

The FR-BDF model and an assessment of monetary policy transmission in France¹

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Forecasting and policy analysis in semi-structural models
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¹This paper is the outcome of a modelling project, which benefited from the expertise of many Banque de France economists. Still, the views expressed are those of the authors and do not necessarily reflect those of Banque de France.

Motivation and approach

Why a new model for France of Banque de France (FR-BDF)?

- ▶ Former model (Mascotte) unsatisfactory for analyzing e.g. transmission of monetary policy and financial shocks
- ▶ As the former model lacked important channels, marginal improvements would have been insufficient

Chosen approach inspired by FRB/US

- ▶ Good compromise btw traditional semi-structural models focused on data fit and DSGEs which have strong theoretical consistency
- ▶ Error-correction equations with role for expectations
- ▶ Large-scale model estimated under VAR-based expectations and model-consistent exp. possible for simulations Estimation

Some specific features of our approach

- ▶ France modeled as small open economy (projection process)
- ▶ Emphasis on financial block and role of bank lending rates

Comparison with other institutions

Outline of the presentation

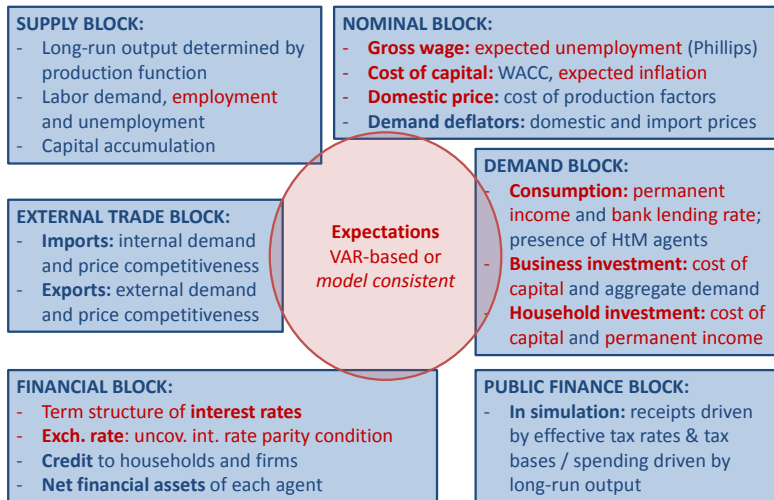
Model specification

Model properties under VAR-based expectations

Short rate shock under different types of expectations

Conclusion

Simplified scheme of FR-BDF: the widespread role of expectations



In red, variables directly affected by expectations

Expectation formation: several possibilities

VAR-based expectations obtained from a small-scale semi-structural satellite model (E-SAT)

- ▶ Agents form their expectations based on few variables: output gap and inflation for FR and EA + EA interest rate
- ▶ With a small-scale model: 2 IS curves, 2 Phillips curves and a Taylor rule + rules for long-run anchors of inflation(s) and short rate
- ▶ Expectations for other variables can be computed after adding auxiliary equations to the model

Alternative setups of expectations in simulations

- ▶ *Model-consistent expectations (MCE)*: come from forecasts of the model itself under the assumption of perfect foresight
- ▶ *Hybrid expectations*: MCE for some agents (e.g. financial) and VAR-based for others

Polynomial Adjustment Cost framework: rationalization of error correction equations

First step: targets obtained from standard theory without frictions

- ▶ Long-run targets y_t^* derived with static optimization w/o frictions
- ▶ E.g. target for investment obtained from a standard firms' FOC

Second step: adding frictions, we get error-correction equations extended **with a role for expectations**

- ▶ Given y_t^* , minimization of deviations of choice variables y_t from y_t^* under polynomial adjustment costs (PAC)
- ▶ Solution: change of choice variable related to its former deviation from target, its lags and **expected present value of target changes**

$$\Delta y_t = a_0 (y_{t-1}^* - y_{t-1}) + a_1 \Delta y_{t-1} \dots + PV(\Delta y^*)_t$$

- ▶ PAC applied to headline variables: investment, employment etc

Example on investment

Construction of PV

Main blocks

Supply and firm behavior Details

- ▶ CES production function (better fit than Cobb-Douglas)
- ▶ NK wage Phillips curve with strong role for min. wage
- ▶ Bus. investment related to WACC (importance of banks in France)

Demand Details

- ▶ Inertial household spending & weak sensitivity of C to interest rate
- ▶ Foreign trade: strong sensitivity to price competitiveness

Financial block Details

- ▶ Policy rate, key driver of expectations: of long-run rate (term structure), exchange rate (UIP) and non-fin. variables (PAC)
- ▶ Monetary policy transmission through rich set of interest rates

