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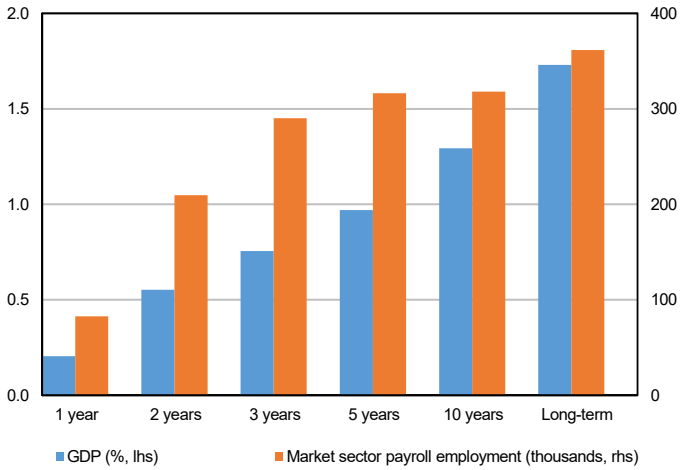
Use of macroeconomic modelling in public policy evaluation

- Macroeconomic models provide quantitative estimates of relationships between macroeconomic variables such as employment, gross domestic product (GDP) and inflation. They are used for forecasting (to project the spontaneous evolution of a country's economy in the short to medium term) or for assessing changes to public policies (to assess the macroeconomic effects of a policy reform prior to actual implementation).
- The Mésange model co-developed by DG Trésor (Directorate General of the Treasury) and Insee (National Institute of Statistics and Economic Studies) is used for ex-ante assessment of the macroeconomic impact of policy reforms. The results of the model – whose source code is publicly available – help to inform public policy development and contribute to democratic debate.
- Using a single model to assess different measures ensures comparability of the estimated effects of those reforms. The complexity of the assessment methodology depends on the type of reform investigated, and often requires supplementing the model by estimates from the economic literature or specific modules aimed at addressing the measure being assessed.
- The effects estimated by the model must then be interpreted by the user. The macroeconomic effects of reforms must be understood as being the difference between the future situation with the reform and the future situation without that reform, and not as the difference between the future situation with the reform and the current state. The time horizon for the impact of the reform, and whether or not the assessment includes the impact of financing the measure, must also be specified when the results are interpreted.
- Macroeconomic models rely on theoretical assumptions and on econometric estimation of their equations. Results accordingly reflect past behaviour patterns and they are surrounded by uncertainties. Periodic re-estimation of the models is a way to ensure that the equations capture recent changes in the economy, and to update the model to meet the latest requirements for assessing proposed reforms.

Ex-ante assessment of the impact of a permanent 1%-of-GDP reduction in employer social contributions, before the cost of financing the measure



Source: Mésange model co-developed by DG Trésor and Insee.

How to read this chart: A permanent reduction in employer social contributions equal to 1% of GDP, ex-ante, before considering the impact of financing the measure, raises GDP by 1.7% and leads to the creation of 360,000 jobs in the long run.

1. Use of macroeconomic models in public administration

1.1 Quantitative macroeconomic models describe relationships between macroeconomic variables

A country's economic situation can be represented using a limited set of aggregates, called macroeconomic variables. The most commonly used variables include employment, the unemployment rate, gross domestic product (GDP), consumption, investment, the trade balance, the consumer price index, wage levels, as well as the country's level of deficit and government debt. Changes in macroeconomic variables depend on numerous factors including individual decisions by domestic and foreign private economic agents (households and firms) and public policy decisions by authorities (government and the central bank). This makes the relationships between macroeconomic variables over time extremely complex.

One major objective of a country's economic policy is to cause these variables to move in the desired direction, for instance to reduce the unemployment rate while limiting adverse effects on related variables such as competitiveness. Macroeconomic models can contribute to economic policy making by providing a summary analytical framework that describes interactions between variables consistent with evidence from past observations. By quantifying relationships between variables, they provide a firm foundation for economic policy analysis, while guarding against economic misjudgement, undesired knock-on effects, or failure to appreciate orders of magnitude.

