ANALYSIS OF RECENT INFLATION DYNAMICS IN SPAIN. AN APPROACH BASED ON THE BLANCHARD AND BERNANKE (2023) MODEL

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Abstract

The recent inflationary episode is the result of a series of shocks that have taken place over a short period of time. In this article we use the Blanchard and Bernanke (2023) model as an analytical framework to assess the relative importance of different factors over the course of this episode. Two main conclusions can be drawn from our results. First, supply-side shocks (related to energy, food and bottlenecks) have played a major role in recent inflation developments in the Spanish economy. Second, now that these supply shocks have been absorbed, labour market tightness is becoming more important as a determinant of wage inflation, with a pass-through to prices that has been limited so far but that, if it intensifies, could generate risks with a higher degree of persistence.

Keywords: inflation, wages, inflation expectations, labour market.

JEL classification: E31, E32, J30.

Resumen

El reciente episodio inflacionista responde a la conjunción de varias perturbaciones cercanas en el tiempo. En este documento utilizamos el modelo de Blanchard y Bernanke (2023) como marco analítico para evaluar el peso relativo de los distintos factores explicativos en diferentes etapas de este episodio. De acuerdo con los resultados obtenidos, se pueden extraer dos conclusiones principales. En primer lugar, las perturbaciones por el lado de la oferta (energía, alimentos, cuellos de botella) han tenido un papel fundamental en la evolución reciente de la inflación en la economía española. En segundo lugar, una vez absorbidas las mencionadas perturbaciones de oferta, el tensionamiento del mercado laboral habría ganado recientemente un mayor peso relativo como factor determinante de la inflación salarial, con una traslación a precios que por el momento parece limitada pero que, de intensificarse, puede dar lugar a riesgos al alza con un mayor grado de persistencia.

Palabras clave: inflación, salarios, expectativas de inflación, mercado de trabajo.

Códigos JEL: E31, E32, J30.

Contents

1 Introduction

Since mid-2021, inflation has risen in the euro area and in Spain in response to a succession of – mainly global – shocks with varying degrees of intensity. At the outset, the inflationary episode was triggered by the imbalances caused by the pandemic and the subsequent economic reopening. This prompted significant disruption in global value chains – especially in shipping – which led to supply and demand mismatches for some goods, such as semiconductors. In 2022, this process intensified, exacerbated by the effects of Russia's invasion of Ukraine on energy and non-energy commodity markets, mostly through gas, oil and food prices. The inflationary shock thus became more persistent than was initially expected, giving rise to a strong economic – and especially monetary – policy response.[1] Since late 2022 inflation has been moderating. This is due partly to mechanical base effects, and partly to the effects of the downward correction in commodity prices, the monetary policy response of the European Central Bank (ECB) and the appreciation of the euro. Nonetheless, underlying inflation is showing remarkable persistence, which could be explained by the strong labour market dynamism and the still incomplete pass-through of the various shocks observed in recent years.

Against this backdrop, Blanchard and Bernanke (2023), who analyse inflation dynamics in the United States since the pandemic, provide a simple and attractive conceptual framework that includes some of the main drivers of this inflationary episode. In their theoretical model, firms and workers interact with each other, setting prices and wages, which will depend on how expectations are determined, the existence of real rigidities (i.e. real wage catch-up linked to indexation or to wage demands in future collective bargaining), productivity growth and the type of supply and demand shocks hitting the economy. Blanchard and Bernanke reach two main conclusions for the United States. First, their estimates suggest that temporary supply shocks – for instance, energy or food price shocks – dissipate relatively quickly owing to low real wage catch-up and the anchoring of inflation expectations. Second, now that these supply shocks have been absorbed, inflation is increasingly being driven by tightening labour market conditions, the effects of which, according to historical patterns, may be more persistent.

In this paper we apply the Blanchard and Bernanke methodology to the Spanish economy. This analysis has been carried out within the context of an informal Eurosystem work stream tasked with examining the causes of inflation in the different euro area countries in recent years based on this same analytical and empirical framework. Arce, Ciccarelli, Kornprobst and Montes-Galdón (2023) explain the background of this work stream and set out the findings for the euro area aggregate.[2] The main conclusions drawn from the analysis of the Spanish data using this methodology are in line with those of the original Blanchard and Bernanke paper for the United States: supply shocks have played a key role in recent

1 See Banco de España (2023) for a detailed description of inflation developments and the monetary policy response in the euro area.

2 See Haskel, Martin and Brandt (2023) for the United Kingdom, De Walque and Lejeune (2023) for Belgium and Menz (2023) for Germany.

inflation developments in the Spanish economy but, given its greater persistence, labour market tightening could become increasingly relevant over time.

The rest of this paper is organised as follows. The next section describes in detail the theoretical model that serves as the basis for the subsequent empirical exercise. Section 3 describes the empirical exercise and presents the main findings, including the impulse response functions of the estimated model, the contributions to recent inflation developments and simulations of future inflation dynamics, based on assumptions about the path of the drivers of inflation. Section 4 briefly discusses several robustness checks around the main estimates presented in Section 3, while Section 5 summarises the main findings.

2 Price- and wage-setting model

To identify the main drivers of inflation since the pandemic, Blanchard and Bernanke (2023) start from a simple theoretical framework that models the joint dynamics of prices, wages and short and long-term inflation expectations, à la Layard, Nickell and Jackman (2005).

In particular, the (nominal) wage equation[3] (w_t) consists of a standard part, which depends on the expected price level (p_t^e), the degree of labour market slack (x_t) and trend productivity growth ($z_{w,t}$), and a less conventional part, consisting of an aspiration real wage, which captures whether workers seek to make up for losses of purchasing power owing to past inflationary surprises ($p_{t-1} - p^e_{t-1}$). This real wage catch-up term would reflect rigidities in real wage adjustment (i.e. the extent to which indexation mechanisms and future wage bargaining enable lost purchasing power to be regained). This results in a price-expectations-augmented and catch-up-augmented wage Phillips curve:

$$w_t - w_{t-1} = (p_t^e - p_{t-1}) + \alpha\,(p_{t-1} - p^e_{t-1}) + \beta\,(x_t - \alpha x_{t-1}) + z_{w,t} \qquad [1]$$

The price equation (p_t) depends on unit labour costs (considering nominal wages and trend productivity separately), the relative cost of energy (in wage terms) and a series of supply shocks considered important in recent years, such as (relative) food prices or supply chain bottlenecks, all considered within the term z_{pt}:[4]

$$p_t - p_{t-1} = (w_t - w_{t-1}) + (z_{pt} - z_{pt-1}) \qquad [2]$$

Equations [1] and [2] combined would suggest that the inflation rate (i.e. $p_t - p_{t-1}$) would also be governed by an expectations-augmented Phillips curve.[5]

To complete the model, we use two equations that describe the formation of agents' short and long-term inflation expectations, which are crucial variables in the inflationary process, as explained, for instance, in Banco de España (2023). Thus, short-term expectations ($\pi_t^e = p_t^e - p_{t-1}$) consist of a weighted average of long-term inflation expectations (π_t^*) and the inflation rate in the previous period:

$$p_t^e - p_{t-1} = \delta\pi_t^* + (1-\delta)\,(p_{t-1} - p_{t-2}) \qquad [3]$$

while long-term expectations depend on past long-term expectations and on the inflation rate in the previous period:

$$\pi_t^* = \gamma\pi^*_{\tau-1} + (1 - \gamma)\,(p_{t-1} - p_{t-2}) \qquad [4]$$

3 The variables are expressed in logs, unless otherwise indicated.

4 In other words, the term $z_{p,t}$ captures both the level of trend productivity and the supply shocks mentioned. The empirical specification in Section 3 provides further details.

5 More formally, $\pi_t = \pi_t^e + \alpha\,(p_{t-1} - p^e_{t-1}) + \beta\,(x_t - \alpha x_{t-1}) + z_{w,t} + \Delta z_{p,t}$ which is an inflation-expectations-augmented Phillips curve which, in addition to depending on the level of labour slack and other supply shocks, also includes past inflationary surprises through the term $(p_{t-1} - p^e_{t-1})$.

With this specification, the degree of anchoring of short and long-term inflation expectations can be linked, in both cases, to the parameters associated with long-term expectations, i.e. with contemporaneous expectations (δ) in one case and with those of the previous period (γ) in the other. The higher the parameter, the greater the anchoring of expectations.

It should be emphasised that, in such a conceptual framework, the level of persistence of an inflation shock depends both on the anchoring of expectations (δ and γ) and on the degree of real wage catch-up, i.e. the extent to which workers manage to make up for lost purchasing power (α). Replacing [1], [3] and [4] in [2] shows that the lower the anchoring of expectations and the greater the degree of real wage rigidity, the longer the impact of an inflation rate shock.

The source of shocks is also relevant for determining the persistence of their impact on prices in this model. Faced with a persistent and high-intensity non-wage supply shock (i.e. Δz_{pt}), and under a reasonable assumption about the anchoring of expectations and degree of real rigidity, the economy would experience a strong but mostly temporary increase in the inflation rate. By contrast, if the shock stems from continued labour market overheating via the resulting wage rises (Δw_t in [2]), then the increase in inflation will be more gradual and sustained over time. These features are consistent with the findings of many of the macroeconomic models typically used to analyse joint price and wage dynamics.

