MTBE V2025: NEW VERSION OF THE QUARTERLY MODEL OF THE BANCO DE ESPAÑA

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Abstract

The Quarterly Model of the Banco de España (MTBE, by its Spanish acronym) is a large-scale macroeconometric model used for medium-term macroeconomic forecasting of the Spanish economy, as well as for performing scenario and policy simulations. The model is for a small, open economy within a monetary union. It is specified as a large set of error correction equations. This document presents an update of the model, which includes some specification changes and a re-estimation using data up to 2022. The main change in this version is the explicit inclusion of expectations in the main equations. This makes the model suitable for performing simulations under different assumptions about the way agents form their expectations. The update also enhances the financial channels included in the model and introduces additional detail in aspects that have gained importance in recent years, such as energy shocks.

Keywords: Spanish economy, macroeconometric model.

JEL classification: E10, E17, E20, E60.

Resumen

El Modelo Trimestral del Banco de España (MTBE) es un modelo macroeconométrico de gran tamaño utilizado en las proyecciones a medio plazo de la economía española, así como en la elaboración de escenarios y la simulación de políticas económicas. El modelo es el de una economía pequeña y abierta que forma parte de una unión monetaria. Está especificado como un conjunto amplio de ecuaciones de corrección del error. Este documento presenta una actualización del modelo, que incluye cambios en la especificación y una reestimación con datos hasta 2022. El cambio de mayor envergadura es la inclusión de expectativas en las ecuaciones principales. Esto permite al MTBE v2025 realizar simulaciones bajo diferentes supuestos sobre la forma en que los agentes forman sus expectativas. La actualización también mejora los canales financieros introducidos en el modelo y añade detalles adicionales en aspectos que han ganado importancia en los últimos años, como las perturbaciones de los precios energéticos.

Palabras clave: economía española, modelo macroeconométrico.

Códigos JEL: E10, E17, E20, E60.

Contents

1 Introduction

The Quarterly Model of Banco de España (MTBE, for its name in Spanish: *Modelo Trimestral del Banco de España)* is a large-scale macro-econometric model used for medium-term macroeconomic forecasting of the Spanish economy, as well as for performing scenario and policy simulations. In the MTBE, Spain is modelled as a small open economy within a monetary union. The model is specified as a large set of error correction equations.

The first version of this model was developed by Estrada, Fernández, Moral and Regil (2004), and since then it has been continuously updated (see Ortega, Burriel, Fernández, Ferraz and Hurtado, 2007; Hurtado, Fernández, Ortega and Urtasun, 2011; Hurtado, Manzano, Ortega and Urtasun, 2014; Arencibia, Hurtado, De Luis and Ortega, 2017). This document presents a new model version (henceforth referred to as "v2025") which includes changes in the specification of some equations and has been re-estimated with a more up-to-date data sample (2000-2022 instead of 1995-2014), which allows to focus on a homogeneous period during which Spain belongs to the euro area, thereby improving the estimation by ensuring consistency in the monetary and economic environment. The biggest specification change with respect to the previous version is the inclusion of expectations. Some of the main equations (including those describing the evolution of consumption, investment, employment, prices and wages) now include an explicit term that captures expectations of key variables (such as GDP growth, unemployment rate and the inflation rate), this allows for anticipation effects, and also makes it possible to simulate shocks under different assumptions with respect to the behaviour of these expectations: the model can now run either with adaptive expectations (with a backward-looking specification that is estimated using observed data: the model now includes equations describing how current observed variables affect these expectations about the future; these equations are only used when the model works in adaptive expectations model) or with model-consistent expectations (using an iterative algorithm to impose a forwards-looking response of expectations that coincides with what will actually happen in the simulation, so that they are consistent with the ex-post equilibrium path of the relevant variables; this is similar to how rational expectations models work, but in the case of MTBE there are no optimizing agents and no fully-specified microfoundations).

Incorporating expectations into the forecasting model is crucial as it allows for more accurate simulations of economic scenarios. The inclusion of expectations in key equations, such as those for consumption, investment, employment, prices, and wages, enables the model to simulate different scenarios based on how agents form their expectations, either adaptively or in a model-consistent manner. Simulations show that adaptive expectations, which are backward-looking, tend to result in slower and more muted responses to shocks, particularly in terms of price adjustments. In contrast, model-consistent expectations, which are forward-looking, generate faster and more pronounced effects on output and prices. This distinction is particularly evident in simulations of interest rate shocks, where model-consistent expectations lead to a more significant and immediate impact on inflation and output, thereby reducing the sacrifice ratio. Similarly, with the enhanced financial channels in the model, which include detailed relationships between interest rates, credit, and

macroeconomic variables, financial shocks have a more substantial and immediate impact on the economy when expectations are model-consistent. These findings underscore the importance of incorporating expectations into the model to capture the anticipatory behaviour of economic agents and the dynamic interactions with the financial system.

The remainder of this paper is organized as follows. Section 2 summarizes how expectations are now included in the model, and how the enhanced financial channels are specified. Section 3 details the main equations of the model and section 4 presents the corresponding contribution charts. Section 5 showcases a set of common simulations used in the forecasting process and for policy evaluation. Finally, section 6 concludes.

2 Specification changes in MTBE v2025

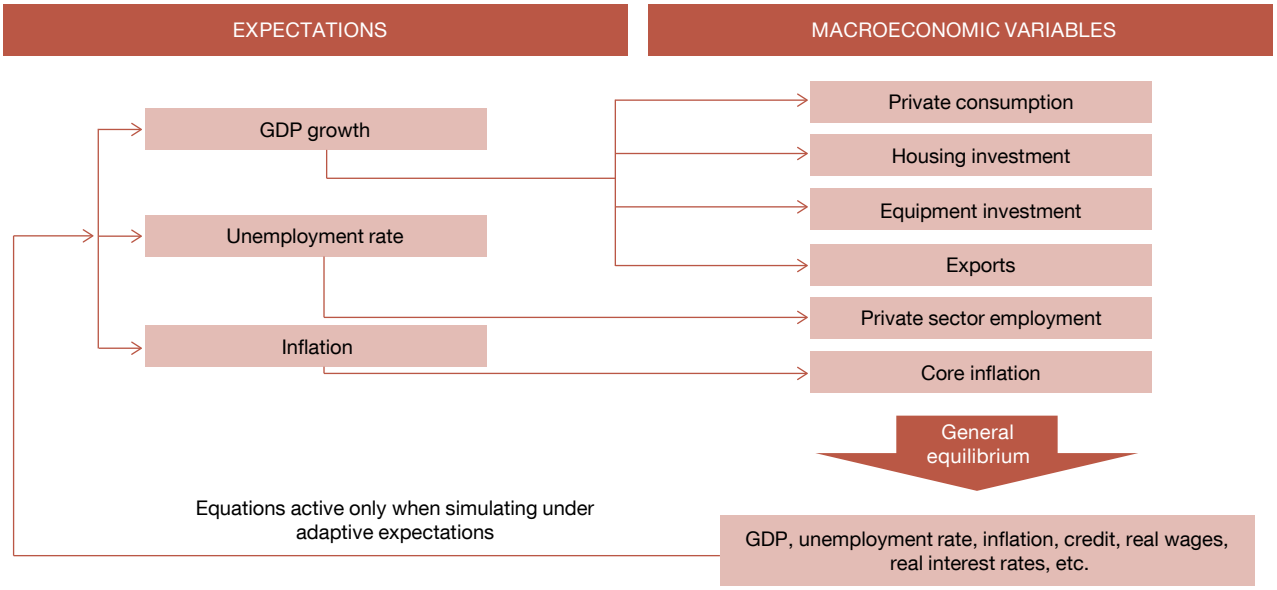
2.1 Expectations

Incorporating expectations into macroeconomic models is crucial because it allows for more accurate forecasting and policy evaluation by capturing the anticipatory behaviour of economic agents. Many central banks have incorporated an explicit role for expectations into their main macroeconomic models used for forecasting and policy evaluation. A notable example is the FRB/US[1], a large-scale estimated general equilibrium model of the U.S. economy developed at the Federal Reserve Board, which since its initial version has been able to generate simulations in two alternative expectations regimes[2]. First, under the VAR-based option, expectations are derived from the average historical dynamics of the economy as manifested in the predictions of estimated VAR models. Second, under the model-consistent option, agents are assumed to form accurate expectations of future outcomes as generated by simulations of FRB/US itself. The latter way of introducing explicit expectations has later been adapted, for example, in the Bank of Canada's LENS model[3], the ECB-BASE model[4], or the Banque de France's FR/BdF model[5]. A large number of expectations variables appear in different equations of these models: typically, consumption depends on expectations of future consumption, business investment depends on expectations about future business investment, etc. All of these expectations variables are linked through a VAR-like structure. On the other hand, the Banca d'Italia's BIQM model[6] also includes explicit expectations, but in this case centred only on inflation expectations, with an emphasis on incorporating survey-based data. Bundesbank's BbkM-DE[7] also includes only inflation expectations, and in this case they are purely backward-looking.

Figure1 summarizes how MTBE v2025 incorporates expectations. There are three variables over which agents in the model form expectations: GDP growth, inflation, and the unemployment rate. These expectational variables enter several model equations (described in section 3). Expectations about future GDP growth directly affect household consumption, housing investment, equipment investment by firms, and exports. The equation for private-sector employment includes the expectations for the unemployment rate. Finally, core inflation reacts to medium-term headline inflation expectations. All other variables in the model will then respond to these, in a general-equilibrium setting, and in turn expectations will react to the new developments in the economy, according to the assumed specification for expectations formation (adaptive vs model-consistent; see below for further details). The number and choice of expectational variables included in MTBE v2025 responds to the desire of moving towards the paradigm of rational expectations (without losing the flexibility

1 The FRB/US model has been in use at the Federal Reserve Board since 1996. Its documentation can be found in Brayton and Tinsley (1996) and at: https://www.federalreserve.gov/econres/us-models-about.htm.
2 See Brayton et al. (1997).
3 See Gervais and Gosselin (2014).
4 See Angelini et al. (2019).
5 See Lemoine et al. (2019).
6 See Bulligan et al. (2017).
7 See Haertel et al. (2022).

Figure 1
Expectations in MTBE v2025



SOURCE: Banco de España.

and agility that the MTBE structure provides) and at the same time introducing a way to anchor the medium-term model forecasts using information from other models and sources (for instance, estimates of NAIRU and potential output can now be used as inputs when generating model forecasts, in a way that would not be possible, or at least practical, if too many expectations variables entered the model).

Two different specifications of expectations formation are considered: adaptive (backward-looking) and model-consistent (forward-looking).

- **Backward-looking** expectations are determined by equations that link the expectational variables to each other and to realizations of observable variables. For example, expectations about future GDP growth are influenced by current GDP growth, credit, interest rates, and real wages. Similarly, expectations about the unemployment rate are influenced by observed GDP growth, credit, interest rates, and real wages. These relationships are illustrated in Figure 1, where the feedback arrow at the bottom represents how current variables affect expectations.

- **Model-consistent** expectations, on the other hand, assume that agents form accurate expectations of future outcomes based on the model's own simulations. This forward-looking approach ensures that expectations are consistent with the ex-post equilibrium path of the relevant variables. The iterative algorithm

used in this specification adjusts expectations until they reflect what will actually happen in the simulation given that effect on expectations, providing a more rigorous conceptual framework.

