strong assumptions are now modelled in a more flexible way, making them likely to be more resilient out of sample. These changes substantially simplify the usage and the interpretation of the model in a forecasting setting, while exhibiting reaction functions in line with the reaction functions of FR-BDF.

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