3 Empirical exercise

The estimation strategy adopted is the approach used by Blanchard and Bernanke (2023), i.e. an equation-by-equation estimation using ordinary least squares, imposing a number of constraints on the contemporaneous relationships between the endogenous variables (consistent with the theoretical model) in the spirit of structural VAR models. The main identification constraint concerns the wage equation, where it is assumed that this variable responds with a lag of one quarter to the other variables (equation [5]). Accordingly, wage growth will have a contemporaneous impact on the inflation rate and, therefore, inflation expectations will also respond immediately. Furthermore, four lags of each variable and of a series of regressors that capture the influence of a set of exogenous shocks are added in each equation. A homogeneity constraint is also imposed on each equation, in line with the long-term properties of the conceptual framework, implying the existence of a vertical Phillips curve in the long run.[6]

More specifically, the (nominal) wage equation includes four lags of all variables, except trend productivity growth (which is already calculated as an 8-quarter moving average), such that the equation to be estimated is as follows:

$$\Delta w_t = \sum_{k=1}^{4} \beta_k^w \Delta w_{t-k} + \sum_{k=1}^{4} \beta_k^{\pi e1} \pi_{t-k}^{e1} + \sum_{k=1}^{4} \beta_k^{vu} vu_{t-k} + \beta_A \Delta A_{t-1}^{LT} + \sum_{k=1}^{4} \beta_k^c catchup_{t-k} + \varepsilon_t^w \quad [5]$$

where Δw_t is the annualised quarter-on-quarter log change in wages, π_t^{e1} denotes 1-year ahead inflation expectations, vu_t is the measure of labour market slack (the vacancy-to-unemployment (v/u) ratio, see below), ΔA_{t-1}^{LT} is trend productivity growth, and $catchup_t$ captures how workers seek to make up for lost purchasing power, which is a function of inflation surprises.

The price equation also includes four lags of all variables, except productivity growth, in addition to their contemporaneous values (including for productivity). Hence:

$$\pi_t = \sum_{k=1}^{4} \alpha_k^{\pi} \pi_{t-k} + \sum_{k=0}^{4} \alpha_k^w \Delta w_{t-k} + \sum_{k=0}^{4} \alpha_k^{En} \pi_{t-k}^{En} + \sum_{k=0}^{4} \alpha_k^F \pi_{t-k}^F + \alpha_A \Delta A_t^{LT} + \sum_{k=0}^{4} \alpha_k^s shortage_{t-k} + \varepsilon_t^{\pi} \quad [6]$$

where π_t is the inflation rate, Δw_t is wage growth, π_{t-k}^{En} is the inflation rate for the relative price of energy vis-à-vis wages, π_{t-k}^F is the inflation rate for the relative price of food vis-à-vis wages, ΔA_t^{LT} is trend productivity growth and $shortage_t$ is an indicator of supply chain bottlenecks (see below).

The equations for short and long-term inflation expectations, respectively, are as follows:

$$\pi_t^{e1} = \sum_{k=1}^{4} \gamma_k^{e1} \pi_{t-k}^{e1} + \sum_{k=0}^{4} \gamma_k^{\pi} \pi_{t-k} + \sum_{k=0}^{4} \gamma_k^{e5} \pi_{t-k}^{e5} + \varepsilon_t^{\pi e1} \quad [7]$$

6 In practical terms, this means imposing that the sum of the coefficients of the nominal endogenous variables (and their lags) is equal to one in each equation. For instance, in the price equation, it means that $\sum_{k=1}^{4} \alpha_k^{\pi} + \sum_{k=0}^{4} \alpha_k^w = 1$.

and

$$\pi_t^{e5} = \sum_{k=1}^{4} \delta_k^{e5} \pi_{t-k}^{e5} + \sum_{k=0}^{4} \gamma_k^{\pi} \pi_{t-k} + \varepsilon_t^{\pi e5} \quad [8]$$

where π_t^{e1} and π_t^{e5} denote short-term (1-year ahead) and long-term (5-years ahead) inflation expectations, respectively, and π_t is the inflation rate.

ε_t^w, ε_t^{π}, $\varepsilon_t^{\pi e1}$ and $\varepsilon_t^{\pi e5}$ are the error terms, with the usual properties.

Before estimating this empirical specification, the variables that best proxy the different theoretical concepts must be selected. In this case, in addition to respecting the spirit of the Blanchard and Bernanke (2023) paper, the variables chosen must also be reasonably uniform across the different countries replicating this exercise. For this purpose, quarterly series are used for a maximum sample period from 1995 Q1 to 2023 Q2, depending on the availability of the variables described in Table 1 and discussed below.

Compensation per employee in the National Accounts is used to proxy wages (w_t). Although this measure has its problems (for example, it is sensitive to employment composition effects, which can distort its evolution over time), it is a reasonable choice in terms of its availability and comparability across countries. In any event, as will be seen in Section 4, the results are robust to the use of alternative wage measures.

The price index (p_t) used is the Harmonised Index of Consumer Prices (HICP). The robustness section shows that the results are similar if core inflation (which excludes food and energy prices) is used. The short-term inflation expectations (π_t^{e1}) are the 1-year ahead expectations taken from the European Commission's Business and Consumer Surveys. The long-term inflation expectations (π_t^{e5}) are 5-year ahead expectations for the euro area, as there is no analogous variable for the Spanish economy, taken from the ECB Survey of Professional Forecasters (SPF). The variable that captures how workers seek to make up for lost purchasing power ($catchup_t$) is constructed based on the difference between the cumulative inflation rate over the past year and the 1-year ahead inflation expectations four quarters earlier. This is a reasonable proxy given how collective bargaining works in the Spanish labour market (highly focused on recent or 1-year ahead expected inflation) and could be partly related to wage indexation clauses. The variable capturing trend labour productivity growth (ΔA_t^{LT}) is an 8-quarter moving average of gross value added (GVA) growth per employee for the total economy.[7]

The degree of slack in the labour market (vu_t) is a more delicate variable, since the variable proposed by Blanchard and Bernanke – the v/u ratio – depends on information on job vacancies which, for various reasons, provides inadequate coverage in the case of

7 By contrast to Blanchard and Bernanke, who use GVA per hour worked in the non-agricultural private economy. In any event, the robustness section includes estimates obtained using measures of productivity and hourly wages for the total economy, with no impact on the main findings.

Table 1
Variables used in the estimation of the model

Variable	Definition	Source
Nominal wage (per person)	Compensation per employee (seasonally and cal. adj.), 1995 Q1 - 2023 Q2	National Accounts (INE)
Nominal wage (per hour)	Compensation per employee (per hour, seasonally and cal. adj.), 1995 Q1 - 2023 Q2	National Accounts (INE)
Labour cost index	Ordinary wage (Dec-2020 = 100, seasonally and cal. adj.)	Eurostat
Headline inflation rate	Headline HICP, 1995 Q1 - 2023 Q2	HICP (INE)
Core inflation rate	HICP excl. energy & food, 1995 Q1 - 2023 Q2	HICP (INE)
Food prices	HICP food, 1995 Q1 - 2023 Q2	HICP (INE)
Energy prices	HICP energy, 1995 Q1 - 2023 Q2	HICP (INE)
Supply chain bottlenecks	Google Trends, "shortage" in Spain, 2004 Q1 - 2023 Q2	Google Trends Data
v/u ratio	Vacancy-to-unemployment ratio 2001 Q1 - 2023 Q2	Eurostat
1-year ahead inflation expectations	1-year ahead inflation expectations 1995 Q1 - 2023 Q2	Business and Consumer Survey (EC)
5-years ahead inflation expectations	5-years ahead inflation expectations, 1999 Q1 - 2023 Q2	ECB Survey of Professional Forecasters (SPF)
Labour productivity (per person)	GVA per employee (seasonally and cal. adj.), 1995 Q1 - 2023 Q2	National Accounts (INE)
Labour productivity (per hour)	GVA per hour worked (seasonally and cal. adj.), 1995 Q1 - 2023 Q2	National Accounts (INE)
Wage settlements	Average negotiated wage (wage bargaining) (quarterly avge., y-o-y rate), 1995 Q1 - 2023 Q2	Collective bargaining statistics (Ministerio de Trabajo y Economía Social)
Unemployment rate	Unemployment rate (seasonally and cal. adj.), 1995 Q1 - 2023 Q2	Labour Force Survey (EPA-INE)

SOURCE: Banco de España.

Spain.[8] Although the unemployment rate (u_t) or the gap between the unemployment rate and the NAIRU are generally used, some authors believe that during the period analysed (post-pandemic) the ability of both measures to provide information on the degree of labour market slack has diminished somewhat.[9] This is because the unemployment rate does not directly incorporate information on firms' hiring needs, which is typically captured via the vacancies to labour force ratio (v_t). In any event, several robustness checks have been conducted using the unemployment rate as a measure of labour market slack (see Section 4) and the results hold.