The decision to include both specifications, rather than relying solely on model-consistent expectations, is justified by the need for flexibility and robustness in different simulation scenarios. While model-consistent expectations are conceptually rigorous and provide a more accurate representation of anticipatory behaviour, they can sometimes lead to instability in the model, especially under certain types of shocks. Backward-looking expectations, being more stable, offer a practical alternative for scenarios where model-consistent expectations might generate explosive behaviour.

Section 5 shows simulations carried out under both expectations regimes.

2.2 Financial channels

The new model version also includes enhanced detail regarding financial transmission channels. The variables that appear in the model are similar to those in the previous version: short-term and long-term interest rates, three different bank lending rates, and changes in the stock of credit. But some new relationships between them are included in the model, their interactions with macroeconomic variables have been updated, and there is a new channel operating through expectations.

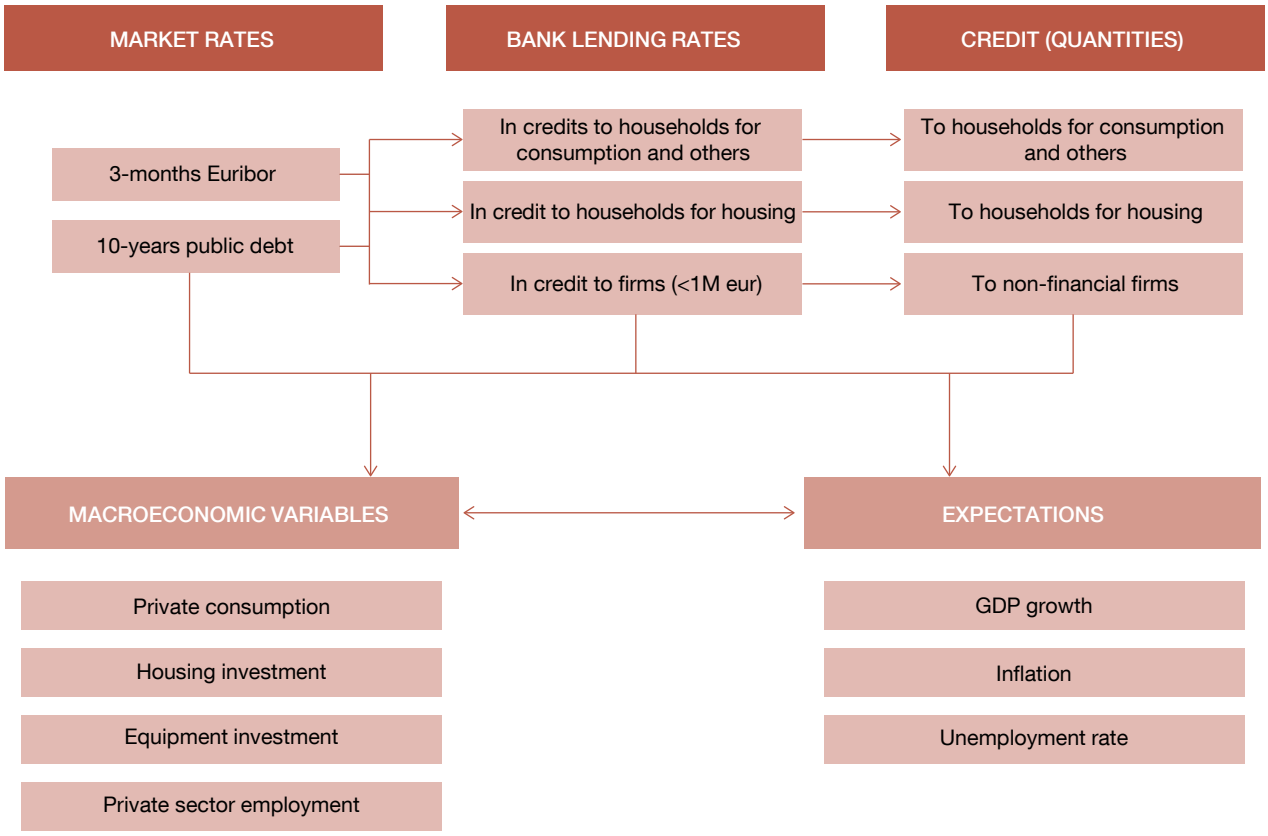
Figure 2 summarizes the modelled relations between financial variables and the main macroeconomic variables (more details are provided in section 3, which describes the model equations).

The main change with respect to the previous model version, in terms of financial channels, is related to the inclusion of expectations: credit and interest rates now affect expectations of GDP growth and of inflation, and these in turn affect consumption, investment, prices, wages, etc.

Apart from that, there are new terms in equations that already existed in previous versions. Short-term interest rates now appear in the equation for household consumption, together with the average rates of credit to households for consumption purposes; the latter captures the effects through new credit, while the former intends to capture effects related to pre-existing debt indexed to short-term rates (which includes most mortgages in Spain). The equation for equipment investment still depends on the corresponding bank lending rate in the short term, but now the long-term relationship also depends on the interest rate of 10-year Spanish sovereign debt; this implies that the main financial channel remains as in the previous version (bank lending rates only have short-term effects) but the new extra term makes confidence effects appear, particularly in turbulent times.

Figure 2

Financial channels in MTBE v2025



SOURCE: Banco de España.

The rest of the financial equations in the model remain mostly unchanged, with only updates in the estimated coefficients. This includes the equations for house prices and the housing investment deflator, and accounting definitions that track the evolution of households' net financial wealth of households, public debt, etc.

3 Main equations in MTBE v2025

The model is estimated equation-by-equation[8], using ordinary least squares to identify both the long-term relationships (with the variables in log-levels), and the short-term dynamics (with the variables in log-differences). For the long-term equations, the main estimation test is the stationarity of the residuals (checked through an augmented Dickey–Fuller test) that marks cointegration relationships. In the short-term equations, the aim is to obtain residuals of small size and without systematic behaviour, particularly at the end of the sample[9]. In both cases this is balanced against the need to obtain statistically-significant coefficients with the correct sign as predicted by theory and capturing sizeable effects. The use of autoregressive coefficients is discouraged in the estimation of MTBE because, even if they can often improve the fit to the data, they also hinder the usefulness of the model in later stages as a tool to interpret the evolution of the economy. For instance, an analysis of contributions that explains current high growth of a specific variable as a result of previous high growth of that same variable is not helpful at explaining the genuine economic determinants of the evolution of the economy. Instead, an interpretation based on explanatory variables with meaningful relationships with respect to the variable of interest are preferred, particularly if these relationships can be derived from theoretical underpinnings.

3.1 Expectations

As explained in the previous section, three expectations variables appear explicitly in MTBE v2025: the ones for GDP growth, the unemployment rate, and inflation.

Introducing expectations explicitly in the model requires a decision on which values to use in the estimation, and another one on how to make them behave in the simulations. The observed variables used as proxies for expectations in the estimation of the MTBE v2025 are the values at the end of the projections from Banco de España at each point in time (e.g. the expectation of GDP growth, inflation and the unemployment rate in the second quarter of 2016 are the values of these variables for 2018 in the forecast made by Banco de España in that second quarter of 2016). This 3-year horizon is chosen because it represents the medium-term forecasting horizon, which is commonly used in macroeconomic models, including those of the European Central Bank (ECB). This horizon is appropriate for capturing the anticipatory behaviour of economic agents and for making policy evaluations. The two specifications for the behaviour of the expectations variables in the simulations (adaptative vs model-consistent) were presented in section 2.1 and will be further discussed in section 5.

8 Apart from those commented here, the model contains hundreds of other equations, identities and definitions, usually without any estimated coefficients, in order to correctly capture the flows and relations between variables, replicating most of the structure of the national accounts and enforcing the relevant general equilibrium restrictions.

9 This restriction about the good fit at the end of the sample is imposed solely through the expert judgement of the econometricians involved, and its purpose is to ensure that the model keeps working correctly as new data comes out, as we have found over the years that a bad fit in important equations at the end of the sample may have low weight in statistical terms but still reduce the shelf life of the whole model.

Table 1
Equations for expectations

	Coefficients (a)
Equation for expectations of GDP growth	
Expectations of unemployment rate	-0.04
Observed GDP growth	0.11
Credit	0.02
Interest rates	-0.10
Real wages	-0.12
Equation for expectations of unemployment rate	
Expectations of GDP growth	-0.97
Observed unemployment rate	0.73
Observed GDP growth	-3.32
Real wages	2.72
Equation for inflation expectations	
Expectations of unemployment rate	-0.06
Observed inflation	0.67
Interest rates	-0.04

SOURCE: Banco de España.

a When several lags appear in the estimation, the table presents the sum of their coefficients.

As explained before, in the case of backward-looking expectations, these are determined by equations linking the expectational variables to realizations of a number of observable variables (as well as expectations of other variables). Table 1 summarizes the equations for the three expectational variables included in MTBE v2025, showing the estimated coefficients (without being explicit about details like which lags appear where, since it's usually several lags with different levels of statistical significativity and presenting them all would make the main messages harder to convey).

The expectations of GDP growth, unemployment rate and inflation include crossed terms that capture some interconnectedness between these variables, but crucially, with coefficients that are small enough to not generate instability issues in the model. The other main determinants of expectations in these equations are interest rates (in particular, an average of the bank lending costs for households and firms), and real wages (which generate supply-side effects of wage moderation, though with a limited size, as the simulations in section 5 will show).

3.2 Household expenditure: private consumption and housing investment

As seen in Table 2, in the long term, both forms of household expenditure (private consumption and housing investment) are explained mainly by a proxy of permanent income (a combination of current income and total wealth, both in real terms) and by real interest rates and credit variables.

Table 2
Equations for household consumption and housing investment

	Long term coefficients	Short term coefficients (a)
Equation for household consumption		
Disposable income	0.96	0.48
Total wealth	0.04	
Financial wealth		0.02
Short-term interest rate	-0.07	-0.13
Interest rate of credit to households for consumption		-0.25
Credit to households for consumption	0.17	0.10
Credit to households for housing		0.03
Expectations of GDP growth		0.49
Equation for housing investment		
Disposable income	0.84	0.76
Total wealth	0.16	0.11
Interest rate of credit to households for housing	-0.21	-0.52
Credit to households for housing	0.39	0.14
Expectations of GDP growth		0.60

SOURCE: Bancode España.

a When several lags appear in the estimation, the table presents the sum of their coefficients.

Additionally, in the short term, the estimation for the growth rate of consumption also identifies effects from financial wealth (the more liquid type of wealth), separate terms for interest rates of new credit and of pre-existing mortgages (proxied through short-term interest rates), a small effect of credit for housing (in addition to the direct effect of credit for consumption), and a sizeable effect of expectations over future GDP growth. The short-term equation of housing investment broadly replicates the long-run one, and adds, again, a sizeable effect of expectations over future GDP growth. As expected, the estimated coefficients for interest rates and credit are bigger in the equation for housing investment than in the equation for consumption.

Compared with the previous version of the model, the consumption equation in MTBE v2025 shows a faster and tighter relationship with disposable income, whereas that same variable now has smaller coefficients than it did in the equation for housing investment. This changes the composition of the response of household expenditures when an income shock is simulated: consumption will react more and housing investment less than they did in the past. The coefficients for interest rates, wealth and credit on consumption are now smaller, but in simulations private consumption now reacts more to all financial shocks than it did in the previous version of the model, because the new channels and the stronger response of other variables end up being quantitatively more important than the reduction in these coefficients. Because this is relatively common, in the rest of this section, comments on the changes of coefficients with respect to previous versions will only appear when simulations confirm a change in the effects, once all general equilibrium channels are taken into consideration.