1.2 Macroeconomic models allow ex-ante assessment of the macroeconomic effects of reforms

In practice, macroeconomic models are used primarily for two purposes in France's economic government departments. They are used for forecasting purposes to predict the spontaneous evolution of short-to-medium-term macroeconomic variables, as in the case of the Opale model used by DG Trésor.[1] They are also used to evaluate public policy through ex-ante assessment[2] of the economic impact of implementing a policy. The second form of use is the one discussed in this document.[3]

Ex-ante evaluation consists in quantifying the effects of proposed reforms, before they are implemented. Ex-ante evaluations serve a twofold purpose. First, they enable the government to examine and compare the macroeconomic effects of different reform scenarios, e.g., the impact on jobs or GDP, thus reducing the risk that a partial or strictly qualitative analysis could overlook major channels for transmitting the reform to the economy. In this respect, macroeconomic models are first of all a decision-making tool. Furthermore, completing quantified assessments before a measure is decided upon and put in place improves transparency and communication regarding its economic justification and expected effects – for households and firms, investors, international organisations, and more generally for all economic agents and partners.

1.3 Despite their differences, the models used to assess public policies have points in common

The macroeconomic models used for assessments by the French economic government departments can be divided into two main categories:

- Macroeconometric models, which are built with a system of accounting and behavioural equations that seek to capture the relationships between macroeconomic aggregates, but are not necessarily derived from modelling the underlying individual behaviour of economic agents. The parameters for these equations are estimated mainly from time series so as to capture historical relationships as closely as possible. The Mésange model, which follows New-Keynesian approach[4] and is used by French government departments to assess the macroeconomic impact of reforms, is part of that category (Box 1).
- Micro-founded general equilibrium models, the most recent versions of which are dynamic stochastic general equilibrium (DSGE) models.[5] These are structural models that seek to describe economic agents' behaviour, typically in the form of rational expectations whereby

(1) See Daubaire A., Lefebvre G. and O. Meslin (2017), "La maquette de prévision Opale 2017", *DG Trésor Working Document* no. 2017/06 (in French).
(2) Assessment of a reform is said to be "ex-ante" when carried out before the reform is implemented, and "ex-post" when performed after implementation based on the observed data.
(3) Models are also used on an ad hoc basis for post-mortem analysis of earlier forecasts.
(4) It describes short-term Keynesian dynamics that extend past behaviour, and a long-run equilibrium derived from a theoretical framework and driven primarily by supply-side determinants.
(5) The category also includes calculable general equilibrium models.

households maximise intertemporal utility and firms maximise profit. They are generally calibrated to reproduce economic behaviour using databases or values from the literature. One example is QUEST, the model that the European Commission uses to assess the impact of France's structural reforms.[6]

All those models are typically dynamic, allowing short-, medium- or long-term assessment of the impacts of reforms and estimation of the time lags before the full effects of the measures appear. They include macroeconomic feedback loops that capture interactions between the variables, without which a potentially significant portion of the effects of the change in the economic environment could be omitted. To take one example, price-level changes depend not only on market conditions – supply and demand for goods and services – but also on wage-level changes, and can only be interpreted correctly by modelling the interactions between the labour market and the markets for goods and services.

Box 1: The range of macroeconomic models used to analyse France's economy

Macroeconomic models have been used by French government departments since the mid-1960s, when the first econometric model was used to prepare the Sixth Plan (1971-1975). The report by René Lenoir and Baudouin Prot, "L'information économique et sociale des Français", submitted to President Valéry Giscard d'Estaing on 18 June 1979, stressed the importance of economic modelling tools to inform public decision-making. The report proposed setting up three economic research organisations (OFCE for academic institutions, IRES for trade unions, and what would later become Rexecode for employer federations) in order to promote competition in economic modelling, which had previously been limited mainly to Insee and the Directorate for Forecasting at the Finance Ministry, with the METRIC model[a] that was commissioned in Autumn 1977.