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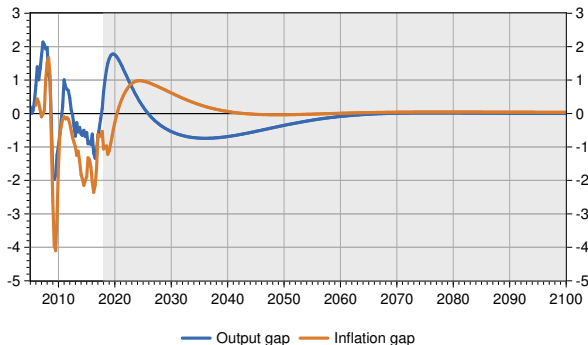
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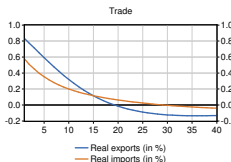
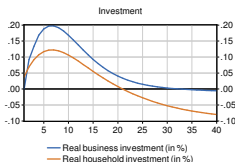
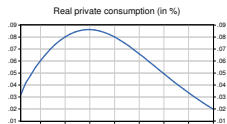
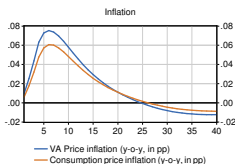
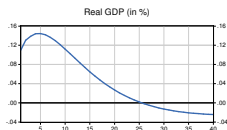
Long-run convergence

- ▶ Convergence toward the BGP in $\simeq 40$ years, only through price competitiveness and net exports adjustment
- ▶ Phase shift of inflation w.r.t. output gap: convergence of interest rates toward pre-crisis level
- ▶ Slow convergence : (i) no independent monetary policy (ii) price stickiness and (iii) slow convergence of stock variables [Implementation details](#)



Foreign demand shock: +1% on foreign demand to France

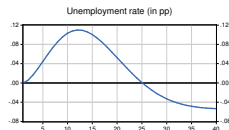
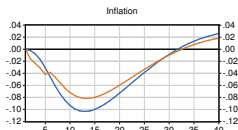
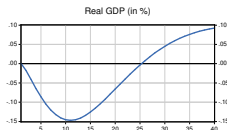
- ▶ Direct effect on exports, imports and real GDP, which transmits progressively to consumption and investment
- ▶ Higher inflation progressively causes a real appreciation in the medium run
- ▶ Losses of price-competitiveness reduce net exports, employment and real GDP



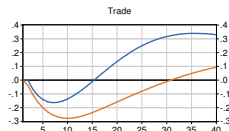
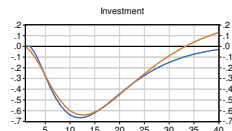
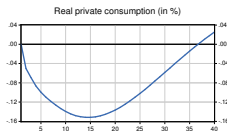
Short-term interest rate shock: +100bp annualized

- ▶ Short rate shock endogenously transmits to long rate through term-structure equation and to nominal exchange rates through UIP
- ▶ Hike of cost of capital implies investment fall
- ▶ Appreciation weights on exports in short run, but price decreases boost them in medium run
- ▶ Short rate directly affects all VAR-based expectations, notably expected unemployment and, hence, wage inflation

Other IRFs



— VA Price inflation (y-o-y, in pp)
— Consumption price inflation (y-o-y, in pp)



— Real business investment (in %)
— Real household investment (in %)

— Real exports (in %)
— Real imports (in %)

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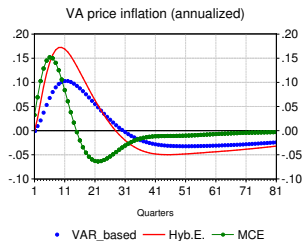
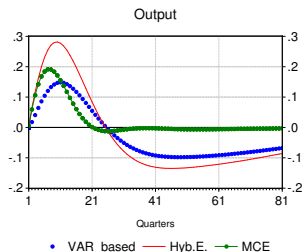
Implementation of the experiment

- ▶ One-off decrease of short rate by 100bp; EA og and infl. left exo.
- ▶ Three simulations: VAR-based, MCE and hybrid (MCE for fin. var.)

Despite common features, some differences among simulations

- ▶ *Hyb. vs MCE*: smaller output response under MCE (dampening effect) as non-fin. agents aware of future undershoot
- ▶ *Hyb. vs VAR-based*: bigger output response under Hyb. (amplification effect) because of large response of financial variables

Extra hints



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Conclusions and further research

Some general conclusions

- ▶ Compared to our former model, goal fulfilled of having reinforced role of financial variables and expectations
- ▶ The last application also shows the interest of analyzing monetary policy transmission under different types of expectations

Other results not shown here about non-standard monetary policy

- ▶ *Forward guidance*: linear increase of output and inflation responses with duration of interest rate shocks (no puzzle)
- ▶ *Asset purchase programmes*: large inflation response comes more from depreciation than from compression of term premia