3.3 Equipment investment

The equation for equipment investment is one of the most volatile and forward-looking elements of the model. As Table 3 shows, the estimation finds a coefficient bigger than one both in the short-term and in the long term. The coefficients of interest rates are also sizeable, and, in particular, bigger than the ones in other equations of the model. The long-run equation also finds sizeable effects for the stock of credit and for a measure of wage competitiveness: unit labour costs in relative terms with respect to the euro area. The estimation of the short-run equation adds terms related to exports, the stock market, electricity prices (which is a new variable in the v2025 model), and the expectations about future GDP.

Table 3
Equation for equipment investment

	Long term coefficients	Short term coefficients (a)
Equation for equipment investment		
Demand	1.17	1.10
Exports		0.29
Long-term interest rate	-1.05	
Interest rate of credit to non-financial firms		-1.70
Credit to non-financial firms	0.09	0.01
Stock market		0.05
Unit labor costs	-0.24	
Price of electricity		-0.08
Expectations of GDP growth		0.69

SOURCE: Banco de España.

a When several lags appear in the estimation, the table presents the sum of their coefficients.

The comparison with previous versions of the model is not easy, because those included an equation for private productive investment instead of one for equipment investment. This change in the specification of the model has been introduced because of operational issues, since equipment investment is readily available when new national accounts data is released, but private productive investment has to be derived by subtracting public investment (which is published with a different schedule and requires extra steps in order to estimate a seasonally-adjusted series in real terms) and housing investment from total investment.

3.4 Private-sector employment and wages

The long-run equation for private-sector employment is loosely derived from a simple production function, which explains a forced unitary response to demand and a negative coefficient for the capital stock (that is related to the role of the labour share in that production function). Other elements included in the estimation (see Table 4) are real wages, population, and expectations of future unemployment rate. The estimation of the

Table 4
Equations for private sector employment and private sector wages

	Long term coefficients	Short term coefficients (a)
Equation for private sector employment		
Demand	1.00	0.93
Capital	-0.61	
Real wages	-0.13	-0.19
Population	1.56	
Credit to non-financial firms		0.01
Expectations of unemployment rate	-0.41	-0.03
Equation for private sector wages		
Prices	1.00	0.50
Productivity	0.05	0.00
Public-sector wages	0.28	0.03
Unemployment rate		-0.03

SOURCE: Banco de España.

a When several lags appear in the estimation, the table presents the sum of their coefficients.

short-run equation also incorporates credit to firms as a labour-financing element, but the estimated coefficient is small.

The equation for private-sector nominal wages has an imposed unitary long-term response to prices, and an estimated sizeable signalling effect from public-sector wages. Together with the unemployment rate, these factors also appear in the short-term equation, though the estimated coefficients are much smaller there. An absence is also important in this case: the estimation with recent data gives almost no role to productivity, either in the long-run or in the short-run, at least when using the available measures, such as value added per employee; in previous versions of the model, productivity showed a bigger effect on wages, though the coefficients had been falling progressively, from one in the 2011 version, which imposed these values as a modelling assumption, to approximately 0.4 in the 2014 and 2017 versions, and to almost zero now. We considered including the expectations of inflation, but once the effect of actual observed inflation is allowed for, the estimation rejected an additional role for those expectations; but since observed inflation will react to shocks to inflation expectations, general equilibrium simulations will show a response of wages to inflation expectations, even without including that variable in this equation.

3.5 Exports and imports

The main drivers of exports and imports equations in the model (see Table 5) are still demand indicators, but the importance of the competitiveness indicators has grown in this new estimation with respect to the previous version of the model, particularly in the short run equations for exports. The relative unit labour cost is still a strong competitiveness factor in the equation for exports of goods to the euro area, alongside relative prices. The elasticity of imports with respect to final demand is still bigger than unity, and in the short-run also

Table 5
Equations for exports and imports

	Long term coefficients	Short term coefficients (a)
Equation for exports (b)		
External demand	0.93	0.75
Price competitiveness	0.90	0.76
Unit-labor-cost competitiveness	0.14	0.19
Expectations of GDP growth	0.62	
Equation for imports (b)		
Demand	1.29	1.31
Exports		0.40
Price competitiveness	-0.35	-0.47

SOURCE: Banco de España.

a When several lags appear in the estimation, the table presents the sum of their coefficients.
b The model has separate equations for exports or imports of goods to the euro area, of goods to the rest of the world, and of servides. The weighted average of the respective estimated elasticities is presented here, to represent what the response of aggregate exports or imports would be.

includes a specific term for exports that captures a particularly strong relationship across external-trade variables[10].

3.6 Prices

As in previous versions of the model, the central indicator for prices is core CPI (a consumer price index excluding energy and processed food items). But this update includes more detail regarding energy prices.

The specification of the equation for core CPI, shown in Table 6, is an updated version of the ones provided by experts in this area at Banco de España (see Álvarez, Gómez-Loscos and Urtasun, 2015, and Álvarez and Sánchez, 2017). There is no long-run equation[11], just a short-run one, which implies that higher-than-usual inflation will be consolidated in simulations and forecasts carried out with the model (it will not be followed by lower-than-usual inflation until the price level returns to an estimated long-term reference). This short-term equation is basically a Phillips curve, with a relatively low slope of 0.13 with respect to GDP growth but with additional effects coming from the expectations channels; the effective slope of the Phillips curve, taking all channels into account, will be revealed by the simulations in section 6. There is also an effect from relative unit labour costs and wages, and an estimated pass-through for changes in indirect taxes.

10 Because of this additional term for exports in the estimation of the equation for imports, even though the response of imports to a general demand shock is now smaller than in previous versions, it is bigger if the shock is centered particularly on exports, introducing a nuanced response that was not available in the previous version of the model.

11 As in the previous version, since there is no long-term equation and price-wage feedback is low, the model does not generate inflationary spirals (which was sometimes a problem in very old versions of this model). For example, the effect of an increase in oil prices or indirect taxes will fade out after one year: price levels will remain higher but inflation will eventually return to its baseline level.

Table 6
Equation for underlying inflation

	Short term coefficients (a)
Equation for HICP excluding energy and food	
GDP growth	0.13
Unit labor costs and wages	0.10
Energy HICP	0.05
Indirect taxes	0.60
Inflation expectations	0.88

SOURCE: Banco de España.

a When several lags appear in the estimation, the table presents the sum of their coefficients.

Table 7
Equations for other prices

	Short term coefficients (a)
Equation for electricity HICP	
Price of natural gas	0.21
Price of emissions (ETS)	0.07
Indirect taxes	0.29
Equation for energy HICP	
HICP excluding energy and food	0.02
HICP electricity	0.29
Oil price	0.28
Indirect taxes	0.63
Equation for food HICP	
HICP excluding energy and food	1.08
Price of food commodities	0.25
Price of natural gas	0.01
Indirect taxes	0.32

SOURCE: Banco de España.

a When several lags appear in the estimation, the table presents the sum of their coefficients.

The additional detail regarding energy prices comes from the introduction of an estimated equation for the electricity component of HICP, which depends mainly on natural gas prices and the price of emissions (ETS). As Table 7 shows, this will in turn be included in the energy HICP, together with oil prices and core inflation. Food HICP also has its own estimated equation, which includes different commodity prices and an above-unity response to core inflation (capturing the higher volatility of food prices relative to core inflation, beyond what the commodity prices already generate; the coefficient is not so big that it would generate explosive behaviour).

General HICP is then constructed as a weighted average of core HICP, energy HICP and food HICP. As in previous versions, other prices are modelled as a mixture of core inflation, external prices and, in some cases, commodity prices, always with estimated weights. This is the case for the deflators of value added, private consumption, private productive investment, exports, imports, etc.

4 Model analysis

In this section, we will conduct a series of exercises with the MTBE v2025 model to showcase its utility. The analysis is divided into two main parts. Section 4.1 helps us understand the historical determinants of fluctuations in key macroeconomic variables during the sample period. By examining the contribution charts, we can validate the model's fit and the narrative it generates for the evolution of the main macroeconomic variables. In section 4.2, on the other hand, we assess how the economy represented by the model reacts to various shocks and policy interventions by means of simulations. The latter are crucial for policy evaluation and scenario analysis, as they provide insights into the dynamic responses of the economy under different assumptions and conditions. Together, contributions and simulations offer a comprehensive evaluation of the model's capabilities and its relevance for forecasting and policy analysis.

4.1 Determinants of observed fluctuations

Contribution charts show the evolution of a variable (e.g. the year-on-year rate of change of private consumption) as explained by the various determinants of its behavioural equation (e.g. income, wealth, etc.) and the equation residuals. These graphs serve as a tool for validating staff projections, which is one of the main uses of MTBE. They also show the fit of the model (whether the contribution of the residuals is big or shows a trend or any other kind of systematic behaviour), together with the narrative that the model generates for the evolution of the main macroeconomic variables during that period (looking at the contribution of the different explanatory variables). The contribution charts in Chart 1 portray observed data until 2023Q4, that is, two years after the end of the estimation period. It is always observed data: these contribution charts don't show forecasts done with the model, instead they represent how observed variables are filtered through the model to provide a consistent explanation of the evolution of each other[12].

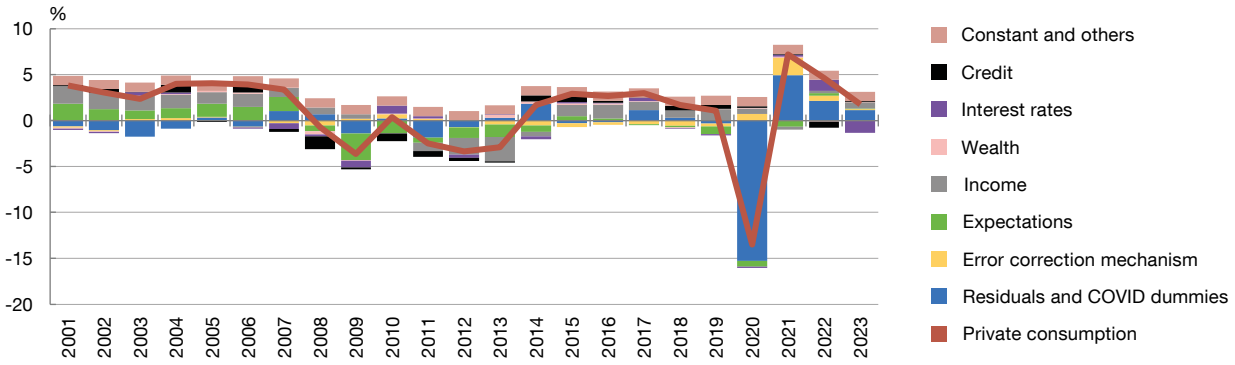
- Private consumption: the model attributes the rapid growth observed from 2001 to 2007 to high income growth and positive expectations, with credit growth contributing also in the latter part of that period. The subsequent decline in consumption is primarily attributed to credit factors in 2008 and to a significant shift in expectations in 2009, while the double dip experienced between 2011 and 2013 is linked to a sharp reduction in real disposable income. The recovery starting from 2014 is characterized by positive contributions from wealth, credit, and later income. Despite observing a relatively dynamic growth rate for several years, the error correction mechanism indicates a negative contribution from 2014 to 2019, suggesting that consumption levels remained below those predicted by the long-run model equation. The marked decline at the onset of the pandemic is captured by dummy variables included in the estimation,

12 In the case of expectations, this implies that the variables used here are the observed ones, i.e. their medium term forecasts made by Banco de España at each point in time.