The many models currently used to analyse the French economy differ in several ways. At DG Trésor, Opale is used for short- and medium-term GDP forecasting, whereas Mésange is used for ex-ante assessment of the macroeconomic impact of policy reforms. The European Commission assesses France's policy reforms using the QUEST DSGE model. Other organisations that perform macroeconomic forecasts include the Banque de France, which replaced the Mascotte model in 2019 by FR-BDF,[b] and OFCE (French Economic Observatory), which uses the e-mod.fr model.[c]

Models differ in several ways. They may have varying levels of disaggregation. The Three-ME model,[d] for instance, was developed by OFCE and ADEME (French Environment and Energy Management Agency) with particularly fine-grained modelling of the energy sector[e] specifically to estimate the impact of environmental policies. Models also differ in terms of geographical scope; some like Mésange are specific to France, while other models, e.g. NiGEM,[f] cover many countries or regions. Finally, models may differ in terms of their structural characteristics. Opale, Mésange and NiGEM, for instance, are macroeconometric models, whereas QUEST is a DSGE model.

a. See "Metric: Modèle économétrique trimestriel de la conjoncture" (1977), Annales de l'Insee 26/27 (in French).
b. See Lemoine *et al.* (2019), "The FR-BDF Model and an Assessment of Monetary Policy Transmission in France", *Banque de France Working Paper Series* no. 736.
c. See Chauvin V. *et al.* (2002), "Le modèle France de l'OFCE. La nouvelle version: e-mod.fr", *Revue de l'OFCE* 81 (in French).
d. Multi-sector Macroeconomic Model for the Evaluation of Environmental and Energy policy.
e. See Callonnec G. *et al.* (2013), "A full description of the Three-ME model: Multi-sector Macroeconomic Model for the Evaluation of Environmental and Energy Policy", 1 March.
f. National Institute Global Econometric Model.

(6) See Roeger W., Varga J. and J. in't Veld (2008), "Structural Reforms in the EU: A simulation-based analysis using the QUEST model with endogenous growth", *Economic Papers* 351.

Table 1: Principal macroeconomic models of the French economy

Model	Category	Government department or institution	Example of use	Example of publication
Public policy evaluation				
Mésange	Macroeconometric model	DG Trésor Insee	Assessment of the impact of economic policy measures on the French economy	*Trésor-Economics* no. 226 - A tentative evaluation of some macroeconomic effects of the PACTE bill[a]
NiGEM	Macroeconometric model	DG Trésor Insee (developed by NIESR)[b])	Assessment of the impact of economic policy measures on global economies	*Trésor-Economics* no. 208 - Why is global inflation still so low?[c]
Quest	DSGE model	DG ECFIN (European Commission)	Assessment of the impact of economic policy measures on the French economy	Country reports (European Commission, European semester reports)[d]
Three-ME	Calculable general equilibrium model	OFCE ADEME	Assessment of the impact of energy and environmental policies for France	Macroeconomic and environmental effects of carbon taxation (*Les effets macroéconomiques et environnementaux de la fiscalité carbone*, in French)[e]
Macroeconomic forecasting				
Opale	Macroeconometric model	DG Trésor	Short- and medium-term forecasting	Economic, social and financial report appended to the Budget Bill (*Rapport économique social et financier annexé au Projet de loi de finances*)[f]
e-mod.fr	Macroeconometric model	OFCE	Short- and medium-term forecasting, economic policy analysis	*Perspectives économiques de l'OFCE*[g]
Mascotte	Macroeconometric model	Banque de France	Short- and medium-term forecasting	Macroeconomic projections of the Banque de France[h]

a. De Williencourt C., Faci A. and S. Ray (2018), "A tentative evaluation of some macroeconomic effects of the PACTE bill", *Trésor-Economics* no. 226.
b. National Institute of Economic and Social Research.
c. *Cf.* Bara Y-E *et al.* (2017), "Why is global inflation still so low?", *Trésor-Economics* no. 208
d. European Commission website: https://ec.europa.eu
e. See special report (Rapport particulier n° 4, "Les effets macroéconomiques et environnementaux de la fiscalité carbonne", French Tax Policy Council, September 2019 (in French).
f. DG Trésor website: https://www.tresor.economie.gouv.fr/publications
g. OFCE website: https://www.ofce.sciences-po.fr/indic&prev/prevision.php
h. Banque de France website: https://www.banque-france.fr/economie/projections-macroeconomiques-france

2. Use of the Mésange model in practice

2.1 Overview of Mésange

Mésange is the macroeconomic model used by DG Trésor for ex-ante evaluation of the macroeconomic impact of government reforms. The model is co-developed with Insee; the source code has been published[7] and its mechanisms have been described in a working paper.[8] Mésange is a quarterly model[9] of the French economy with approximately 1800 equations. Approximately fifty of the equations are econometric equations describing the economic behaviour of various agents, while most of the others are accounting equations and express the equilibrium in the goods and services markets. The model identifies five sectors of the economy (agriculture and manufacturing, energy, tradable services, non-tradable services, and non-market services) based on their exposure to international competition, as well as two categories of workers by level of qualification, which enables a relatively fine-grained analysis of the measures that specifically affect certain categories of staff. The most recent version of Mésange, which was re-estimated in 2017, reflects current economic debates and the corresponding needs for assessment, including support for competitiveness and employment, particularly among the low skilled; the French economy's exposure to international competition; and energy transition policies.