Further research

- ▶ To connect FR-BDF to a euro area model, in order to capture trade spillovers and EA monetary policy response
- ▶ To improve modeling of leverage dynamics, in order to study the possibility of financial accelerator at least in stressed times

Appendix

Similar approach in some other large central banks

- ▶ An approach applied at FRB (e.g. in Bernanke et al. 2019), in BoC since 2014 and currently developed at ECB
- ▶ Some other large central banks, like BuBa and Bol, improved their traditional models with an emphasis on macro-financial linkages

French institutions improved their traditional models along other dimensions

- ▶ The Mésange model (INSEE and Treasury) was extended in 2017 with differentiated qualifications in the labor market for improving the analysis of targeted cuts of labor costs
- ▶ The e-mod model of OFCE was extended in 2011 with non-linear hysteresis effect in the labor market, which leads to larger government spending multipliers in recessions

Example: equations for firms' investment Back

- ▶ Long run equation:

$$\log \bar{l}_t = \log Y_t^{SM} - 0.52 \log R_t^k + \left(\frac{I^*}{K^*} \right) + v$$

- ▶ Where

$$R_t^k = (WACC_t + \delta_t - VP_{t-1}[\pi]) \frac{P_{invest,t}}{P_{output,t}}$$

- ▶ Short run equation:

$$\begin{aligned} \Delta \log l_t = & 0.08 \log \left(\frac{\bar{l}_{t-1}}{l_{t-1}} \right) + 0.3 \Delta \log l_{t-1} + 0.2 \Delta \log l_{t-2} \\ & + VP_{t-1}[\Delta \bar{l}] \\ & + 0.5 (\Delta \log Y_{t-1}^{SM} - \Delta \log Y_{t-1}^{POT}) \\ & (1 - 0.3 - 0.2) (\Delta Y_{t-1}^{POT} - 0.52 \Delta HTR_{t-1}^k) \end{aligned}$$

Example of the expected component of long-run interest rate

- ▶ Approximation of the long-run bond by console with exponentially decaying payments
- ▶ In such a case, simplified term structure: expected component = present value of future discounted short-run rates

$$PV(i)_t = (1 - \kappa) \sum_{j \geq 0} \kappa^j i_{t+j}$$

Alternative constructions of the PV variable within the model

- ▶ *VAR-based expectations*: using iterated VAR-based forecasts, this present value appears to be a weighted sum of VAR variables

$$PV(i)_t = c_0 + c_1(i_{t-1} - \bar{i}) + c_2(\bar{i}_{t-1} - \bar{i}) + c_3 \hat{y}_{EA,t-1} + c_4(\pi_{EA,t-1} - \bar{\pi}_{EA,t-1})$$

- ▶ *Model-consistent expectations (MCE)*: written in a recursive way with a single lead

$$PV(i)_t = (1 - \kappa)i_t + \kappa PV(i)_{t+1}$$

Main blocks I: Supply and firm behavior Back

Long run output determined by a CES production function

- ▶ Long run behavior of VA price also derived from CES price frontier augmented by a markup
- ▶ Deviation from FRB/US (Cobb-Douglas) because of low elasticity of substitution estimated on French data (0.5)

Labor market strongly influenced by minimum wage

- ▶ Labor supply: wages related to expected wages and unemployment (NK Phillips curve), with a strong role for min. wage (SR elasticity at 0.35)
- ▶ Labor demand target derived from production function; depends on value added, labor efficiency and real wage (PAC in the short run)

Business investment related to WACC, taking into account importance of banks in France

- ▶ Investment target derived from production function; depends on value added and user cost (PAC in the short run)
- ▶ User cost mainly driven by WACC, with large share for BLR (30%)

Inertial household spending

- ▶ Despite of a role for current demand in SR, important consumption smoothing of income shocks due to permanent income in LR
- ▶ Weak sensitivity of C to interest rate: no direct role for financial wealth & implicit intertemporal elasticity around 0.1
- ▶ Investment target driven by perm. income, house prices and BLR

Foreign trade: strong sensitivity to price competitiveness

- ▶ Export market shares and import penetration related to price competitiveness with strong LR elasticities (-1.3 and -1.1)
- ▶ Large import content of exports (around 33%)

Public finances: determined by satellite model in forecasts / by fiscal rule, effective tax rates and shares in simulations

Demand deflators driven by VA price and import price

Policy rate: a key driver of expectations

- ▶ In simulations, follows a Taylor rule based on EA output gap and inflation
- ▶ Still, EA variables generally exogenized because foreign demand and prices are exogenous
- ▶ In forecasts, from Eurosystem assumptions
- ▶ As it belongs to the core of the VAR, it influences all expectations

Monetary policy transmission through a rich set of interest rates

- ▶ 10 year public rate related to policy rate through term structure equation (in simulations)
- ▶ Bank lending rates, CoE and BBB determined from 10 year rate