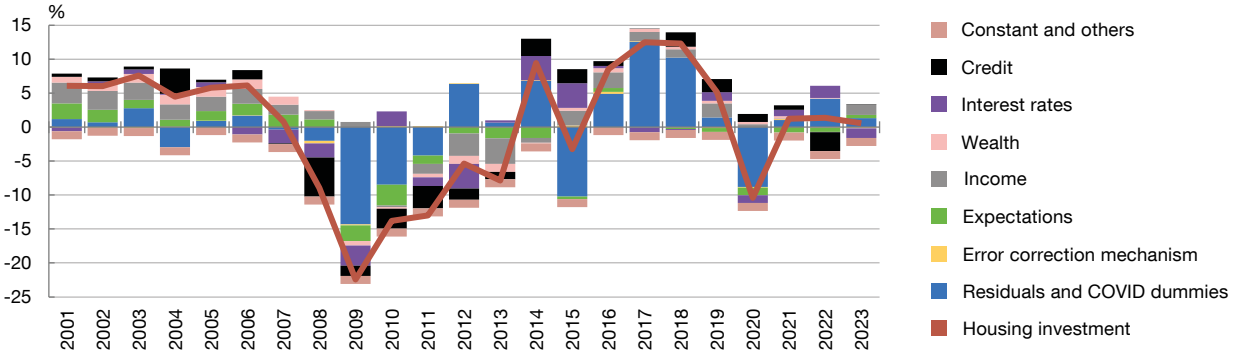
Chart 1

Contributions to the evolution of the main variables in the model

1.a Private consumption



1.b Housing investment



SOURCES: MTBE using data that comes mostly from the Quarterly National Accounts, produced by National Statistics Institute (INE, Instituto Nacional de Estadística).

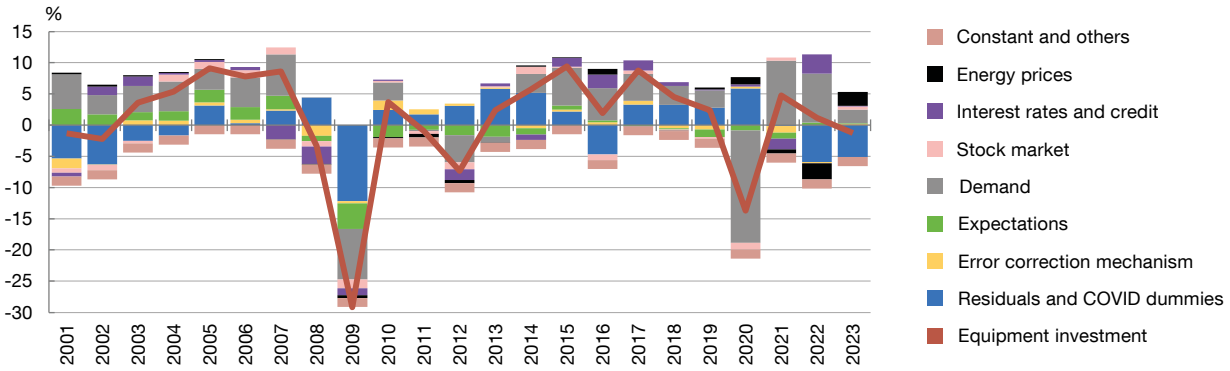
whose contributions are shown along with those of the residuals. Lastly, the recovery from 2021 to 2023 is partially explained by the error correction mechanism (indicating a return towards long-run consumption levels), but predominantly driven by residuals, which, although sizeable, cumulatively have a smaller contribution compared to the substantial negative impact observed in 2020.

- Housing investment: similarly to consumption, housing investment saw a boom from 2001 to 2007, which the model interprets as driven by income, wealth, expectations, and credit. Interest rates began contributing negatively in 2006, with credit reversing sharply in 2008. From 2009 to 2013, all these factors contributed negatively, but nevertheless large residuals were required to explain the decline. Recovery started in 2014 due to improved financial conditions, followed by income. Unlike the earlier boom, expectations and wealth had moderate contributions from 2014 to 2019. The fall in 2020 was mainly due to

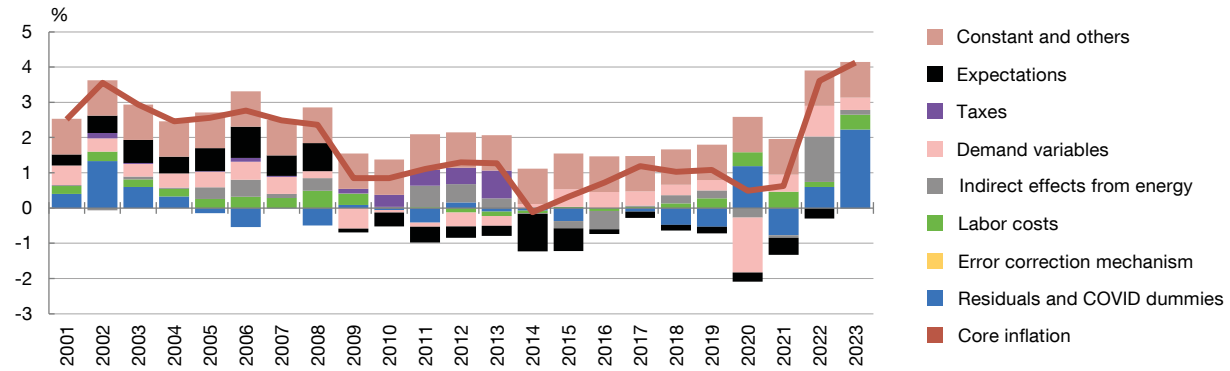
Chart 1

Contributions to the evolution of the main variables in the model (cont'd)

1.c Equipment investment



1.d Core inflation



SOURCES: MTBE using data that comes mostly from the Quarterly National Accounts, produced by INE.

the effects of the pandemic[13]. Since 2021, various factors have neutralized each other, leading to a lack of dynamism.

- Equipment investment: throughout the period, the model has seen equipment investment as primarily driven by demand, followed by expectations, and various financial factors such as interest rates, credit, and stock prices. Although the model's coefficients remain constant for the entire sample, energy prices have only played a significant role since 2020.

- Core inflation: this variable from 2001 to 2007 was driven by demand, labor costs, and expectations. From 2008 to 2013, demand and expectations had

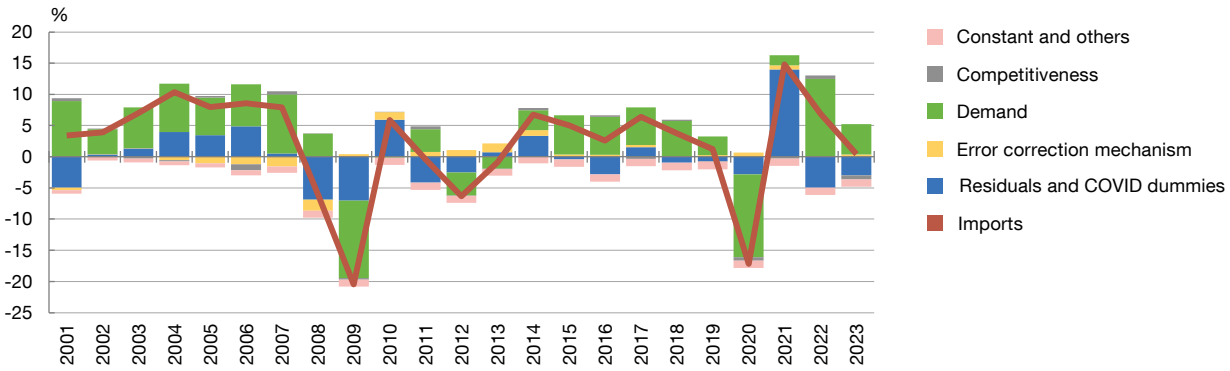
13 The effect of the pandemic dummies is always presented in these charts together with the residuals. Including these dummies in the estimation helps prevent this specific episode from dominating the estimation and biasing the estimation of the coefficients, as it contains such a big part of the observed variance of most variables. But in terms of explaining the evolution of the economy, it is treated as an unexplained exogenous shock and presented as part of the residuals.

Chart 1

Contributions to the evolution of the main variables in the model (cont'd)

1.e Exports

1.f Imports



SOURCES: MTBE using data that comes mostly from the Quarterly National Accounts, produced by INE.

negative contributions, while the ones from labor costs were minimal. Temporary factors like tax increases and energy effects boosted inflation during these years, but when these factors diminished in 2014, core inflation declined further. After this, expectations had consistently negative contributions until 2022. The 2022-2023 inflation spike stemmed from energy shock effects and residual factors like trade bottlenecks and high energy pass-through.

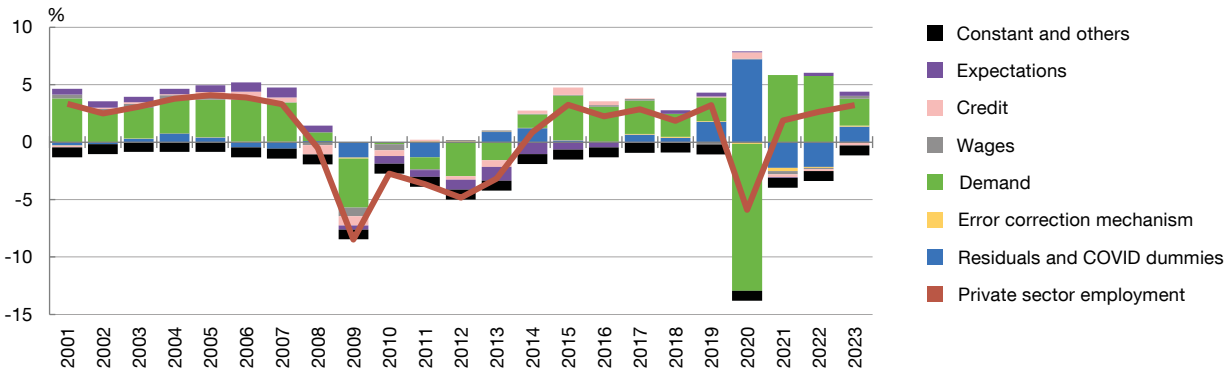
- Exports and imports: they are primarily demand-driven, as was the case in previous versions of MTBE. Competitiveness has a small but notable impact, especially on exports, with consistently negative contributions from 2001 to 2009, a strong recovery in 2010-2012, and a dip and rebound again in 2020 and 2021-2022. Residuals in all these variables are large and hard to predict due to the high variance.

- Employment: it remains driven primarily by firm demand (i.e., output growth), as in MTBE-2017. Credit and expectations influenced employment cycles from

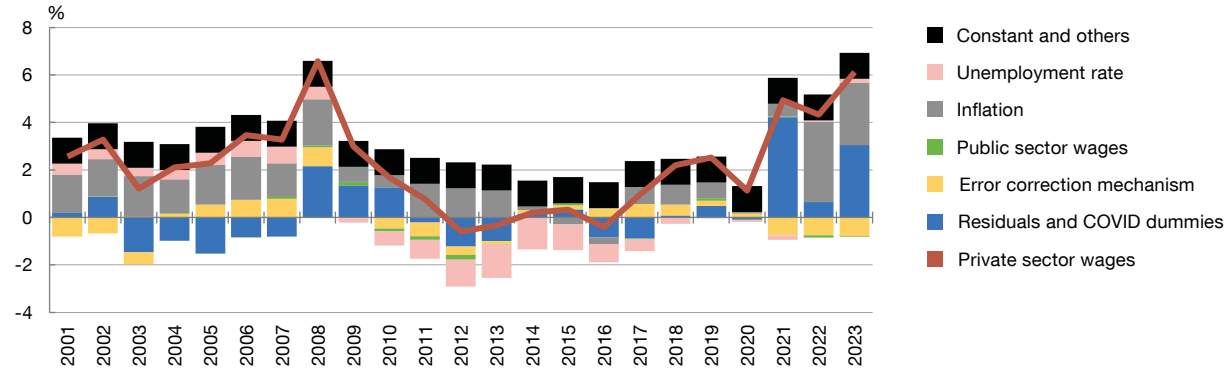
Chart 1

Contributions to the evolution of the main variables in the model (cont'd)

1.g Private sector employment



1.h Private sector wages



SOURCES: MTBE using data that comes mostly from the Quarterly National Accounts, produced by INE.