Mésange is used to assess the impact of shocks to the economy, including fiscal and tax shocks, exogenous shocks (e.g., a rise in global demand), and structural shocks (e.g., an increase in the labour force). Because the model allows economic policy measures to be ranked according to the intended objective (e.g., to create jobs or raise GDP),

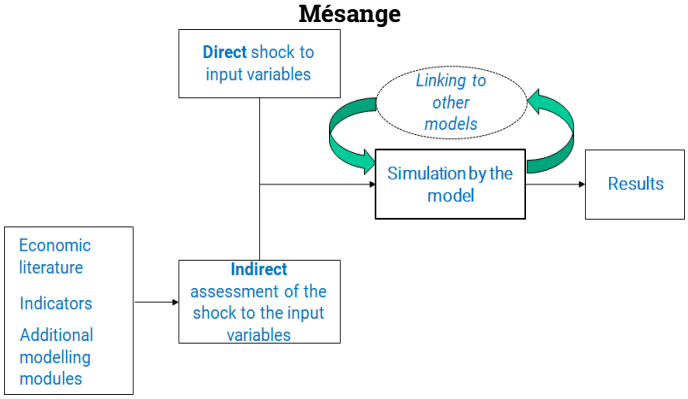
(7) https://www.tresor.economie.gouv.fr/Articles/2018/09/05/la-dg-tresor-met-a-la-disposition-du-public-les-codes-sources-des-modeles-mesange-opale-et-saphir (DG Trésor publishes source code for Mésange, Opale and Saphir).
(8) See Bardaji J. *et al.* (2017), "Le modèle macroéconomique Mésange: réestimation et nouveautés", *DG Trésor Working Document* no. 2017/04 (in French).
(9) The macroeconomic variables described by the model are quarterly, but annual series can be reconstructed from the quarterly series.

systematic use of the model to evaluate all government reforms ensures consistency and comparability of the orders of magnitude of their expected effects.

2.2 Use of the model depends on the type of reform being assessed

As a general rule, policy assessment begins with a description of the economic channels underlying the reform (supply shock or demand shock, sectors and economic stakeholders concerned, and so on). This stage always involves a review of the economic literature for evidence that can be used during the assessment. The subsequent use of Mésange depends on the reform being assessed.

Chart 1: Example of an assessment methodology using Mésange



The most direct use of the model concerns tax shocks and fiscal shocks, as the principal tax and social security contribution rates are exogenous variables in the model, and a change in the rates, e.g., an increase in value added tax, is easily simulated directly within Mésange, without requiring any other module.

Other shocks require more complicated modelling combining Mésange with complementary modules, e.g., partial-equilibrium microeconomic or sector models. The evaluation of the CICE (Competitiveness and Employment Tax Credit), for instance, required use of the Matis module[10] upstream from Mésange, because the reform did not have a uniform impact on employment for all salary levels; this required calibrating the percentage of low-skilled workers for whom the tax credit was intended, because their level of employment is more sensitive to changes in the cost of labour.[11]

For shocks affecting the global economy (e.g., exchange rates or oil prices), estimation of the impact on France must also consider the response by the international environment, which is not modelled and therefore assumed to be neutral in Mésange. For example, an increase in oil prices tends to dampen activity in Germany, which ultimately has negative repercussions in France, on top of the negative effects of the initial shock. These interactions are assessed separately using multicountry models such as NiGEM.[12]

Some reforms cannot be satisfactorily modelled directly in Mésange because they affect variables that are not included in the model. In these cases, prior analysis is required to determine how the measure can be translated into economic shocks for the input variables. For instance, the introduction of employee profit-sharing measures in firms has impacts on labour productivity that must be estimated by the modeller before the reform can be assessed using Mésange.