Financial asset incomes explicitly modeled, rate of return determined by 10 year rate

Estimation strategy: a three-step approach Back

1st step: Calibration of the production function

- ▶ Elasticity of substitution of the CES: from free estimation of LR equation of investment
- ▶ Markup and other parameters of the CES: recovered from estimated intercepts of LR equations of employment, investment and prices
- ▶ This ensures equality btw output and LR output on balanced growth path

2nd step: Estimation of the satellite model of expectations

- ▶ Joint Bayesian estimation of the core block of equations
- ▶ Least squares for auxiliary equations

3rd step: Estimation of PAC equations with iterative least squares

- ▶ Given expected present values of target changes, estimation with least squares of each equation
- ▶ Given coefficient estimates of each equation, computation of expected present values of target changes

Model version

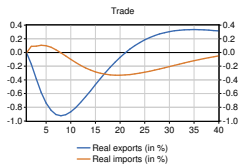
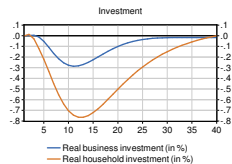
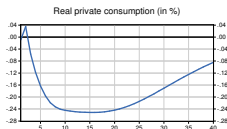
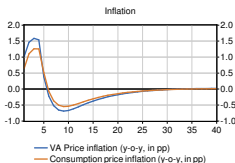
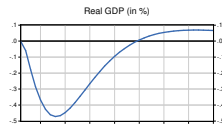
- ▶ VAR-based expectations
- ▶ Exogenous og and inflation of euro area

Baseline and shocks

- ▶ Baseline constructed by setting residuals at zero and extrapolating other exogenous variables with their steady state growth rate
- ▶ Shocks hit in 2150Q1, i.e. at an horizon where the baseline is close to its balanced growth path
- ▶ Historical persistence (when estimated) or calibrated at 0.9 (for shocks on exo. variables)

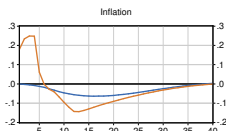
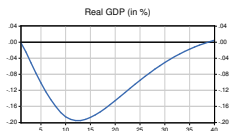
Cost-push shock: +1% on value added price Back

- ▶ Markup shock of +1% on VA price: transmits to all PAC equations through expectations
- ▶ Direct negative impact on exports of the loss of competitiveness
- ▶ Households consumption and investment strongly decrease through expected permanent income. Business investment decreases with VA of market branches

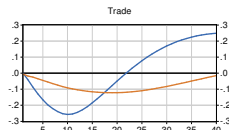
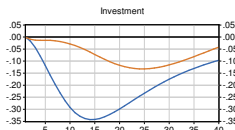
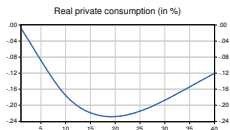


Oil price shock: +10% on oil price

- ▶ No direct effect of energy price on VA price and no effect on competitor prices (i.e asymmetric shock)
- ▶ Increase in consumption price inflation through energy import price reduces HH real income and consumption
- ▶ Net exports decreases in the short run due to import content of exports
- ▶ VA price inflation decreases and progressively restores price competitiveness of exports



— VA Price inflation (y-o-y, in pp)
— Consumption price inflation (y-o-y, in pp)

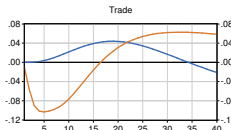
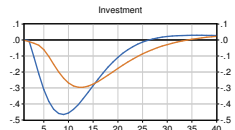
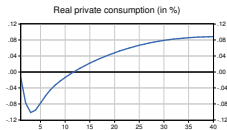
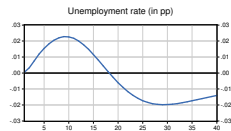
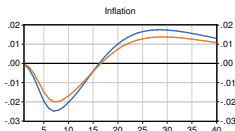
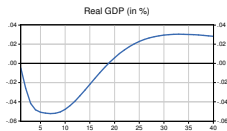


— Real business investment (in %)
— Real household investment (in %)

— Real exports (in %)
— Real imports (in %)

Term premium shock: +100bp annualized on the long rate

- ▶ Endogenous transmission to bank lending rates and user cost of K (no impact on short rate and nominal ER)
- ▶ Negative impact on the real side through investment sub-components
- ▶ Disinflation causes a real depreciation on the nominal side
- ▶ Stabilization through net exports in the short run and consumption reaction in the medium run



Differences among simulations

- ▶ *Hyb. vs MCE*: expected unemployment responses illustrate the awareness of non-fin. agents of future undershoot under MCE compared to Hyb. (lhs figure)
- ▶ *Hyb. vs VAR-based*: long-term rate responses illustrate large responses of financial variables under Hyb. compared to VAR-based (rhs figure, related to exo. EA)