2001 to 2015. Wages had a small negative contribution in 2008-2011 and 2021-2022, suggesting nominal rigidities may affect wage response to output shocks. Since 2019, residuals have increased, indicating challenges in predicting the evolution of employment based on macroeconomic factors.

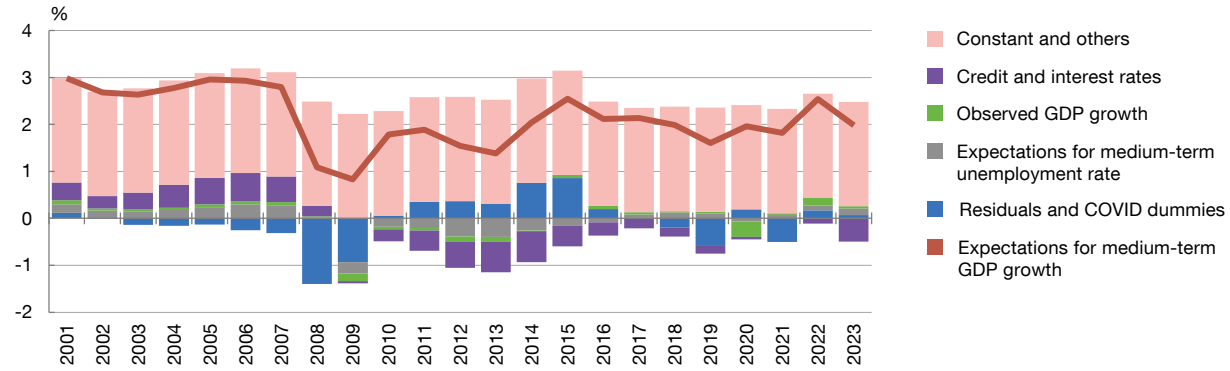
- Wages: according to MTBE, inflation and unemployment are the primarily drivers of wage cycles. While mirroring effects from public sector wages show an influence in certain periods, their overall impact is minor. Residuals are significant, especially during major cyclical events, due to factors like wage drift, which are not easy to introduce in an aggregate model such as MTBE.

- GDP Growth Expectations: this variable represents the projected GDP growth rate by Banco de España at the 2-years forecasting horizon, elaborated at the time shown by the horizontal axis in the corresponding panel of chart 1 (see below: e.g. forecast for 2018 made in 2016 appears with an x label of 2016). Due to low variance, the constant dominates the graph. The contribution from current

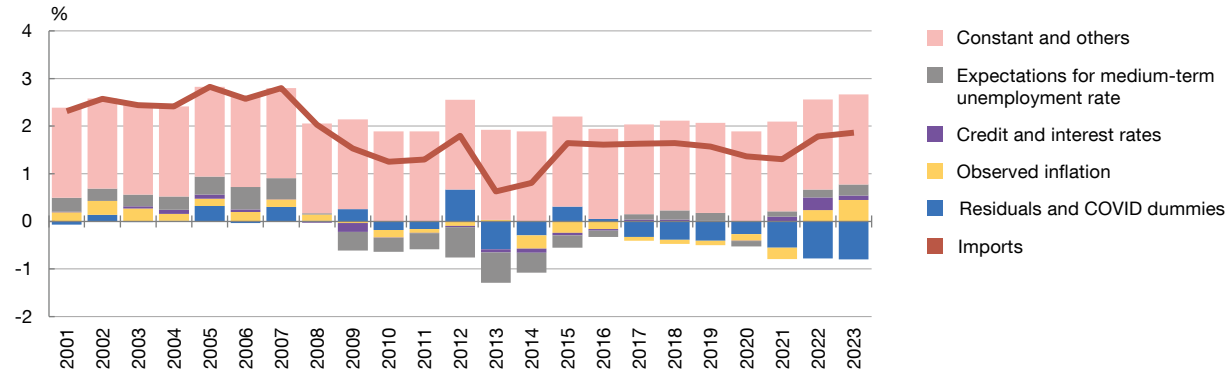
Chart 1

Contributions to the evolution of the main variables in the model (cont'd)

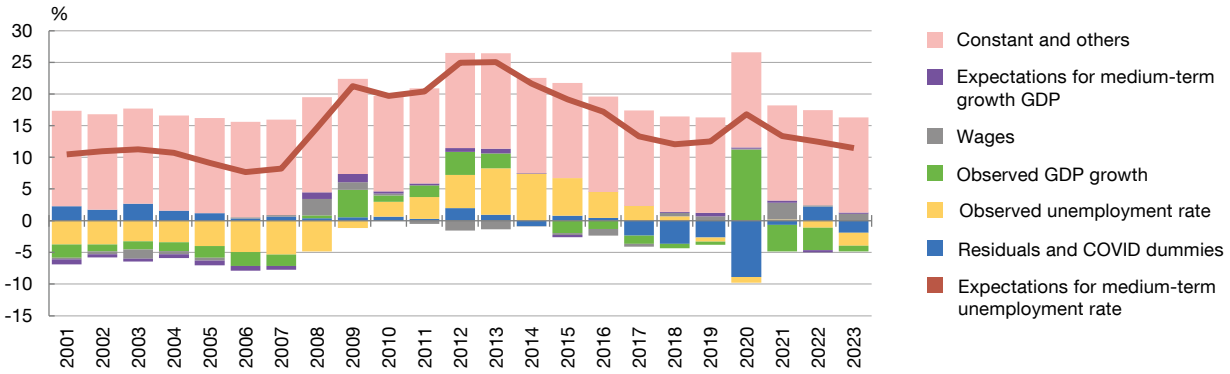
1.i Expectations for medium-term GDP growth



1.j Expectations for medium-term inflation



1.k Expectations for medium-term unemployment rate



SOURCES: Banco de España and MTBE using data that comes mostly from the Quarterly National Accounts, produced by National Statistics Institute (INE, Instituto Nacional de Estadística).

GDP growth is relatively small, and cyclical deviations are mostly explained by financial factors like credit and interest rates.

- Inflation expectations: these expectations are largely driven by other expectation variables and observed inflation, with financial factors like credit and interest rates playing a lesser role compared to GDP growth expectations.

- Unemployment rate expectations: these expectations show a significant impact due to its slow change. The observed rate plays a larger role here than in other variables. Current GDP growth adds a drift to the observed rate, lowering future expectations (e.g., in 2015-2016, high observed unemployment was countered by GDP recovery). Wages have a notable effect on unemployment expectations, influencing employment through this intermediate effect.

4.2 Simulations

Constructing alternative scenarios and running policy simulations are some of the most important uses of MTBE. For that purpose, one variable (or a small set of them) is assumed to deviate from its baseline evolution, and the model calculates the reaction of all other macroeconomic variables, taking into account all general equilibrium effects. The results are then defined in terms of deviations from a given baseline evolution of the economy.

The model is mainly demand-driven, especially in the short run, which limits its ability to accurately capture the dynamics of supply shocks. This fact remains in this version of the model even though the introduction of expectation channels allows supply-side effects to be featured to some extent. This happens directly if an estimated elasticity makes it possible; e.g. the fact that there is a term for wages in the equation for GDP growth expectations can allow the model to include the supply-side effects of structural reforms in the labor market. And it can also happen indirectly: if we want to simulate the effects of supply-side measures aimed at improving productivity and competitiveness, an estimate of its long-run effects can be obtained outside the model, and plugged into the expectations equations in order to get the short-run dynamics that would be consistent with those long-run effects, according to MTBE. But even with these advancements and new capabilities, in most simulations, demand is still the main channel through which shocks are propagated to the economy. For instance, in case of contractionary shocks, lower demand induces firms to reduce equipment investment and market-sector employment, so household income falls and this affects private consumption and housing investment too; higher unemployment pushes wages down, and both slower growth and falling unit labour costs reduce inflation; the external sector shows a positive contribution to growth mainly because the fall in demand reduces imports (the effect of improved competitiveness in exports and imports is also present but is relatively small, unless the original trigger is a price shock). Additionally, there is a credit channel in the model, which works as an amplifier for this demand channel: lower activity reduces credit, and this in turn affects private consumption, equipment investment, and housing investment. The feedback loop operating through expectations tends to amplify these effects as well, though in this case results will depend on the combination of effects on expectations of GDP growth, inflation and the unemployment rate.

This section presents the results from shocks to interest rates, world demand, competitiveness, oil and housing prices, the stock exchange, a wide variety of fiscal instruments, and prices and wages. In most of these simulations the transmission channel works with an initial response by a limited set of variables, and once this response is

translated into a change in demand, it spreads to the rest of the model following the demand channel described above.

Notice that, for certain types of shocks, model-consistent expectations cannot be imposed with the current version of MTBE, as they would make the model unstable[14]. The subsections below will detail what specification of expectations (backward-looking vs model-consistent) is used in each case, and discuss the differences in the responses under both specifications where appropriate.

4.2.1 Interest rate shocks

The possibility of simulating monetary policy shocks including forward-looking effects is the main reason why the model-consistent expectations specification was introduced into MTBE v2025. Table 8 presents results for simulations of short- and long-term interest rates (+1 pp), both under adaptive and model-consistent expectations.

Households react directly to three different interest rates in MTBE: housing investment depends on the average interest rate on loans to households for housing purchases, and private consumption responds to the average interest rate on other bank loans to households (capturing the effect of interest rates of new credit) and also to short term interest rates (capturing the effect stemming from pre-existing variable-rate loans). The long-run equation for equipment investment by firms depends on the long-term interest rate (the one for 10-year Spanish public debt), whereas the short-term equation depends on the average interest rate on loans of less than one million euros to non-financial corporations. Additionally, these three macroeconomic variables also depend on the quantity of credit.

The financial channels are completed by including transfer equations that describe how bank lending rates react to changes in reference short-term and long-term interest rates (the 3-month Euribor and the interest rate for 10-year Spanish government bonds, respectively), and also equations that capture the effect of financial and macroeconomic conditions on credit flows. Additionally, there's a direct expectation channel triggered by the coefficients of interest rates in the equations for the expectations of GDP growth and inflation.

All of these direct effects generate an initial response by consumption and investment, which triggers the usual demand channel in the model.

As would be expected in the Spanish economy, where most credit is tied to short-term rates, the simulated response of GDP and inflation is bigger when there is a change in short-term rates than when the same shock affects long-term rates. Private productive investment is the variable that shows the biggest response, followed by housing investment, and private consumption. The procyclical response of imports mitigates these effects.

14 The necessary restrictions to avoid explosive behaviour in a model of this size are not simple and have not been imposed in MTBE v2025.