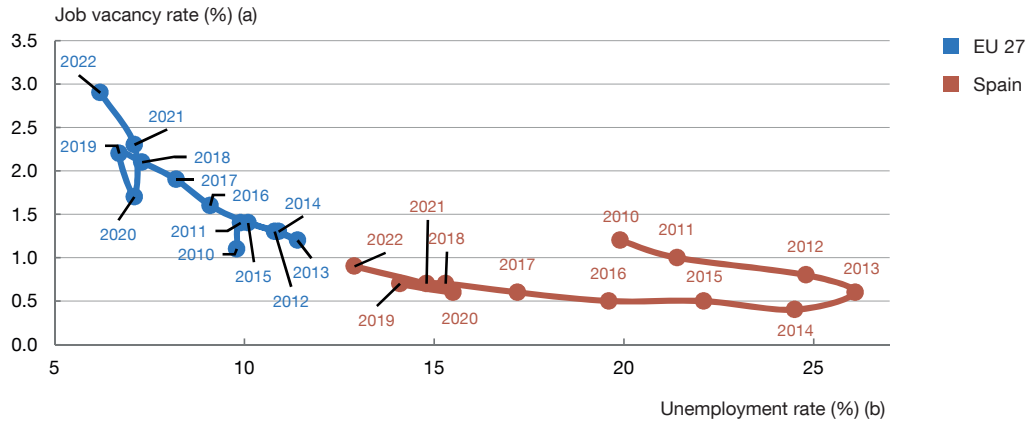
8 For a description of the problems with the job vacancies variable in Spain, see Boscá, Doménech, Ferri and García (2017).

9 See Blanchard, Domash and Summers (2022) for the United States and Leythienne (2023) for the euro area.

Chart 1

Beveridge curve for Spain and EU 27

1.a Beveridge curve



SOURCE: Eurostat (Labour Force Survey and job vacancy rate).

a The job vacancy rate is measured as the ratio of job vacancies to the number of occupied posts plus job vacancies.
b The annual unemployment rate is measured as the ratio of the unemployed population to the total labour force (aged 15 to 74).

In recent years this ratio has risen markedly in the United States and less sharply in the euro area. Indeed, the relationship between the two variables – the Beveridge curve – has shifted upwards and to the left, suggesting that, for a given unemployment rate, more vacancies are needed for each job to be filled. This indicates a deterioration in labour market matching, and also greater labour market tightness than is suggested by the unemployment rate alone. In any event, shifts in the v/u ratio have been less pronounced in the Spanish economy than in other economies (see Chart 1), as shown by its Beveridge curve which has shifted slightly upwards and to the left. This suggests that labour market matching has deteriorated less in Spain than in the euro area. Moreover, the fact that the curve is so flat implies that there is still a high correlation between the v/u ratio and the unemployment rate, so the use of one proxy or the other should be relatively indifferent. For comparability reasons, the v/u ratio will be used in the baseline specification. The robustness section shows that the results would be similar if the unemployment rate were used.

A significant proportion of recent years' inflation is due to a sharp rise in food and energy prices, which was largely unexpected (Banco de España, 2023). In consequence, in the price equation, we take as the proxies of these shocks the rates of change of the food (π_t^F) and energy (π_t^{En}) components of the HICP, measured relative to the nominal wage growth rate, i.e. they are included as shocks to relative prices. As the exogeneity of these price indices relative to the headline index may be questionable, Section 4 includes a robustness check in which the reference price is the core inflation rate which excludes both components.

Another crucial element for inflation developments since the pandemic have been the global supply chain bottlenecks ($shortage_t$), caused by the pandemic-related restrictions

and other shipping disruptions, among other factors.[10] Difficulties accessing certain products in a strong demand environment triggered a distinct inflationary dynamic. We use the Blanchard and Bernanke methodology to proxy these bottlenecks and construct an index based on the number of searches for the word "escasez" ("shortage" in Spanish) in Google's search engine.[11]

3.1 Results of the estimation

Table 2 summarises the results of these estimates. The first row of each regression presents, for each of the explanatory variables, the lags included and, in the following rows, the sum of the estimated coefficients and two p-stats: the first is the probability of rejection of the null hypothesis that the sum of the coefficients is zero, while the second statistic tests the joint hypothesis that each of the (contemporaneous and lag) coefficients is zero.

The estimates for the wage equation point to high wage growth inertia (sum of coefficients 0.83), which prevails over the effect of the inflation expectations (0.17) (both coefficients add up to 1 owing to the homogeneity constraint). In both cases, both the sum and the (set of) coefficients are (jointly) statistically significant. If we compare these estimates with estimates for the euro area and the United States,[12] the opposite is the case in the euro area (0.21 for the sum of the wage lags vs 0.79 for the sum of the coefficients of the inflation expectations), whereas for the United States both coefficients are more balanced (0.46 vs 0.54). They are also statistically significant in both economies. In other words, in the Spanish economy, inflation expectations feed into wage growth much more slowly than in both the euro area and the United States. In the case of the catch-up coefficients, they are not statistically significant in either Spain (0.23) or the United States (-0.02), whereas in the euro area the set of coefficients is statistically significant (0.07). In any event, as we will see below, this lack of long-term statistical significance does not necessarily imply the absence of short-term dynamic effects.[13]

Moreover, the sensitivity to labour market slack is low (0.15), with coefficients that are jointly significant, indicating a relatively flat wage Phillips curve for Spain. This contrasts with both the euro area (0.31) and the United States (0.69), where the cyclical sensitivity of wages is much higher. The estimated coefficient for trend productivity growth does not appear to be statistically significant, although its impact could be partly captured by the regression constant. Nor are the estimates for the euro area (0.13) and the United States (0.03) significant.

The estimates for the price equation also show high inflation inertia (0.88), which prevails over the impact of wage growth (0.12) which appears to be quite slow.[14] This

10 For an analysis of the causes and consequences of supply chain difficulties for the Spanish economy, see Fernández-Cerezo, Montero and Prades (2021).

11 This indicator can only be compiled for 2004 onwards; for earlier years, the pre-pandemic average is used. Burriel, Kataryniuk, Moreno-Pérez and Viani (2023) construct an indicator of supply bottlenecks for Spain based on comprehensive information from press articles, but only as from 2007.

12 Compared with Table 5 in Arce, Ciccarelli, Kornprobst and Montes-Galdón (2023) for the euro area, and with Table 2 in Blanchard and Bernanke (2023) for the United States.

13 Some individual coefficients are significant and others are possibly not significant owing to the small sample size.

14 In both cases, both the sum and the (set of) coefficients are (jointly) statistically significant.

Table 2

Estimates for Spain using the Blanchard and Bernanke (2023) model (a)

Dependent variable: rate of change nominal wages	Wage equation				
Explanatory variables	Wages	v/u ratio	*Catch up* (infl. surprise)	1-yr ahead infl. expectations	Rate of change productivity
Lags	-1 to -4	-1 to -4	-1 to -4	-1 to -4	-1
Sum of coefficients	0.83	0.15	0.23	0.16	-0.07
p-stat (sum)	0.00	0.24	0.60	0.16	0.84
p-stat (joint)	0.00	0.00	0.12	0.05	0.84
R-squared	0.63		Num. Obs. =	80	

Dependent variable: inflation rate	Price equation					
Explanatory variables	Inflation rate	Wages	Energy prices	Food prices	Bottlenecks	Rate of change productivity
Lags	-1 to -4	0 to -4	0 to -4	0 to -4	0 to -4	0
Sum of coefficients	0.88	0.12	0.03	0.06	0.09	-0.05
p-stat (sum)	0.00	0.30	0.08	0.39	0.44	0.42
p-stat (joint)	0.00	0.00	0.00	0.00	0.18	0.42
R-squared	0.90		Num. Obs. =	109		

Dependent variable: 1-yr ahead inflation expectations	1-year ahead inflation expectations equation			
Explanatory variables	1-yr ahead	5-yrs ahead	Inflation rate	
Lags	-1 to -4	0 to -4	0 to -4	
Sum of coefficients	0.82	-0.22	0.40	
p-stat (sum)	0.00	0.13	0.03	
p-stat (joint)	0.00	0.14	0.00	
R-squared	0.91		Num. Obs. =	80

Dependent variable: 5-yrs ahead inflation expectations	5-years ahead inflation expectations equation			
Explanatory variables	5-yrs ahead	Inflation rate		
Lags	-1 to -4	0 to -4		
Sum of coefficients	0.99	0.01		
p-stat (sum)	0.00	0.02		
p-stat (joint)	0.00	0.06		
R-squared	0.80		Num. Obs. =	80

SOURCE: Banco de España.

a The sample period is 1995 Q1 to 2023 Q2 for the price equation and 1999 Q1 to 2019 Q4 for all the other equations (see Table 1 for more details). The p-stat (sum) tests the null hypothesis that the sum of the coefficients is zero, while the p-stat (joint) tests the joint hypothesis that each of the individual coefficients is zero.

contrasts with the estimates for the United States (0.34 for inflation and 0.66 for wages) and for the euro area (0.69 and 0.31),[15] where the pass-through of wage shocks is considerably

15 In this case, compared with Table 6 in Arce, Ciccarelli, Kornprobst and Montes-Galdón (2023) for the euro area, and with Table 3 in Blanchard and Bernanke (2023) for the United States.

faster than in the Spanish economy. This suggests that a sustained wage shock is slow to pass through to Spain's inflation rate but that, once passed through, it is long-lasting. As will be seen below, this is important to understand the contributions of different shocks to recent inflation developments and the simulations of future price paths according to different degrees of labour market tightness.