This preliminary work is conducted in partnership with the experts on the reform and draws from available statistics or from findings in economic literature. The literature can sometimes identify a similar reform from the past which was assessed ex-post; this can be used to adapt the results of the study to address the proposed reform.[13] It may however be difficult to transpose those results when the available research concerns situations that are only remotely comparable, for instance in other countries or when the scope is too dissimilar. These cases call for even greater caution when analysing the simulation results.

2.3 Results must be interpreted with care

The quantified results generated by the models must be interpreted with precaution. For an ex-ante assessment of a reform using Mésange, for instance, the macroeconomic effects must be understood ceteris paribus. In particular, the effects must not be seen as the difference between the future state following the reform and the current state, but rather as the difference between the future state following the reform and the future state without that reform. The time horizon for the presentation of results is important, as effects can vary considerably over time depending on the type of reform examined. (Broadly speaking, long-term

(10) See Bock S., Lissot P. and S. Ozil (2015), "Matis: une maquette d'évaluation des effets sur l'emploi de variations du coût du travail", *DG Trésor Working Document* no. 2015/02 (in French).
(11) More complex assessments require interaction between models in successive iterations to ensure they are used in a consistent, coherent manner.
(12) For more details see box 17 in Bardaji J. *et al.* (2017), "Le modèle macroéconomique Mésange: réestimation et nouveautés", *DG Trésor Working Document* no. 2017/04 (in French).
(13) See, e.g., *Trésor-Economics* no. 226, op. cit.

effects dominate following supply-side measures and short-term effects dominate following demand-side measures.)

The question of financing policy changes is also critical. For the assessment of proposed tax measures, Mésange is not intended to reproduce either the fiscal policy response[14] (in spending or revenue), or the presence of fiscal rules (whether prescribed by law or merely followed in practice). A presentation of the gross macroeconomic effects, as opposed to the net effects after financing the measure, helps to understand the economic mechanisms set in motion by the measure, and its specific effects. A stimulus measure will generally always have positive effects on the economy, but those benefits fail to take account of the ex-ante deterioration of public finances, which can have negative effects not explicitly captured by Mésange, e.g., by raising the cost of public debt.

This often makes it worthwhile to also examine the effects of the measure "after financing", in order to provide even a rough approximation of offsetting effects, for instance by introducing into the model a generic measure to reduce public spending or to increase average taxes such that the proposed measure would be neutral ex-ante for public finances. In particular, this allows comparison, especially the short- and medium-term, between the impacts of measures that are costly for public finances, e.g., reductions in taxes and social contributions, and the effects of reforms that do not reduce public revenue, e.g., easing regulatory constraints on a given market.

3. Limits to the use of macroeconomic models

The results of the simulations depend on modelling choices; they are subject to uncertainties related to the estimation of the model and how the proposed measures are translated into shocks to the input variables.

3.1 Analysis of the results of a model requires an understanding of its structure

The results must be interpreted in keeping with the model's analytical framework, which must be described explicitly.

First of all, use of a macroeconometric model may lead to overstating or understating the effect of certain reforms, compared to the results yielded by other types of models. Box 2 illustrates divergences observed between the Mésange model and the QUEST model used by the European Commission.

Beyond the general analytical framework, the degree of complexity chosen in building the model can affect the results of assessments by incorporating additional economic channels. There is a trade-off between the benefits of a simple model that allows government decision-makers to readily take its results on board, and the benefits of more complex models capable of providing a consistent framework to address a varied set of proposed reforms. When the evaluation of a reform requires introducing sectoral shocks or changes in taxation of a specific production factor, the use of a stylised model with too high a level of aggregation can prove to be unappropriate.[15]