Table 8

Simulations: shocks to interest rates

With adaptive expectations

	Short-term interest rates, +1pp				Long-term interest rates, +1pp				Short and long-term rates, +1pp			
% deviations from baseline levels	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	-0.2	-0.4	-0.5	-0.5	0.0	-0.1	-0.1	-0.2	-0.2	-0.5	-0.6	-0.7
Private consumption	-0.3	-0.7	-0.8	-1.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.7	-1.0	-1.1
Private productive investment	-0.8	-1.9	-2.1	-2.2	-0.2	-0.8	-1.2	-1.3	-1.0	-2.7	-3.3	-3.5
Housing investment	-0.2	-0.7	-1.1	-1.5	-0.1	-0.2	-0.3	-0.5	-0.3	-0.9	-1.4	-2.0
Exports (goods and services)	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
Imports (goods and services)	-0.1	-0.5	-0.7	-0.7	0.0	-0.1	-0.2	-0.2	-0.1	-0.6	-0.9	-1.0
HICPX	0.0	-0.1	-0.2	-0.3	0.0	0.0	-0.1	-0.1	0.0	-0.2	-0.3	-0.4
HICP	0.0	-0.1	-0.2	-0.4	0.0	0.0	-0.1	-0.1	0.0	-0.2	-0.3	-0.4
Compensation per employee	0.0	-0.1	-0.1	-0.2	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2
Total employment	-0.2	-0.4	-0.5	-0.6	0.0	-0.1	-0.2	-0.2	-0.2	-0.5	-0.7	-0.8
External balance (% of GDP, differences)	0.1	0.3	0.4	0.5	0.1	0.2	0.3	0.3	0.1	0.4	0.7	0.8
Public balance (% of GDP, differences)	-0.1	-0.3	-0.4	-0.6	-0.1	-0.2	-0.4	-0.4	-0.2	-0.6	-0.8	-1.0

With consistent expectations

	Short-term interest rates, +1pp				Long-term interest rates, +1pp				Short and long-term rates, +1pp			
% deviations from baseline levels	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	-0.3	-0.6	-0.7	-0.8	-0.1	-0.1	-0.2	-0.2	-0.4	-0.8	-0.9	-1.0
Private consumption	-0.5	-1.0	-1.4	-1.6	-0.1	-0.2	-0.2	-0.3	-0.5	-1.2	-1.6	-1.8
Private productive investment	-1.2	-2.6	-3.0	-3.2	-0.3	-1.0	-1.3	-1.4	-1.5	-3.5	-4.3	-4.6
Housing investment	-0.3	-1.0	-1.8	-2.5	-0.1	-0.3	-0.5	-0.6	-0.4	-1.3	-2.3	-3.2
Exports (goods and services)	0.0	0.1	0.3	0.4	0.0	0.0	0.1	0.1	0.0	0.2	0.4	0.5
Imports (goods and services)	-0.2	-0.7	-1.0	-1.1	0.0	-0.2	-0.2	-0.3	-0.2	-0.9	-1.3	-1.4
HICPX	-0.1	-0.3	-0.5	-0.8	0.0	-0.1	-0.1	-0.2	-0.1	-0.4	-0.7	-0.9
HICP	-0.1	-0.3	-0.6	-0.8	0.0	-0.1	-0.1	-0.2	-0.1	-0.4	-0.7	-1.0
Compensation per employee	0.0	-0.1	-0.3	-0.4	0.0	0.0	-0.1	-0.1	0.0	-0.1	-0.3	-0.5
Total employment	-0.3	-0.7	-0.9	-1.0	-0.1	-0.2	-0.2	-0.3	-0.4	-0.8	-1.1	-1.3
Net lending or borrowing (% of GDP, diffe	0.1	0.4	0.6	0.7	0.1	0.2	0.3	0.4	0.2	0.6	0.9	1.1
Balance (% of GDP, differences)	-0.2	-0.5	-0.7	-0.9	-0.1	-0.3	-0.4	-0.5	-0.3	-0.8	-1.1	-1.4

SOURCE: MTBE v2025.

When expectations are adaptive (i.e. they follow their respective backward-looking estimated equations), the effect of interest rates on prices is slow and muted, giving rise to a very adverse sacrifice ratio (between three and four points of output lost for every point of reduction of prices achieved, after two years). As shown by Ghirelli, Santabárbara and Pérez (2024), the observed evolution of the main macroeconomic variables during the latest monetary tightening episode was consistent with sacrifice ratios that were smaller than those implicit in ECB/Eurosystem macroeconomic projections, which are based to a large extent on models such as MTBE. Incorporating expectations into MTBE allows us to use model-consistent expectations, which generates a slightly bigger response of output, and, more importantly, a stronger and faster effect on prices, implying a less adverse sacrifice ratio

(between 1.8 and 2.0 points of output lost for every point of reduction of prices achieved, after two years). Because of this, model-consistent expectations seem particularly important for simulating monetary policy shocks, as it brings the sacrifice ratio in the simulations closer to the one implied by the data.

4.2.2 Other financial shocks

Thanks to the wide variety of financial variables that have been included in MTBE over the years, the model can run simulations for other types of financial shocks, or for combinations of them that can generate responses with specific characteristics. For example, in the simulations of interest rate shocks described in the previous subsection, credit endogenously responds, and this explains part of the response of investment, consumption, etc.; but in specific circumstances we may want to run simulations of changes in credit that are not caused by movements in interest rates (e.g. when a deleveraging process is set in motion); or we may want to simulate changes in interest rates with a bigger-than-normal or smaller-than-normal response of credit (e.g. to decompose the response of investment into the part that would happen only if credit can endogenously react, and the part that would happen even if credit is restricted and doesn't change after the shock to interest rates). A simulation in which credit is shocked but interest rates don't change can be rescaled and combined with other simulations to create this type of scenarios.

Table 9 shows the results of simulating this type of financial shocks using MTBE. According to the model, an increase in the stock of credit that is not accompanied by a reduction in interest rates generates an expansion in the economy that is slightly different in

Table 9
Simulations: shocks to other financial variables

With adaptive expectations

	Credit, +1%				Stock market prices, +10%				House prices, +10%			
% deviations from baseline levels	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Private consumption	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3
Private productive investment	0.5	0.4	0.4	0.3	0.4	0.5	0.4	0.4	0.1	0.3	0.4	0.4
Housing investment	0.8	0.6	0.4	0.4	0.1	0.2	0.2	0.2	0.6	1.2	1.2	1.3
Exports (goods and services)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
Imports (goods and services)	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.2	0.2
HICPX	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
HICP	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Compensation per employee	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total employment	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
External balance (% of GDP, differences)	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2
Public balance (% of GDP, differences)	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3

SOURCE: MTBE v2025.

two ways: first, the variable showing the biggest effect is, in this case, housing investment; and second, the shock is more short-lived, with the effect dying out after just one year[15].

Regarding asset price shocks, stock market shocks have a greater impact on private investment, while house price shocks have a stronger effect on housing investment. In terms of the size of the effect, the impact of stock market price shocks in MTBE-v2025 is comparable to that in earlier model versions. However, the effect of house price shocks has diminished over time: it is smaller in MTBE-v2025 than it was in MTBE-v2017, which itself showed a reduction compared to MTBE-v2014.

4.2.3 Shocks to prices and wages

Table 10 shows that an internal inflationary shock generates contractionary effects in MTBE. The decline in competitiveness reduces exports, but this effect is relatively small compared with internal channels, which appear as the reduced disposable income in real terms makes households cut their consumption and housing investment, triggering the demand channel that then also reduces private productive investment, and employment.

An increase in wages reduces employment but the negative effect on output is relatively mild, resulting from a combination of a very small positive effect on consumption and a negative response by private productive investment (an aggregate of much smaller size). A key factor in this result is the very small (estimated) effect of wages on prices. If the shock to wages were to affect prices to a higher degree (as could happen e.g. in the case of a particularly big shock), then the contractionary effect of the combined wage and price increase would be bigger[16]. This result -that the estimated effect of wages on prices is small but an eventual bigger response would generate negative effects- is common to the previous versions of the model, and has been used by Banco de España to emphasize that positive real effects are found when wage moderation is coupled with price moderation[17].

In terms of international price shocks, the inclusion of more detail in the energy block of MTBE now allows for different simulations that assess the effects of oil prices, gas prices, and ETS prices for emissions. The channels through which these shocks affect the economy are similar, so the differences between the three simulations come from the size of their effect on overall prices (which determines the size of the initial reduction of real disposable income) and also on electricity prices (which, beyond their share on overall prices, have an additional effect in the equation for private productive investment). The effect of energy prices on the Spanish economy is bigger in MTBE-v2025 than in previous versions of the model, in line with the results from other estimations that have found particularly high effects for recent shocks[18].

15 That is the case if the increase in credit is a permanent level shift (as simulated here) and not a permanent increase in the rate of growth of credit (that would be: an infinite sum of consecutive level shifts).

16 The model is approximately linear, so this third simulation is approximately a linear combination of the previous two.

17 See, for example, the recommendations found in Box 1.3 of Banco de España Annual Report 2011, which, as explained there, are based on analogous simulations carried out with the version of MTBE available then.

18 See González-Mínguez et al. (2023).

Table 10

Simulations: shocks to prices and wages

With adaptive expectations

	Internal prices, +1%				Private-sector wages, +1%				Prices and wages, +1%			
% deviations from baseline levels	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	-0.3	-0.4	-0.5	-0.5	-0.03	0.00	-0.01	-0.01	-0.4	-0.4	-0.5	-0.5
Private consumption	-0.5	-0.9	-0.9	-1.0	0.03	0.03	0.02	0.02	-0.5	-0.8	-0.8	-0.9
Private productive investment	-1.1	-1.6	-1.7	-1.8	-0.2	-0.1	-0.1	-0.1	-1.3	-1.6	-1.8	-2.0
Housing investment	-1.1	-1.6	-1.5	-1.6	0.1	0.0	-0.1	-0.1	-1.0	-1.5	-1.5	-1.8
Exports (goods and services)	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.2	-0.2	-0.1	-0.1
Imports (goods and services)	-0.2	-0.7	-0.7	-0.7	-0.1	-0.1	-0.1	0.0	-0.3	-0.8	-0.7	-0.8
HICPX	1.0	1.1	1.1	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0
HICP	1.0	1.1	1.1	1.1	0.0	0.0	0.0	0.0	1.0	1.1	1.1	1.1
Compensation per employee	0.3	0.5	0.5	0.5	0.6	0.5	0.3	0.2	1.0	1.1	1.0	1.0
Total employment	-0.3	-0.5	-0.5	-0.6	-0.1	-0.2	-0.1	-0.1	-0.4	-0.7	-0.7	-0.8
External balance (% of GDP, differences)	0.0	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.3
Public balance (% of GDP, differences)	0.1	-0.1	-0.1	-0.1	0.1	0.1	0.0	0.0	0.2	0.0	0.0	-0.1

	Oil prices, +10%				Natural gas prices, +10%				Price of emissions (ETS), +10%			
% deviations from baseline levels	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	-0.1	-0.3	-0.4	-0.5	0.0	-0.1	-0.1	-0.1	-0.01	-0.02	-0.03	-0.03
Private consumption	-0.1	-0.4	-0.5	-0.5	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
Private productive investment	-0.2	-0.7	-0.9	-1.1	-0.1	-0.3	-0.3	-0.3	0.0	-0.1	-0.1	-0.1
Housing investment	-0.3	-0.7	-0.8	-0.9	-0.1	-0.2	-0.2	-0.2	0.0	0.0	0.0	-0.1
Exports (goods and services)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Imports (goods and services)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HICPX	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HICP	0.3	0.4	0.4	0.3	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Compensation per employee	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total employment	-0.1	-0.3	-0.4	-0.5	0.0	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
Net lending or borrowing (% of GDP, diffe	-0.3	-0.3	-0.3	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Balance (% of GDP, differences)	0.0	-0.1	-0.2	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOURCE: MTBE v2025.