Meanwhile, the effect of changes in relative energy prices (0.03) and relative food prices (0.06) is positive and statistically significant, but it is quite small in the short and medium term. The estimates for the euro area (0.03 and 0.08, respectively) are very similar, while for the United States (0.07 and 0.13) they are double those for Spain. By contrast, the long-term multiplier is 25% for energy prices and 50% for food prices,[16] in both cases well in excess of their weight in the HICP basket (10% and 23%, respectively). As the price equation controls for wage growth, these multipliers suggest significant indirect effects of energy and food price shocks on the prices of other goods and services over time.[17]

The sum of the coefficients estimated for the supply chain bottleneck variable (0.09) and productivity growth (-0.05) has the expected sign but is not statistically significant. In the case of the United States, both variables are significant and have the expected sign (0.02 and -0.14, respectively). However, the estimates for the euro area give a counterintuitive outcome: a positive and statistically significant coefficient for trend productivity growth (0.19) and a bottleneck coefficient that has the expected sign (0.10) but is not significant.

Lastly, the estimates for the long-term inflation expectations equation are very similar for the economies of Spain, the United States and the euro area.[18] The sum of the coefficients of the lags of expectations stands around 0.99, which means, assuming long-run homogeneity, that the sum of the coefficients of the inflation rate is very close to zero (in both cases, with high statistical significance). This suggests a very robust anchoring of long-term expectations. By contrast, the estimates for the short-term inflation expectations equation look more heterogeneous. For Spain, the estimates point to a high autocorrelation component (0.82), which would suggest a good anchoring of short-term expectations, but together with a high "adaptive" component, as the sum of the coefficients of the inflation rate is 0.40, in both cases statistically significant. This suggests that a sustained shock to the inflation rate will eventually pass through to expectations and that, once passed through, it is long-lasting. However, the sum of the coefficients of the long-term inflation expectations variable is negative (although not significant), which is difficult to explain. It could suggest that the homogeneity hypothesis is inappropriate.[19]

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16 The multiplier would be calculated, for example for energy, as 0.03/(1 – 0.88) = 0.25.

17 In the United States, the long-term multipliers of energy prices (10%) and food prices (19%) also exceed their weight in the consumption basket, but they are lower than in Spain. In the euro area, the multipliers are 6.8% and 17.9% respectively, but this is below their weight in the HICP (10.3% and 19.9%). This would imply indirect effects in the opposite direction in the euro area.

18 Using for the comparison Tables 4 and 5 of Blanchard and Bernanke (2023) and Tables 7 and 8 of Arce, Ciccarelli, Kornprobst and Montes-Galdón (2023).

19 The sum of the coefficients of the three regressors is equal to 1.

The estimates for the euro area are quite similar to those for the Spanish economy (0.81 for short-term inflation expectations and 0.14 for the inflation rate), but the short-term expectations are sensitive to long-term expectations with a statistically significant coefficient of 0.05 and the homogeneity constraint is verified. The estimates for the United States indicate that short-term inflation expectations are more reliant on long-term expectations, with a coefficient of 0.51, than on short-term expectations (0.37), while their adaptive component is small (0.12).

3.2 Impulse response functions

The impulse response functions of the estimated model help to understand the results of the following two sub-sections, as they capture not only the direct effects of a given economic shock – e.g. a change in the degree of labour slack – but also the indirect impact via the dynamics and interactions of the other variables in the model. Starting from an equilibrium position, a permanent shock the size of one standard deviation (calculated for the period 2020 Q1/2023 Q2) to the variables that are understood to have driven inflation in the recent period (relative energy prices, relative food prices, bottlenecks and degree of labour market slack) is considered, following the Blanchard and Bernanke paper. For the two relative price variables, this implies a permanent increase in their level, but a temporary increase in their rate of change. Similarly, shocks to the supply chain bottleneck proxy and to the v/u ratio will entail a permanent increase in their level, but a temporary increase in their rate of change. The results are presented in Chart 2.

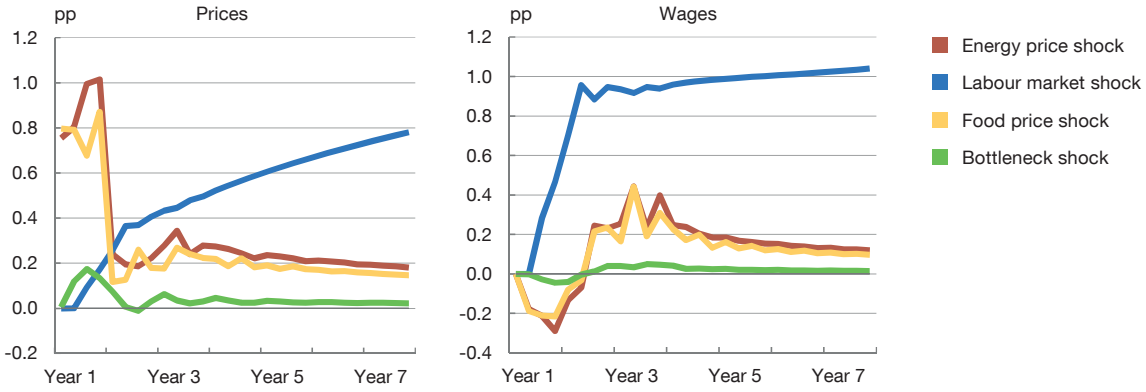
Given the structure of lags embedded in the model, the shock-response functions in the v/u ratio show that although wages take some time to respond,[20] their growth rate quickly stands at a permanently higher level (around 1 percentage point (pp) higher). These tight labour market conditions are also gradually passed through to the inflation rate, which starts to climb after one quarter and then continues to increase gradually over time and, after four years, is expected to be 0.6 pp higher than at the start. In other words, given the structure of the model and the assumptions made, a permanent reduction in labour market slack would continuously drive up inflation and, to a lesser extent, wages, even though the estimates for the inflation expectations equations suggest that they are well – albeit not perfectly – anchored.

By contrast, the effects on the inflation rate of the three shocks in the price equation are less persistent and more concentrated in the short term. This suggests that catch-up effects are limited and that inflation expectations are reasonably well anchored. Even so, the degree of persistence is relatively high when compared with the results for the United States and the euro area. In other words, the Spanish economy has greater real rigidity (higher real wage catch-up following a temporary loss of purchasing power), which is reinforced by the fact that short-term inflation expectations are much more sensitive to current inflation than in the United States and the euro area. The wage response to an energy price shock is noteworthy, as it only peaks more than 18 months later and eases slowly thereafter. This

20 The size of the response is very close to zero because the estimated coefficient for the first lag is very small.

Chart 2
Price and wage response to different shocks

2.a Impulse response functions



SOURCE: Banco de España calculations.

may explain the lagged contribution of energy shocks to wage growth (see Chart 3.b in the next sub-section), while the high persistence of the impulse response function following a permanent shock to labour market tightness would explain the main result of sub-section 3.4 on simulations.

3.3 Contributions to recent inflation developments

The model's linear structure allows changes in prices or wages to be decomposed into their various components, taking into account dynamic and general equilibrium effects. Chart 3.a shows the contributions of the different exogenous variables to the inflation rate between 2020 Q1 and 2023 Q2. To better interpret the charts, the contributions of the initial conditions[21] and the residuals (which, moreover, have no clear structural interpretation) are excluded. The charts therefore focus on the contributions of factors with a clearer economic interpretation.

The main messages in Chart 3.a can be summarised as follows. First, food and, in particular, energy price shocks have been the main drivers of both upward and downward changes in inflation over the period considered. The coefficients for both variables are small, which suggests that the size and persistence of the shocks were high. Second, supply bottlenecks from 2021 Q3 onwards, and even in 2023, have had a sustained impact, even though, according to other indicators such as that of the NYFED,[22] these supply-side constraints have almost disappeared. Third, labour market slack made virtually no contribution between 2020 and late 2022, but it started to gain some importance thereafter.