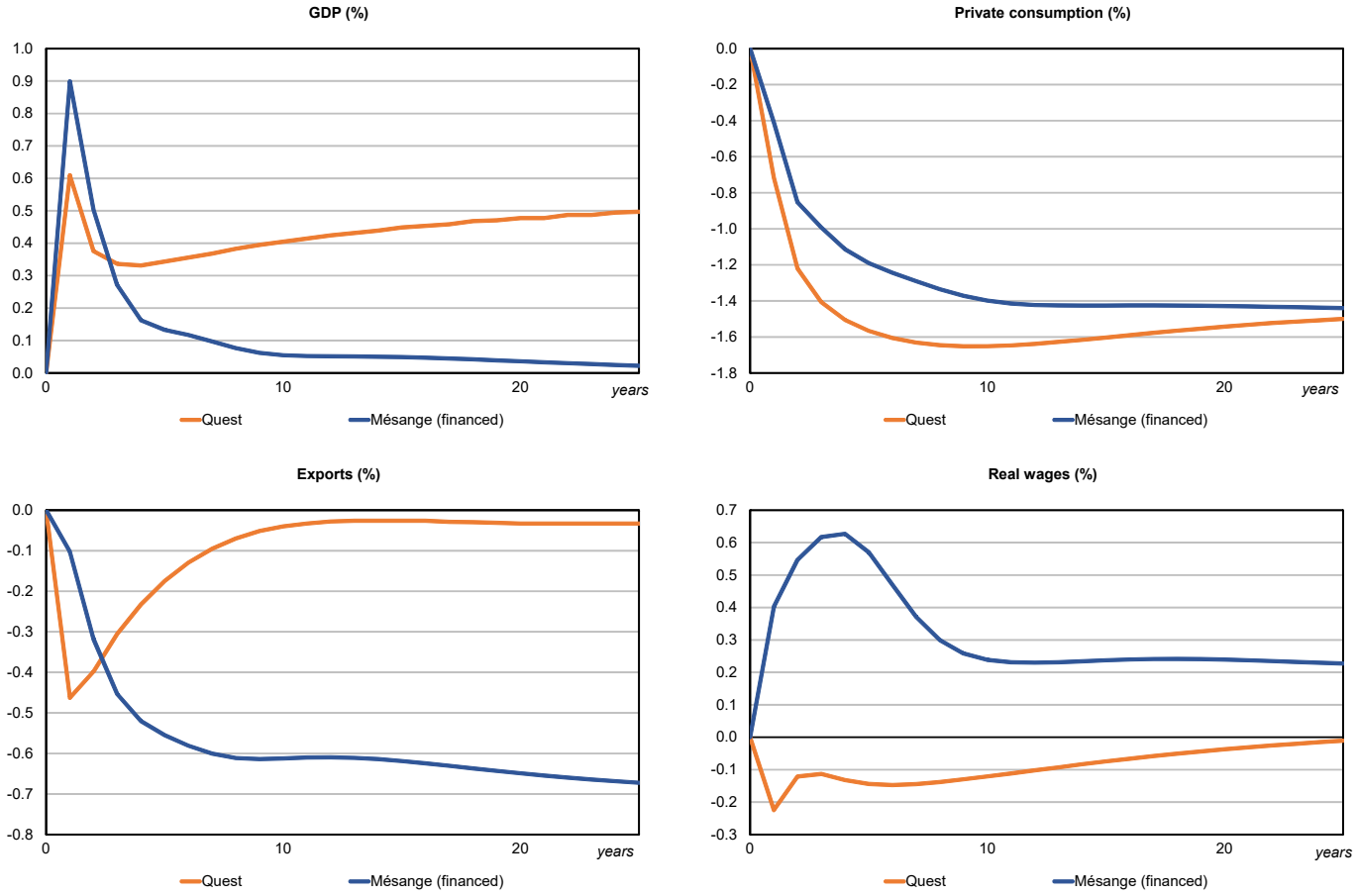
Lastly, regarding the theoretical structure of the behaviour of economic agents, certain macroeconomic relationships incorporated in the model may be open to challenge. For instance, the form of the equation for wage formation is widely debated, and two types of equations are often compared: the Phillips equation, in which the unemployment rate affects wage growth, and the wage setting (WS) equation, in which the unemployment rate affects the level of wages;[16] the latter specification is used in Mésange. Which of the two specifications is used in a model must therefore be explained.

(14) Regarding monetary policy, the simulations are carried out assuming real interest rates are unchanged.
(15) Other aspects of the evaluation of the reforms could also be included in the models, such as redistribution effects, which are currently assessed using distinct models, e.g., microsimulation.
(16) These two specifications do not lead to the same consequences regarding the long-run effects of the measures (and notably on the long-term unemployment rate, which is independent of the tax wedge in a Phillips equation).