4.2.4 External shocks

As seen in Table 11, an increase in world demand makes exports grow, and this triggers the demand channel described previously. Because internal demand grows and this drives up imports, in the end the accounting distribution of the effect on GDP is more balanced than could be initially expected, with a positive net contribution from the external sector (exports minus imports) but also a sizeable positive contribution from internal demand (coming from consumption and investment); in fact, from the second year onwards, the contribution of internal demand to GDP growth becomes bigger than that of the external sector, which is interesting to see as a response to a shock that originated in the rest of the world.

Table 11
Simulations: external shocks

With adaptive expectations	External demand, +1%				Exchange rate depreciation, +10%				Depreciation without oil channel, +10%			
% deviations from baseline levels	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	0.2	0.2	0.2	0.3	0.5	0.1	0.0	-0.2	0.8	0.6	0.6	0.5
Private consumption	0.0	0.1	0.1	0.1	-0.1	-0.2	-0.4	-0.4	0.1	0.3	0.2	0.3
Private productive investment	0.6	0.5	0.6	0.6	0.8	-0.1	-0.4	-0.7	1.3	1.1	1.0	0.9
Housing investment	0.0	0.2	0.3	0.3	-0.3	-0.3	-0.4	-0.5	0.1	0.5	0.7	0.7
Exports (goods and services)	0.8	0.9	0.8	0.8	2.4	2.2	1.9	1.7	2.2	2.3	2.1	1.9
Imports (goods and services)	0.4	0.8	0.7	0.7	1.2	1.7	1.4	1.4	0.9	1.7	1.5	1.5
HICPX	0.0	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.1	0.2	0.3	0.3
HICP	0.0	0.1	0.1	0.1	0.4	0.6	0.7	0.6	0.1	0.2	0.3	0.3
Compensation per employee	0.0	0.0	0.1	0.1	0.1	0.3	0.3	0.3	0.0	0.1	0.2	0.2
Total employment	0.2	0.2	0.2	0.3	0.5	0.1	0.0	-0.1	0.6	0.6	0.6	0.6
External balance (% of GDP, diff.)	0.1	0.1	0.1	0.1	-0.3	-0.4	-0.4	-0.5	0.1	0.1	0.0	-0.1
Public balance (% of GDP, diff.)	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.3	0.4	0.4	0.4

SOURCE: MTBE v2025.

The effect of a depreciation of the euro on aggregate exports is sizeable, but the associated increase in inflation makes consumption and investment fall, so the total effect on output is positive but relatively small. Much of this inflationary effect is mediated through oil prices: if the simulation is of a depreciation of the euro but keeping constant the price of oil in euros per barrel (i.e. a depreciation without oil channel), the effect on consumption and investment becomes positive, and aggregate output shows a much bigger response.

4.2.5 Fiscal shocks

Similarly to previous versions of the model, MTBE v2025 can simulate a wide variety of fiscal shocks, including multiple types of taxes, transfers and expenditures. Table 12 presents a selection of them, whereas Table 13 shows less information (only the ex-ante and ex-post fiscal multipliers[19]) for a wider range of shocks.

The first three are different ways in which the public sector can increase public consumption: through increased purchases of intermediate goods (a real shock where demand to the private sector is directly affected), through higher wages (a nominal shock that affects the deflator and influences real variables only through indirect channels), or through more public employment (a real shock mediated through public production of goods and

19 The ex-ante multiplier is the increase in GDP after a fiscal expansion measure of size 1 pp of GDP, which will typically lead to an increase of public deficit smaller than 1 pp of GDP, as the response of economic activity generates higher public revenues and reduces some expenditures such as unemployment subsidies, partially offsetting the direct effect on the public deficit. The ex-post multiplier is the increase in GDP after a fiscal expansion measure of whatever size is required in order to increase the public deficit by 1pp as a percentage of GDP.

Table 12
Simulations: fiscal shocks

Permanent shocks with adaptive expectations. Size of all shocks is +1% of GDP in exante terms.

% deviations from baseline levels	Public consumption: intermediates				Public consumption: wages				Public consumption: employment			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	1.0	0.9	1.0	1.0	0.2	0.4	0.4	0.5	1.0	1.2	1.3	1.4
Private consumption	0.2	0.5	0.6	0.7	0.3	0.8	1.0	1.1	0.4	1.0	1.3	1.5
Private productive investment	1.7	1.8	1.9	2.1	0.3	0.6	0.7	0.8	1.1	1.5	1.7	2.0
Housing investment	0.2	0.9	1.2	1.5	0.5	1.1	1.4	1.5	0.6	2.0	2.6	3.1
Exports (goods and services)	0.0	-0.1	-0.2	-0.3	-0.1	-0.2	-0.2	-0.3	0.0	-0.1	-0.2	-0.4
Imports (goods and services)	0.8	1.4	1.4	1.4	0.1	0.4	0.5	0.6	0.8	1.7	1.8	1.9
HICPX	0.1	0.3	0.3	0.4	0.0	0.1	0.2	0.2	0.0	0.2	0.3	0.5
HICP	0.2	0.3	0.4	0.4	0.0	0.1	0.2	0.2	0.0	0.2	0.3	0.5
Compensation per employee	0.0	0.1	0.2	0.3	2.4	2.7	3.0	3.2	0.3	0.4	0.6	0.7
Total employment	0.8	0.9	1.0	1.1	0.1	0.2	0.2	0.2	1.7	1.9	2.2	2.4
External balance (% of GDP, differences)	-0.3	-0.6	-0.6	-0.6	-0.1	-0.2	-0.3	-0.4	-0.3	-0.7	-0.8	-0.9
Public balance (% of GDP, differences)	-0.6	-0.5	-0.5	-0.4	-0.4	-0.3	-0.2	-0.1	-0.4	-0.2	-0.1	0.1

% deviations from baseline levels	Public investment				Direct taxes to households				Indirect taxes (VAT)			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	1.1	1.2	1.5	1.7	-0.3	-0.7	-0.8	-1.0	-0.5	-0.7	-0.7	-0.8
Private consumption	0.4	1.1	1.5	1.9	-0.5	-1.4	-1.8	-2.0	-0.5	-1.2	-1.3	-1.4
Private productive investment	1.4	2.3	3.1	3.7	-0.6	-1.4	-1.7	-2.0	-2.1	-2.9	-2.9	-2.9
Housing investment	0.3	1.4	2.4	3.3	-0.8	-2.0	-2.6	-3.0	-1.1	-2.2	-2.1	-2.3
Exports (goods and services)	0.0	-0.2	-0.3	-0.4	0.0	0.0	0.1	0.2	0.0	0.0	0.1	0.2
Imports (goods and services)	0.9	1.7	2.0	2.3	-0.2	-0.9	-1.2	-1.4	-0.3	-1.0	-1.0	-1.0
HICPX	0.2	0.3	0.5	0.7	0.0	-0.2	-0.2	-0.3	0.8	1.0	1.0	0.9
HICP	0.2	0.3	0.5	0.7	0.0	-0.2	-0.2	-0.3	1.0	1.3	1.2	1.2
Compensation per employee	0.0	0.2	0.3	0.4	0.0	-0.1	-0.1	-0.2	0.2	0.5	0.5	0.5
Total employment	0.9	1.2	1.5	1.8	-0.3	-0.7	-0.8	-1.0	-0.4	-0.7	-0.8	-0.9
Net lending or borrowing (% of GDP, differences)	-0.3	-0.7	-0.9	-1.0	0.1	0.3	0.5	0.5	0.1	0.3	0.4	0.4
Balance (% of GDP, differences)	-0.5	-0.3	-0.1	0.1	0.9	0.7	0.6	0.5	0.8	0.6	0.6	0.6

SOURCE: MTBE v2025.

services). The first one is the most common one when fiscal measures are simulated, and has a high but moderate fiscal multiplier of approximately one, in big part because the variable that is directly shocked (real public consumption) is itself part of GDP; the increase in demand generates higher investment and employment, and this incentivizes consumption, but imports also grow strongly, and higher inflation as per the model's Phillips curve also generates a moderate fall in exports. The increase in public wages also creates an increase in consumption and investment, but the overall effect on GDP is much smaller because the variable directly shocked is a deflator, so there is no mechanical direct effect on output. On the other end of the spectrum, when the increase in public consumption is through higher public employment, there's a direct accounting effect because a real variable is shocked, and also a big household-income effect that provides strong support for the response of

Table 13

Fiscal multipliers: Cost in points of GDP per percentage point of planned (ex-ante) or achieved (ex-post) fiscal consolidation

	Ex ante fiscal multipliers				Ex post fiscal multipliers			
Instrument	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
Public investment	1.1	1.2	1.5	1.7	2.0	4.0	18.4	inf
Public consumption (net purchases)	1.0	0.9	1.0	1.0	1.6	1.7	2.0	2.3
Public consumption (employment)	1.0	1.2	1.3	1.4	2.7	6.1	22.2	inf
Public consumption (wages)	0.2	0.4	0.4	0.5	0.4	1.5	2.3	3.5
Pensions	0.2	0.5	0.6	0.7	0.4	1.1	1.4	1.8
Transfers to households	0.3	0.6	0.7	0.8	0.4	1.1	1.5	1.9
Transfers to firms	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4
Direct taxes to households	0.3	0.7	0.8	1.0	0.4	1.1	1.3	1.8
Direct taxes to firms	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Indirect taxes	0.5	0.7	0.7	0.8	0.6	1.1	1.2	1.3
Social contributions	0.2	0.5	0.6	0.7	0.4	1.1	1.4	1.8
Average	0.5	0.7	0.7	0.8	0.7	1.3	1.6	2.0

SOURCE: MTBE v2025.

consumption and investment; because this increase in economic activity progressively improves tax revenues, the negative effect on the public balance can be temporary, which generates a very high ex-post fiscal multiplier in the medium term.

The shock to public investment also displays a very high fiscal multiplier, but in this case because of the strong response of private productive investment (and, again, because the real variable directly shocked is itself part of GDP).

An increase in direct taxes to households reduces their disposable income, which makes them cut their consumption and housing investment, triggering the model's usual demand channel. Similarly, through the increase of prices, indirect taxes also induce a reduction in real disposable income, that makes households reduce their consumption and housing investment and gets the model's demand channel in motion. While the real effects of these two measures are similar, in terms of inflation they completely diverge, as the increase in direct taxes to households becomes deflationary as a result of the model's Phillips curve; this demand channel is also at play in the case of indirect taxes, but it is dominated by the straightforward effect of those taxes on prices.

As can be seen in Table 13, the model predicts that the fiscal multiplier will vary greatly depending on which particular tax, transfer or expense is being shocked. Measures related to public investment, public employment and net purchases have strong short-term fiscal multipliers, because the item that is being reduced is, in accounting terms, part of GDP. It is not just an accounting effect, though, since these measures also have a relatively high cost in terms of employment. Other measures, like direct taxes to households, social contributions and benefits, have almost no direct impact, but their

effect on output and employment increases as agents react to the reduction in their disposable income. On average, the model predicts an ex-ante fiscal multiplier of around 0.7 after two or three years.