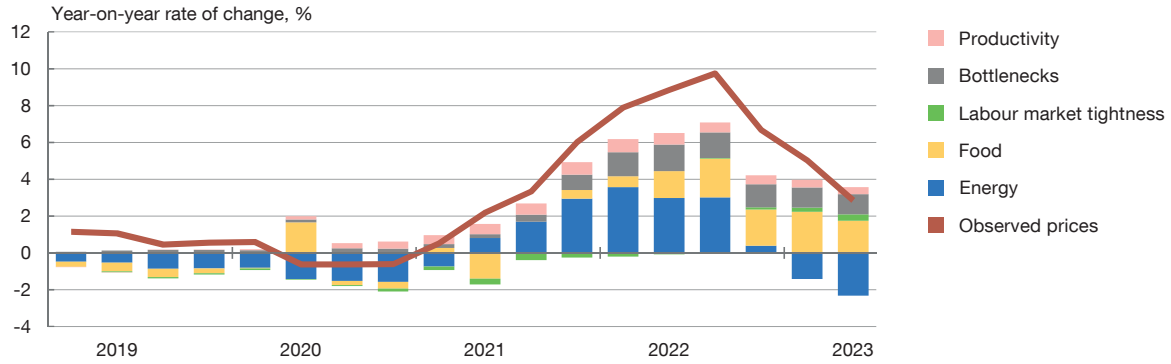
21 The "initial conditions" category includes the contributions of the constant and of the pre-pandemic dynamic effects of the variables. These initial conditions make a fairly stable and small contribution to inflation, of between 1.6 pp and 2 pp, which would have been the inflation rate in the absence of the other shocks (and assuming zero residuals).

22 See https://www.newyorkfed.org/research/policy/gscpi#/overview.

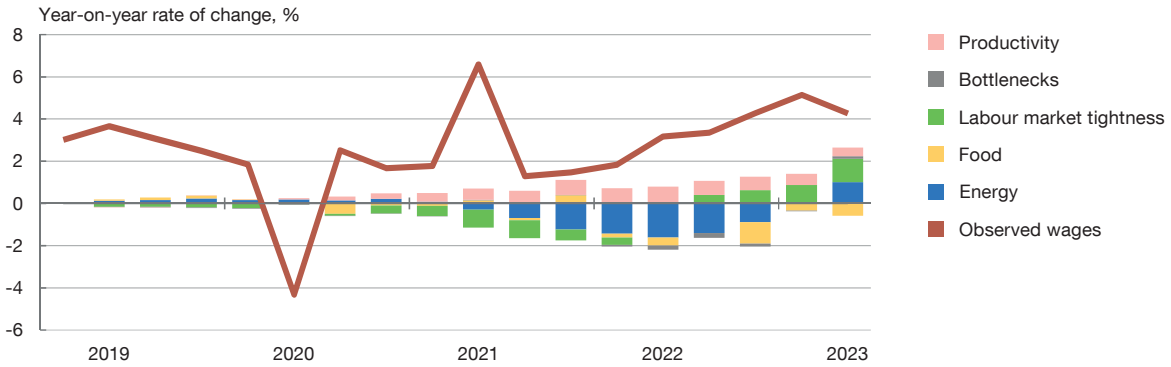
Chart 3

Contribution of the model's various shocks to observed prices and wages

3.a Prices



3.b Wages



SOURCE: Banco de España calculations.

In short, the model indicates that inflation developments over this period were mainly driven by supply-side factors.[23] A caveat to this interpretation is that some of the above-mentioned supply disruptions may be capturing demand factors that could have contributed to amplifying these shocks.

Chart 3.b breaks down nominal wage growth into its different components. Against a pattern of volatility arising from the effects of the pandemic, the growing positive contribution of labour market slack since mid-2022 is noteworthy. Paradoxically, energy and food price shocks made a negative contribution, despite their inflationary nature for much of the period under review. This could stem from the lag with which wage setting in Spain reflected the effects of supply shocks and would be consistent with the estimates of the impulse response functions presented above.

23 As shown by Haskel, Martin and Brandt (2023) for the United Kingdom, these results may be sensitive to the choice of initial conditions. This mainly affects the contribution of the v/u ratio, whose starting level is high, which may make its contribution harder to see.

3.4 Simulations based on the model

An interesting exercise to gain a better insight into the potential future inflation developments implied by the theoretical model is to construct forward simulations based on assumptions about the trajectory of the exogenous variables over the coming years. Naturally, this exercise has to be interpreted with due caution, as explained in detail by Blanchard and Bernanke (see p. 36), as the results crucially depend on the assumptions used. With this in mind, and following the approach of the original paper, we take the data observed up to 2023 Q2 as a starting point and assume that the price of energy and food relative to nominal wages remains unchanged throughout the horizon, while labour productivity grows at a constant rate of 1% per year and the proxy variable for supply bottlenecks returns to its average, with the residuals of the equations set to zero.

Three future simulation scenarios are considered depending on the assumptions about the degree of labour market slack. In the first it is assumed that the v/u ratio remains at its 2023 Q2 level (tight market, "low slack"). In the second, it returns to its pre-pandemic level by mid-2025, which in this simple exercise is considered the "natural slack" level. In the third, it declines and reaches its minimum pre-pandemic level by around mid-2025 ("high slack"). From 2025 Q2, the v/u ratio would remain constant at the level reached in each of the last two scenarios. The results of the simulation exercise are depicted in Chart 4.

The chart shows that, under assumptions similar to those adopted by Blanchard and Bernanke (2023), if the current situation of low labour market slack were to persist,[24] the simulated inflation rate would remain relatively high, around 3.5%, over the entire horizon. In these simulations, the return of labour market slack to its "natural" level (the historical pre-pandemic average) takes inflation towards the medium-term monetary policy target, while in the high slack scenario inflation remains well below 2%. However, these responses have been found to be more persistent in Spain than in the United States, suggesting that, under the assumption that the recent supply shocks are temporary, some inflationary pressures may persist.

In any event, these paths are not actual projections obtained from the model, but rather simulations carried out under ad hoc assumptions, which simply seek to illustrate the implications of a higher or lower degree of persistence of the low labour market slack in this model. Moreover, the model considered does not take into account other relevant factors such as the economic policy response or, in the case of the Spanish economy, the collective bargaining agreement signed by employers and trade unions in 2023,[25] which set a moderate wage increase for the period 2023-2025.

With regard to wage growth dynamics and their relationship with the response of inflation, two messages can be highlighted. First, in the tight labour market (low slack)

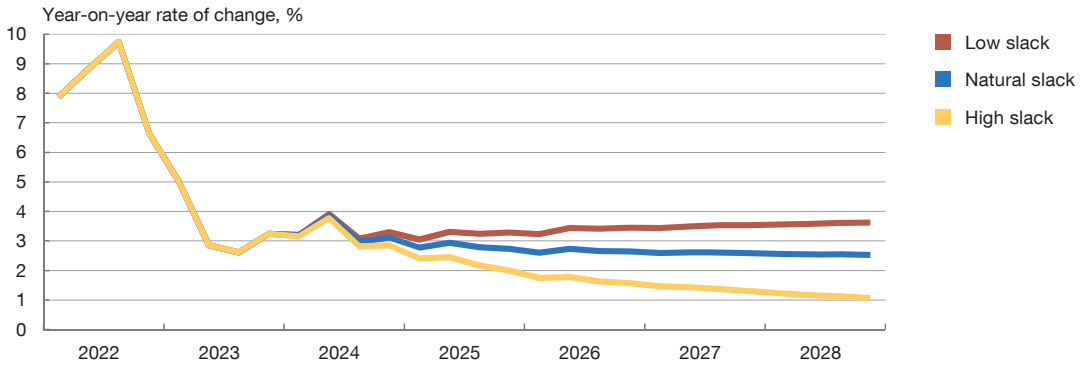
24 The "tight" labour market scenario assumes a constant unemployment rate of 11.2% (the 2023 Q2 level), while the "natural" scenario assumes a rise in the unemployment rate to 13.8% (the end-2019 level) in 2025 Q2.

25 The 5th Employment and Collective Bargaining Agreement established the following benchmarks for wage increases: 4% in 2023, 3% in 2024 and 3% in 2025. These increases are complemented with a revision clause which envisages further increases of up to 1% if inflation exceeds the agreed wage increases.