Box 2: Comparison between a macroeconometric model and a DSGE model

Even when they share theoretical foundations, models can yield significantly different results when assessing the same policy measure. This example involves a simple simulation in both Mésange and QUEST of a permanent increase in public investment. The main effects of the measure are the same – higher demand and upward pressure on wages and prices – but some economic components exhibit different trends due to the specific features of each model.[a]

Chart 2 : Ex-ante impact of a 1%-of-GDP increase in public investment in Mésange and QUEST, assuming financing by a flat tax on households ex-ante in Mésange and ex-post in QUEST



Source : Simulations by DG Trésor, based on the Mésange model and QUEST III R&D for France.

Note: The simulation with the QUEST model (2017 version) is performed for an increase in public consumption (with no impact on the stock of capital) over a period of 500 quarters, applying a fiscal rule intended to stabilise public debt around its long-run target. The simulation with the Mésange model ("after financing") also includes an ex-ante flat tax increase on households.

In the Mésange model without the impact of financing, the increase in public investment raises demand in the short term but is gradually "crowded out" in part by inflationary pressure on wages and prices, which weighs on competitiveness and deteriorates the trade balance. To improve comparability with the simulation in QUEST, which provides for a fiscal rule, the deficit can be offset in Mésange by specifying a flat increase in taxation. This will reduce the results of the Mésange simulation, because the higher taxes reduce households' purchasing power and thus weigh on private consumption.

In QUEST, the policy measure is less efficient in the short term and partly crowds out private consumption. This is related to expectations of future taxes by the share of "non budget-constrained" households that will seek to smooth their consumption,[b] as well as the additional tax on "constrained" households. Lower consumption entails a lower marginal rate of substitution between leisure and consumption, which then affects the wage equation; QUEST predicts an increase in hours worked and lower real wages, which mitigates inflationary pressures. In the long run, the policy measure is found to be more efficient in QUEST, primarily because the deterioration in exports is halted by this deflationary effect, which is absent from Mésange.

a. To take one example, unlike QUEST, Mésange allows deviations for the long-term general government balance and current account balance.
b. These households can optimise utility by drawing from savings to smooth consumption over time, unlike "budget-constrained" households that cannot save and therefore consume all their current income.

3.2 There are uncertainties regarding estimation of the model and quantification of shocks

After taking on board the specificities of the theoretical approach adopted, the results of the estimations are subject to two types of uncertainties, relating to the empirical estimation of the parameters of the equations, and the quantification of the shocks entered into the model.

Estimation of the model's equations is surrounded by uncertainties. While past dynamics provide a good indication of some forms of behaviour, e.g., how household consumption varies as a function of income, other relationships are harder to substantiate from the data. For example, the specification of a form of wage equation with significant coefficients is not trivial, and may require inclusion of additional explanatory variables such as dummies or time trends in the equations. The foreign trade equations are also difficult to estimate, and may require introducing additional variables such as emerging economies' share of trade.

Further uncertainties relate to translating the proposed measures into economic shocks, especially in the least straightforward applications of the model, which require breaking a measure down into elementary shocks. There is seldom a unique decomposition, this being the result of choices made by model users who seek to approximate the effects of the reform as closely as possible. Using results from the literature to calibrate shocks introduces further uncertainties to the assumptions, namely the uncertainties associated with the academic research used.

3.3 A model must be updated regularly and compared to other evaluations

The relevance of a model depends on keeping it up to date; this involves re-examining its structure in light of developments in theory, and re-estimating the equations to take account of new data, possible rebasing of the national accounts, or other changes. Any new assumptions must be shared and discussed with the largest number of experts in the field. The Mésange model is accordingly co-developed with Insee and presented to the community of economists in government and academia through seminars or joint projects (e.g., work with France Stratégie on the impact of an increase in oil prices).

Using a single model to assess various reform options will ensure consistency and comparability, but it is also advisable to simulate reforms with different models in order to verify the consistency of the results obtained. At DG Trésor, Mésange is regularly compared with other macroeconomic models, such as Opale and NiGEM. In some cases, this work may be supplemented by external assessments performed using other techniques.[17] [18]

Cyril de Williencourt, Florian Jacquetin

(17) For instance, OECD analyses of the impacts of reforms are reported in the *OECD Economic Survey of France*.
(18) In addition to ex-ante evaluation, ex-post assessments are also needed to guide public action regarding future reforms. Ex-post assessments use other statistical techniques such as difference-in-differences.

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Editor in chief:
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tresor-eco@dgtresor.gouv.fr

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