4.2.6 The role of expectations in the simulations

Apart from the interest rate shocks, all simulations presented so far in this section have been carried out under adaptive expectations, which are more stable and provide adequate results for most types of shocks. In Table 14 we present the consistent-expectations results for a subset of these simulations, stressing how they change with respect to their counterparts with adaptive expectations.

Table 14
Some additional simulations with consistent expectations

With consistent expectations

% deviations from baseline levels	Stock market prices, +10%				House prices, +10%				Private-sector wages, +1%			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	0.1	0.2	0.2	0.2	0.2	0.3	0.4	0.4	-0.1	-0.1	-0.2	-0.3
Private consumption	0.1	0.2	0.3	0.4	0.2	0.5	0.7	0.8	0.0	-0.1	-0.3	-0.4
Private productive investment	0.5	0.7	0.8	0.8	0.4	0.7	1.0	1.2	-0.3	-0.5	-0.7	-0.9
Housing investment	0.1	0.3	0.5	0.7	0.6	1.4	1.7	2.1	0.0	-0.2	-0.5	-0.7
Exports (goods and services)	0.0	0.0	-0.1	-0.1	0.0	-0.1	-0.2	-0.3	-0.1	-0.2	-0.1	-0.1
Imports (goods and services)	0.1	0.2	0.2	0.3	0.1	0.3	0.4	0.5	-0.1	-0.2	-0.3	-0.4
HICPX	0.0	0.1	0.1	0.2	0.1	0.2	0.3	0.4	0.1	0.1	0.1	0.1
HICP	0.0	0.1	0.1	0.2	0.1	0.2	0.3	0.4	0.1	0.1	0.1	0.1
Compensation per employee	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.6	0.5	0.4	0.3
Total employment	0.1	0.2	0.2	0.3	0.2	0.4	0.5	0.6	-0.1	-0.2	-0.3	-0.3
External balance (% of GDP, differences)	0.0	-0.1	-0.1	-0.1	0.0	-0.2	-0.3	-0.3	0.0	0.0	0.1	0.1
Public balance (% of GDP, differences)	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.1	0.0	0.0	-0.1

% deviations from baseline levels	Public consumption: intermediates				Public investment				Direct taxes to households			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	1.6	2.2	2.7	3.1	1.5	2.0	2.5	2.8	-0.9	-1.8	-2.3	-2.8
Private consumption	1.1	2.7	4.0	4.9	1.0	2.5	3.6	4.4	-1.4	-3.4	-4.6	-5.6
Private productive investment	3.5	5.7	7.5	8.8	2.5	4.5	6.2	7.3	-2.1	-4.8	-6.5	-7.8
Housing investment	0.5	2.7	5.4	7.9	0.4	2.5	4.9	7.1	-1.1	-3.7	-6.2	-8.5
Exports (goods and services)	0.0	-0.4	-1.0	-1.5	0.0	-0.4	-0.9	-1.4	0.0	0.3	0.8	1.2
Imports (goods and services)	1.2	2.8	3.6	4.1	1.1	2.5	3.2	3.7	-0.5	-2.1	-3.0	-3.6
HICPX	0.4	1.1	1.9	2.6	0.4	1.1	1.8	2.5	-0.3	-1.0	-1.6	-2.2
HICP	0.4	1.2	2.0	2.8	0.4	1.1	1.8	2.6	-0.3	-1.0	-1.7	-2.3
Compensation per employee	0.1	0.4	0.9	1.3	0.1	0.4	0.8	1.3	0.0	-0.3	-0.7	-1.1
Total employment	1.4	2.2	3.0	3.7	1.3	2.1	2.8	3.3	-0.8	-1.9	-2.6	-3.2
Net lending or borrowing (% of GDP, differences)	-0.5	-1.2	-1.7	-2.1	-0.4	-1.1	-1.5	-1.9	0.2	0.9	1.4	1.8
Balance (% of GDP, differences)	-0.3	0.3	0.9	1.4	-0.3	0.3	0.8	1.4	0.6	-0.1	-0.6	-1.1

SOURCE: MTBE v2025.

The simulations for stock market prices and house prices display aggregate real effects that are approximately twice as big with model-consistent expectations than with adaptive expectations. This can be interpreted as implying that if the shocks that generate the revaluation of those assets can be expected to generate strong anticipation effects (as in the case of news shocks, or policy measures), the response of the economy could be found to be particularly fast and sizeable.

An increase in private sector wages, which has very moderate negative effects under adaptive expectations, becomes clearly contractionary under model-consistent expectations. The response of inflation to the wage shock also increases with the anticipation effects under model-consistent expectations. This shows how the traditional mechanisms in the model are mostly demand-driven (wages have a small competitiveness effect that is offset by the household income effect) and the simulation under model-consistent expectations enhances the supply-side channels in MTBE.

Effects are also increased for fiscal shocks, but in this case model-consistent expectations make fiscal multipliers close to the upper limit of the range of available empirical estimates, with ex-ante values that are close to 3. This highlights a challenge of this new model version: expert judgement is needed in order to assess which expectations specification is more adequate for different types of shocks. As explained before, the model is more stable under adaptive expectations, as some shocks can generate explosive behaviour under model-consistent expectations (given the assumed specification and estimated coefficients). But as we discussed also for the case of interest rate shocks, the results of the simulations can be more realistic under model-consistent expectations. Factors such as whether a specific shock is likely to generate strong anticipation effects, or empirical evidence that can provide guidance about the expected overall effects, can be used to determine which expectational setup is more adequate for a given simulation.

4.2.7 Shocks to expectations

A particularly useful aspect of MTBE v2025 is that it allows us to simulate shocks to expectations. Table 15 shows those simulations[20].

These results show that, while the model displays some degree of self-fulfilling-expectations behaviour, it is not enough to generate sunspot equilibria. Thus, increasing the expectations of future GDP growth by 1 pp only increases average GDP growth in the first four years by 0.9 pp. Likewise, increasing the expectations of future inflation by 1 pp only increases average inflation in the first four years by 0.8 pp. And increasing the expectations of the unemployment rate in the medium term by 1 pp increases the realized unemployment rate by only 0.4 pp after four years. This “smaller than one-to-one” response is a basic

20 These simulations run under adaptive expectations. Running them under model-consistent expectations would not be possible, as in that case expectations will only react to other shocks: under model-consistent expectations, if the shock has to start at the expectations, the only possible solution of the model is that agents expect that nothing will happen and indeed nothing happens.

Table 15
Simulations: shocks to expectations

% deviations from baseline levels	Higher GDP growth expectations, +1pp				Higher inflation expectations, +1pp				Higher unemployment expectations, +1pp			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
GDP	0.8	1.8	2.7	3.5	-0.1	-0.6	-1.0	-1.5	0.0	0.0	-0.1	-0.1
Private consumption	1.2	3.1	4.8	6.2	-0.1	-0.6	-1.3	-2.1	0.0	-0.1	-0.2	-0.2
Private productive investment	2.3	5.8	8.9	11.4	-0.3	-1.7	-3.3	-5.0	-0.1	-0.1	-0.2	-0.2
Housing investment	0.5	3.1	6.6	10.2	-0.3	-1.4	-2.5	-3.7	0.0	-0.1	-0.2	-0.4
Exports (goods and services)	0.0	-0.1	-0.3	-0.6	-0.1	-0.6	-1.2	-1.8	0.0	0.1	0.1	0.2
Imports (goods and services)	0.5	2.1	3.6	4.8	-0.1	-0.7	-1.6	-2.6	0.0	0.0	0.0	0.0
HICPX	0.1	0.4	0.8	1.3	0.3	1.2	2.1	3.0	0.0	-0.1	-0.2	-0.3
HICP	0.1	0.5	0.9	1.3	0.3	1.2	2.2	3.1	0.0	-0.1	-0.2	-0.3
Compensation per employee	0.0	0.2	0.4	0.8	0.1	0.3	0.7	1.1	0.0	0.0	-0.1	-0.1
Total employment	0.7	1.8	2.9	3.9	-0.1	-0.3	-0.7	-1.1	-0.1	-0.2	-0.3	-0.4
External balance (% of GDP, differences)	-0.2	-0.8	-1.4	-2.0	0.0	0.1	0.3	0.6	0.0	0.0	0.1	0.1
Public balance (% of GDP, differences)	0.4	1.1	1.7	2.3	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.1	-0.2

SOURCE: MTBE v2025.

requirement for a weak form of stability in the simulations, but it is not enough to ensure stability in all simulations, and indeed it is possible to find combinations of shocks for which this version of the model displays explosive behaviour (in practice, most simulations are stable).

An important use for these simulations is to complement others. For instance, when calculating the effects of a structural reform that permanently improves productivity (a shock for which previous versions of MTBE would be particularly badly suited, because of the very weak supply channels these models tend to display), now the simulation can be complemented with an additional shock to, say, expectations of GDP growth. The model does not provide a satisfactory way to generate that shock to expectations, but, if another tool can be used to quantify the effects of the structural reform on expectations, this version of MTBE can incorporate some of those expectational effects into the simulation[21].

Finally, these shocks to expectations can also help guide the model's forecasts. If we can obtain reliable estimates of potential output and medium-term inflation from other models or tools, we can feed them into MTBE v2025. This allows the forecast to start from the inertia of recent Spanish economic trends (as MTBE usually does) and then gradually converge toward the externally estimated medium-term growth and inflation rates. The decision to include only a few expectations variables in the model (unlike other models such as FRB/US, LENS, ECB-BASE, or FR/BdF, which use many) was driven by this approach. We

21 An example of this approach can be found in Aguilar et al. (2024), where a DSGE model is used to calculate the dynamic effect of non-standard monetary policy on output and inflation, and the resulting paths are then fed into MTBE v2025 through shocks to expectations; the simulations with MTBE then provide a more detailed set of results, which allows the authors to assess the effects on fiscal variables with a level of detail that the DSGE model would not provide.

can now focus on building models that provide these anchors for the forecast, concentrating on potential output, medium-term inflation, and the NAWRU. These future models that try to capture the medium-term behaviour of the Spanish economy won't need to include detailed future paths for components like consumption, equipment investment, housing investment, or exports, because MTBE v2025 will provide the detail for those variables based on expectations about future GDP growth.

5 Conclusion

This document presents the new version of the Quarterly Model of Banco de España, MTBE v2025. This version includes changes in the specification of some equations, and is estimated with a more up to date data sample (2000-2022 instead of 1995-2014).

The biggest specification change with respect to the previous version is the explicit inclusion of expectations: some of the main equations of the model (those describing the evolution of consumption, investment, employment, prices, wages, etc.) now include a term that captures the medium term expected behaviour for GDP growth, the unemployment rate, or the rate of inflation. The model also now includes equations describing how current observed variables affect these expectations about the future. This allows for anticipation effects, and also makes it possible to simulate shocks under different assumptions with respect to the behaviour of these expectations: the model can now run either with adaptive expectations (with a backwards-looking response that is estimated using observed data) or with model-consistent expectations (using an iterative algorithm to impose a forwards-looking response of expectations that coincides with what will actually happen in the simulation).

Beyond these changes in the specification, updating the estimation with more recent data, and in particular including part of the recovery after the 2020 pandemic shock, should allow the model to more closely represent the way in which the Spanish economy can be expected to respond to the different shocks that might be observed in the coming years. The updated model describes an economy that is fairly reactive to financial shocks, that is closely linked to external developments through commodity markets and international trade, where price and wage moderation can generate growth and employment, and where fiscal consolidation reduces public deficit and has negative but moderate effects on GDP.

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