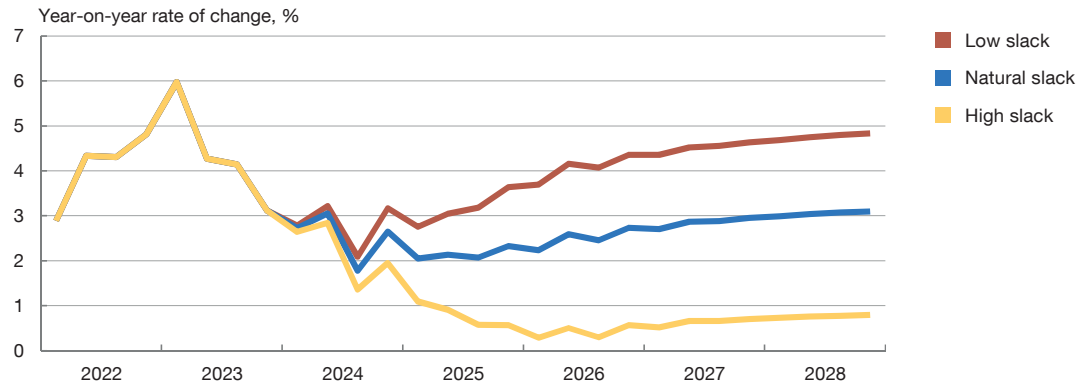
Chart 4

Inflation and wage scenarios

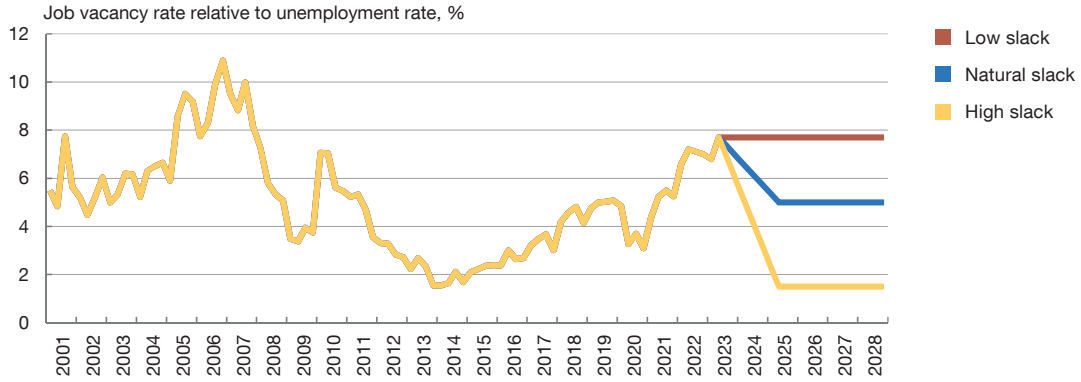
4.a Inflation



4.b Wages



4.c Labour market slack assumption in each scenario



SOURCE: Banco de España calculations.

scenario, the sustained rise in wages is nevertheless not passed on to a similar extent to the inflation rate over the simulation horizon, reflecting a favourable anchoring of expectations. Second, in the high labour market slack scenario, where medium to long-term inflation rates are very low, wage growth is even lower. In other words, the model generates persistent real wage losses.

4 Robustness checks

As discussed above, the chosen empirical specification seeks to obtain results that are as comparable as possible with those in the Blanchard and Bernanke paper and those of other Eurosystem members. However, this specification is not necessarily the most suitable one for the Spanish economy. Several additional exercises have therefore been conducted with alternative specifications to verify the robustness of the results obtained.[26]

First, the core inflation rate – which excludes food and energy prices – was taken as the measure of inflation. This is a more appropriate variable from the point of view of trend inflationary pressures and could be deemed more suitable for assessing the impact of the shocks considered in the conceptual framework developed in Section 2. In addition, it mitigates the simultaneity and endogeneity problems that arise from using the energy and food components of headline HICP as a proxy for actual energy and food prices. Chart 5 shows that the results using this variable are very similar to those of the benchmark specification: supply shocks continue to be the main drivers of inflation during the period considered.

Second, the v/u ratio was replaced by the unemployment rate as the measure of labour market slack. This variable may be more appropriate given the limited representativeness of the vacancy measure for the Spanish economy. In this case, the main results also remain broadly unchanged (see Chart 6), with the particularity that productivity contributes negatively to inflation developments. This is because the estimated coefficient for productivity in the wage equation is now bigger and of the opposite sign, and is then passed through to prices. This suggests that, in the benchmark specification, the vacancy variable, which operates through the labour demand curve, may be capturing an important part of the effect of productivity on wages. In any event, the key outcome of this robustness check is that the change in the measuring variable makes no fundamental difference to the contribution of labour market tightness compared with the results shown in Chart 3.

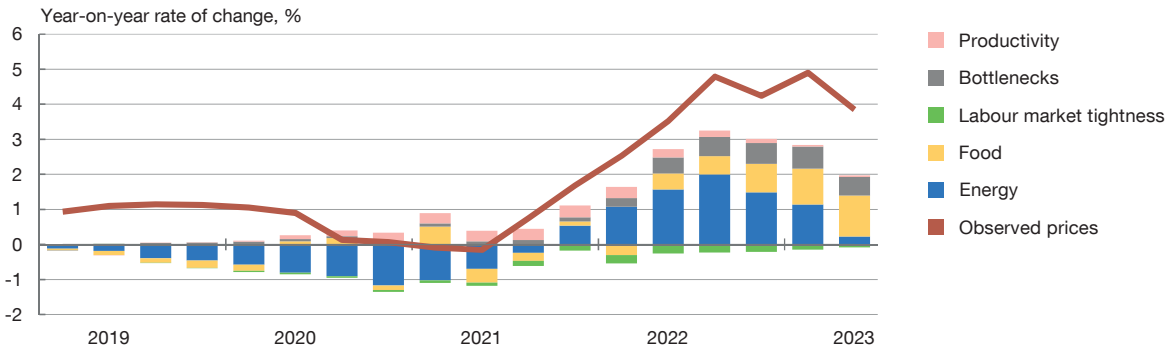
Third, several alternative measures of wages and productivity have been tested. Chart 7 shows the results for a per-hour measure of both variables (i.e. hourly wages and productivity per hour worked), while Chart 8 shows the breakdown of inflation when wages and labour productivity are measured in terms of full-time equivalents, correcting each job for the number of hours worked on average by full-time workers. Reasonably similar results are obtained in both cases, except for the period in which the impact of the pandemic lockdowns was most acute (2020 Q2 and Q3), when job retention schemes accounted for a larger share of total employment and these measures diverged more from the measure based on the number of workers. Chart 9 shows the contributions to inflation when wages are proxied by the wage component of the harmonised labour cost index and productivity is measured in terms of hours worked, and reveals no significant qualitative differences compared to our main specification.

26 For the sake of simplicity, and as these are the most relevant results for the purposes of this paper, only the charts showing the contributions of each shock to the inflation rate and wage growth are presented.

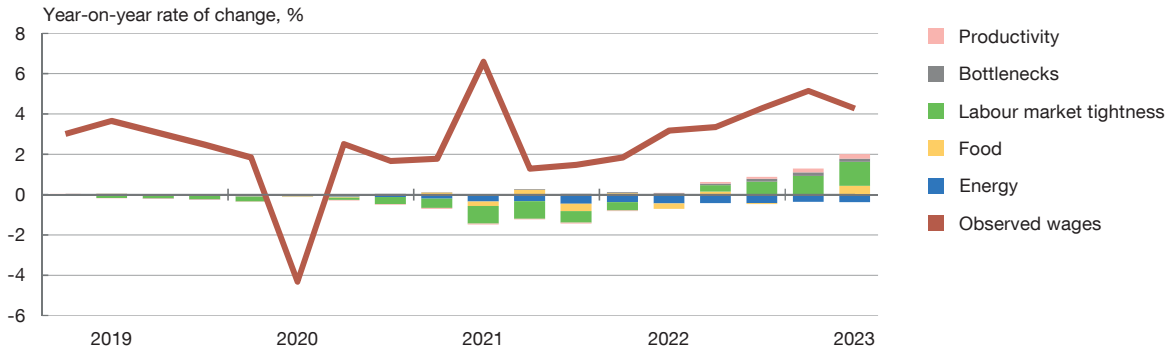
Chart 5

Contribution of the model's various shocks: core inflation rate

5.a Prices



5.b Wages



SOURCE: Banco de España calculations.

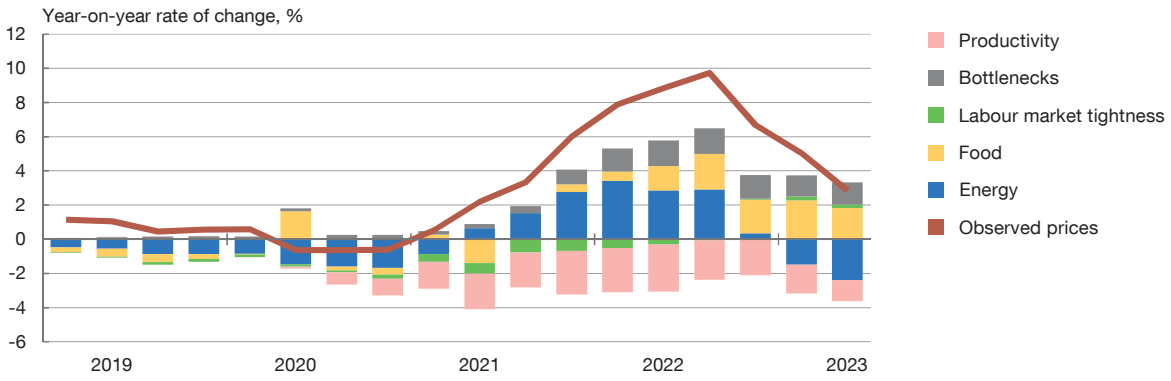
Lastly, a measure of wages based on wage settlements in collective bargaining agreements and of productivity per hour worked are used. As shown in Chart 10, the results would be somewhat different, with labour market slack playing practically no role and food price shocks playing a less important role during the first half of the period considered. The discrepancies are clearer when looking at the forward simulation of the inflation rate under different v/u ratio scenarios, where inflation is less sensitive to labour market developments. However, replacing the v/u ratio with the unemployment rate as a proxy for labour market slack yields similar results to those of the benchmark specification (see Chart 11), and inflation is once again sensitive to the degree of labour market tightness.

In summary, it can be argued that the main results discussed in the previous section hold for the different variants of the model, providing evidence of their robustness.

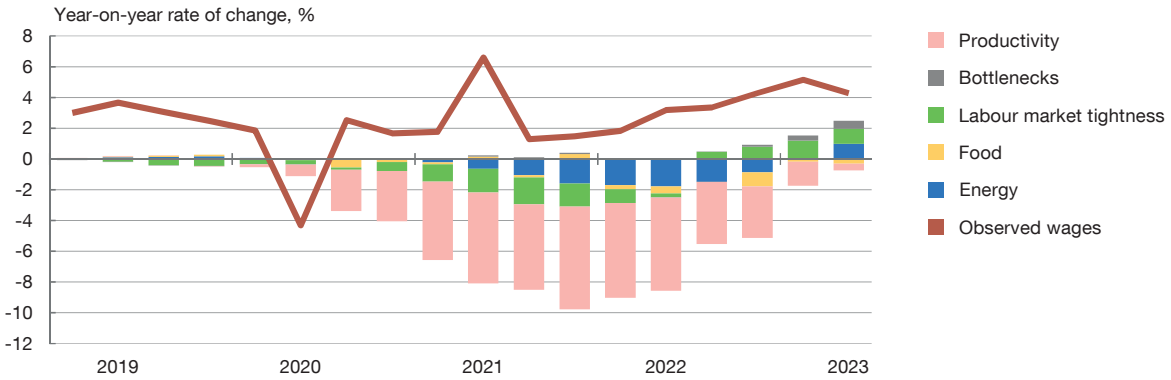
Chart 6

Contribution of the model's various shocks: slack measured by the unemployment rate

6.a Prices



6.b Wages

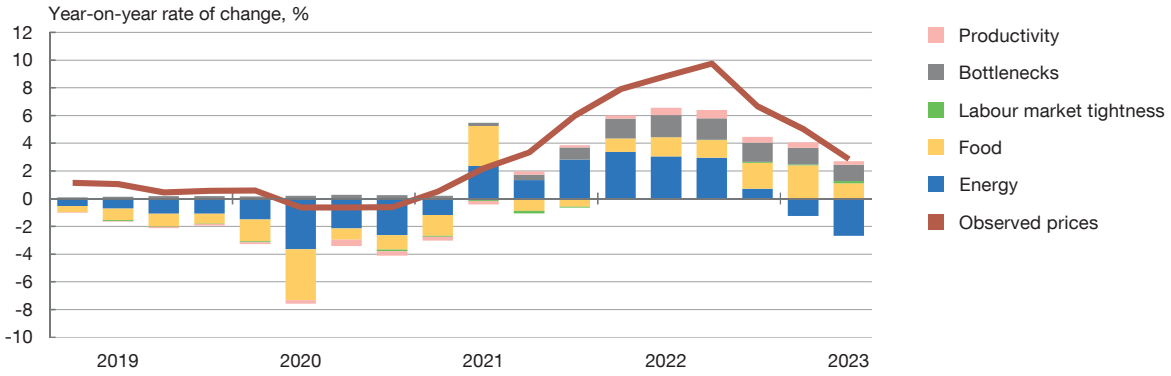


SOURCE: Banco de España calculations.

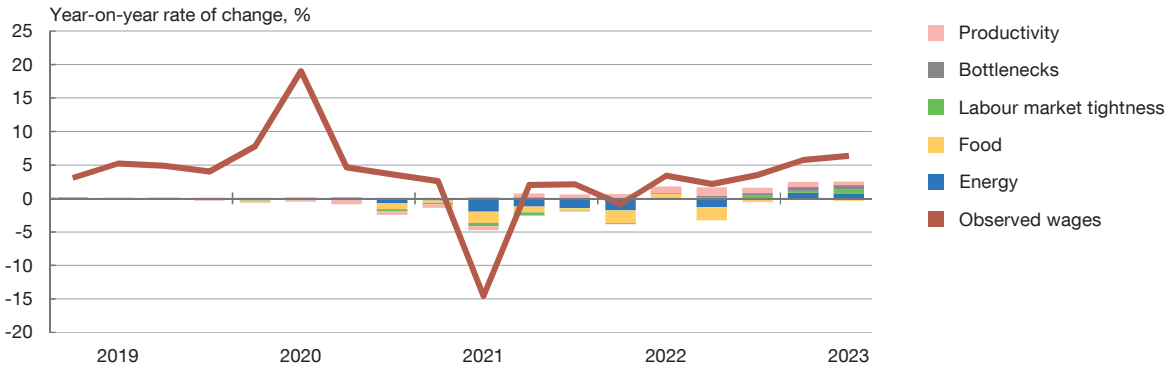
Chart 7

Contribution of the model's various shocks: wages and productivity measured per hour worked

7.a Prices



7.b Wages

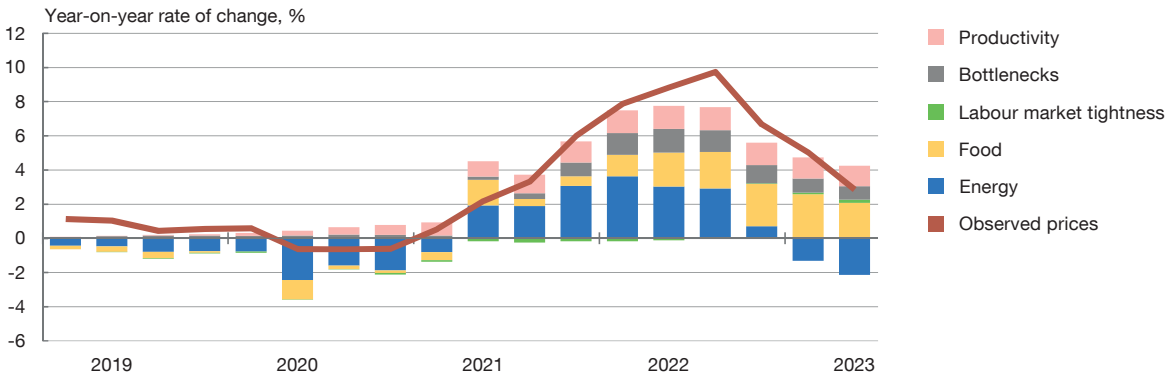


SOURCE: Banco de España calculations.

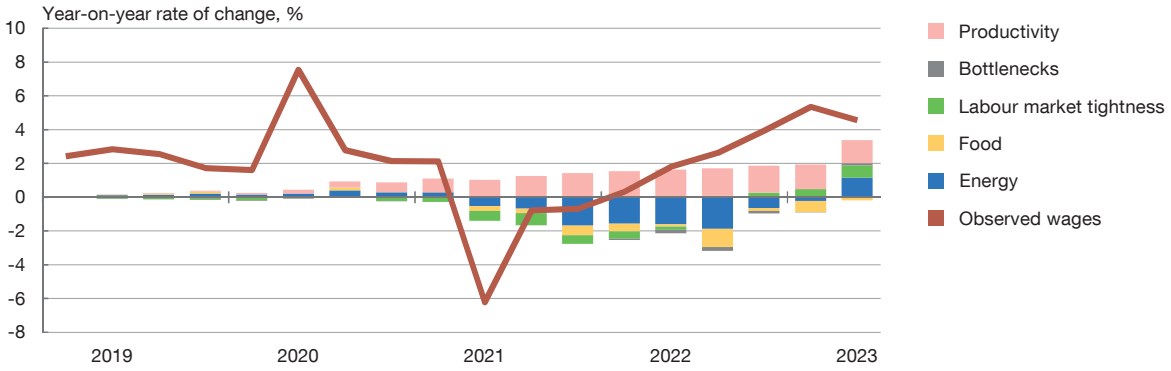
Chart 8

Contribution of the model's various shocks: wages and productivity measured in terms of full-time equivalents

8.a Prices



8.b Wages

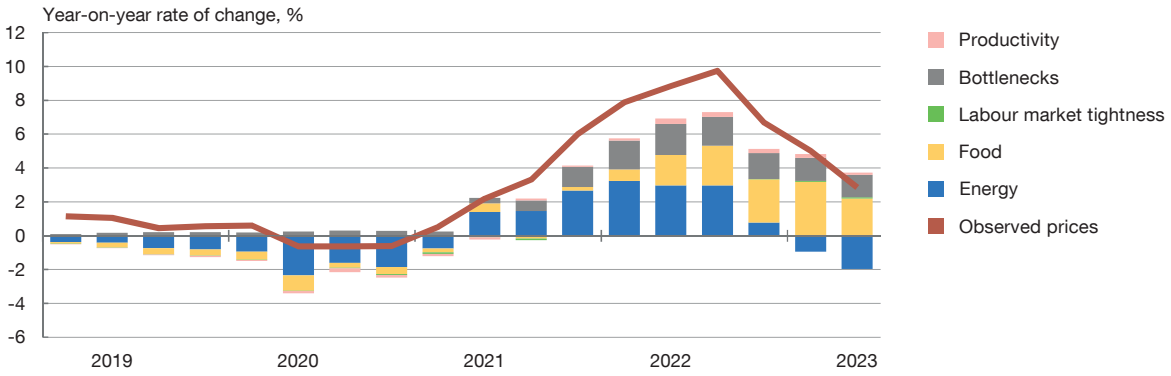


SOURCE: Banco de España calculations.

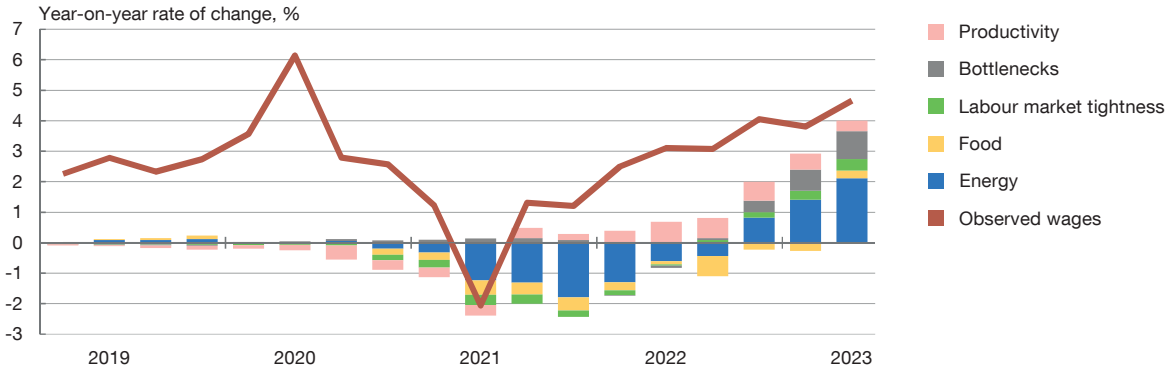
Chart 9

Contribution of the model's various shocks: wages = harmonised labour cost index (ordinary wages) and per-hour productivity

9.a Prices



9.b Wages

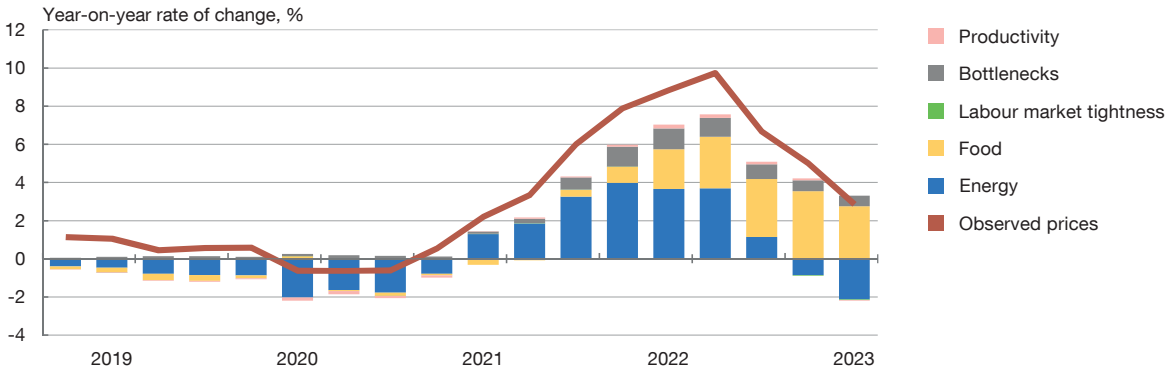


SOURCE: Banco de España calculations.

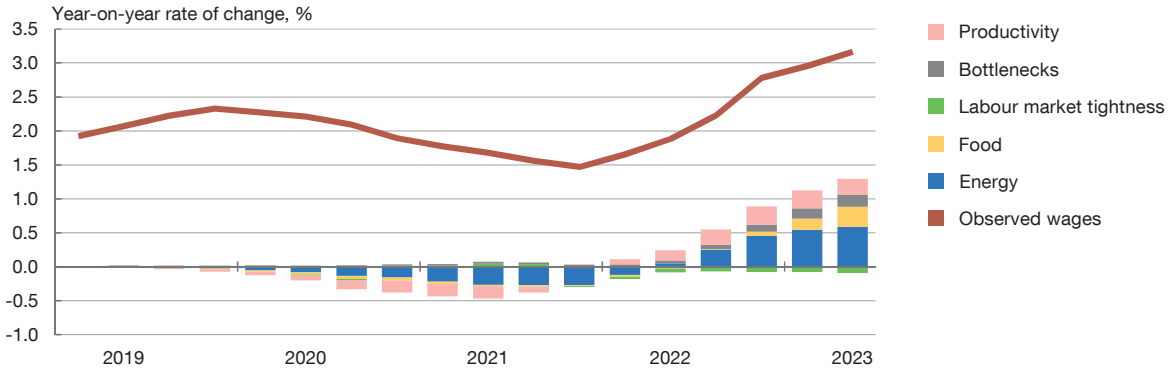
Chart 10

Contribution of the model's various shocks: wages = settlements in collective bargaining agreements and per-hour productivity

10.a Prices



10.b Wages

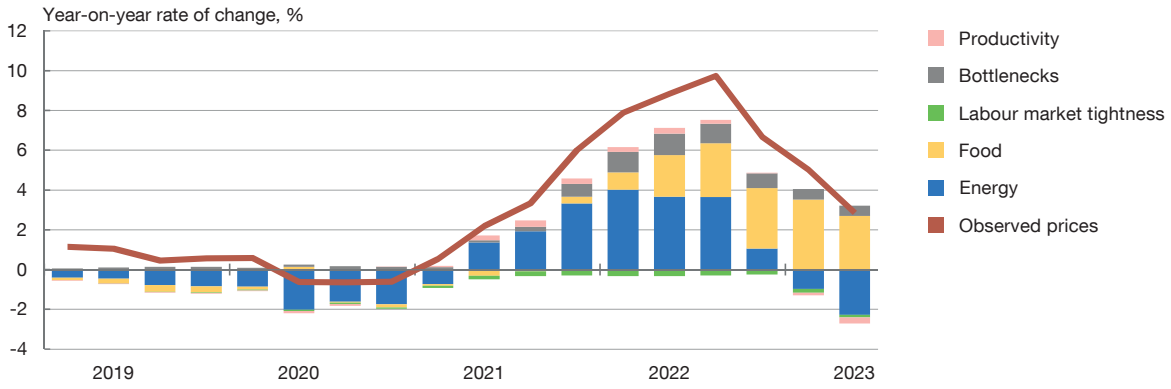


SOURCE: Banco de España calculations.

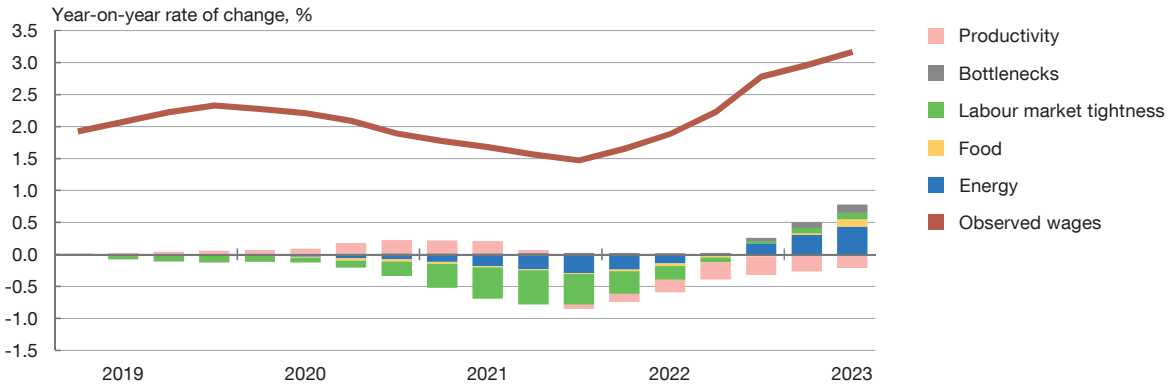
Chart 11

Contribution of the model's various shocks: wages = settlements in collective bargaining agreements, per-hour productivity and slack = unemployment rate

11.a Prices



11.b Wages



SOURCE: Banco de España calculations.

5 Final comments

Inflation developments in the Spanish economy since 2021 have been driven by a variety of factors that have interacted with each other, generating complex dynamics, some of which are unprecedented. In this context, applying the Blanchard and Bernanke (2023) model to the Spanish economy yields results that help to understand these dynamics. In particular, it can be seen how the relative importance of the different determinants of inflation in Spain has changed over time. Energy, bottlenecks and food prices (supply shocks) play a major role in explaining the pick-up in inflation since the start of this inflationary episode. More recently, after the absorption of these supply shocks, wage inflation is increasingly being driven by tighter labour market conditions, with a seemingly limited impact on prices so far but which, were it to increase, could become more persistent than the previous shocks. To sum up, in general, the results for Spain are reasonably similar to those obtained for the US and the euro area.

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