WORKING paper

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EUROSYSTÈME

What caused the post-pandemic inflation? Replicating Bernanke and Blanchard (2023) on French data[1]

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ABSTRACT

We analyse post-pandemic inflation in France using the Bernanke and Blanchard (2023) semi-structural model of wage and price inflation. This model builds on a wage Phillips curve, a mark-up price-setting equation and adaptive equations for short- and long-run inflation expectations. Wage and price inflation as well as inflation expectations are modelled as functions of a labour market slack indicator (the vacancies-to-unemployed ratio), energy and food price shocks, a measure of supply-chain disruptions ("shortages") and other exogenous factors (trend productivity, Covid lockdowns/re-openings). We estimate the model from the 1990s to 2023Q2 and derive impulse response functions and historical decomposition of endogenous variables during the pandemic-era. As Bernanke and Blanchard (2023) for the US, we find that the main driver of the post-pandemic inflation was the energy price shocks at first, followed by the food price shocks. Labour market conditions initially played a minor role in inflation, although the substantial increase in wage inflation observed between 2021Q4 and 2023Q2 can be attributed predominantly to the tightening of the labour market. Finally, we perform conditional simulations of wage and price inflation based on alternative scenarios for labour market tightness.

Keywords: Prices, Inflation, Wages, Inflation Expectations, Phillips Curve

JEL classification: E31

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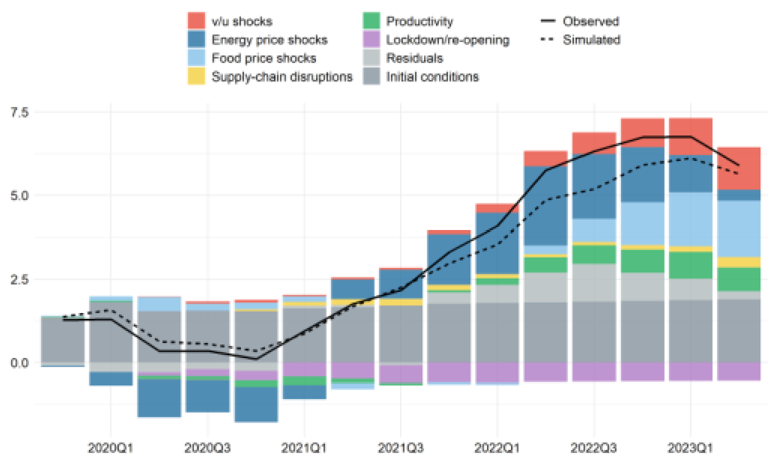
Non-Technical Summary

In France, as in most countries and in the euro area, inflation soared in 2021-2023 to levels unprecedented since the early 80's. A set of factors have likely contributed to this persistent burst of inflation: the global disruption of supply chains in the post-pandemic recovery, the increase in energy and food prices following the Russian invasion of Ukraine, the tightening of the labour market. "Accounting" decompositions based on the contributions of subindices (like energy or food) to aggregate inflation, while useful, do not provide a causal explanation of inflation. For example, energy price shocks directly impact headline inflation through the prices of energy goods, but they also have indirect effects on other components. To sort out the factors contributing to inflation using a formal model is in order.

To isolate the factors that underpin inflation, Bernanke and Blanchard (2023) have developed a semi-structural econometric model, initially applied to the US economy. Under this model, the rise in inflation (just like movements in wages and inflation expectations) is attributable to shocks affecting different variables such as the tightness of the labour market (measured by the ratio of job vacancies to the number of unemployed), energy and food prices, supply chain disruptions and trend productivity. According to their analysis, the surge in US inflation from 2021 on (from 1.2% in 2020 to 8% in 2022) was mainly caused by commodity price shocks and supply chain disruptions. The tightening of the labour market was not a decisive factor for inflation until Q1 2023. However, the effects of overheating in the labour market could have materialised subsequently, given the greater persistence of higher wages. These latter considerations had initially led the authors to contend that the 'last mile' on the road to achieving the Federal Reserve's 2% inflation target could have been harder than anticipated.

We replicated this exercise for France and estimated the Bernanke and Blanchard (2023) model using quarterly data from Q1 1990 through Q2 2023. Overall, our results (see Figure below) corroborate Bernanke and Blanchard's main findings when applied to France.

Figure. Historical decomposition of HICP inflation



Note: The figure shows a decomposition of the sources of price inflation YoY, 2019Q4 to 2023Q2, based on the solution of the full model and the implied impulse response functions. The continuous line shows actual price inflation and the total net heights of the bars are the model's decomposition of price inflation in each period and per shocks. The dashed line represents the dynamic simulation of the model, conditional on observed exogenous variables except unexplained residuals.

The sharp rise in inflation over the 2021-23 period was mainly triggered by energy price shocks in 2021. Food price shocks subsequently played a key role from 2022 onwards. By contrast, the impact of supply chain shocks remained small. However, inflationary shocks did not trigger a wage-price

spiral, due to a low degree of wage indexation and a high degree of anchoring of inflation expectations, thanks to the credibility and strong response of the European Central Bank's monetary policy. According to our findings, although the inflationary response to a commodity price shock is strong, it is short-lived. By contrast, the model shows that persistent tightness in the labour market causes persistent inflation. Interestingly, France stands apart from other advanced economies because of its price shield on energy prices, which limited and deferred price increases in France. Moreover, supply chain disruptions played a less significant role in France than in the United States.

Finally, we run conditional simulations, using the most recent data, up to 2024Q1. Looking forward, this exercise confirms that disinflation should continue in France: the inflation rate should stabilise at around 2% for a lasting period from 2025 on, i.e. at the European Central Bank's medium-term inflation target. The risks around this scenario are balanced. A sharp fall in the unemployment rate leading to persistent tightness in the labour market could push inflation back over 2%. Conversely, a continuing rise in the unemployment rate could push inflation well below 2%. Naturally, both scenarios would lead to monetary policy responses to prevent inflation from becoming too high or too low.

Les causes de l'inflation dans la période post-Covid. Une application du modèle de Bernanke et Blanchard (2023) à la France

RÉSUMÉ

Nous analysons l'inflation post-pandémique en France à l'aide du modèle semi-structurel de Bernanke et Blanchard (2023) de l'inflation des salaires et des prix. Ce modèle repose sur une courbe de Phillips des salaires, une équation de fixation des prix avec mark-up et des équations adaptatives pour les anticipations d'inflation à court et à long terme. L'inflation des salaires, celle des prix ainsi que les anticipations d'inflation sont modélisées comme des fonctions d'un indicateur de tensions sur le marché du travail (le ratio entre postes vacants/nombre de chômeurs), de chocs sur les prix de l'énergie et des produits alimentaires, d'une mesure des perturbations des chaînes d'approvisionnement (« pénuries ») ainsi que d'autres facteurs exogènes (productivité tendancielle, confinement et déconfinement durant le Covid). Nous estimons le modèle depuis les années 1990 jusqu'à 2023 et dérivons les fonctions de réponse et la décomposition historique des variables endogènes pendant la période de la pandémie. Comme Bernanke et Blanchard (2023) pour les États-Unis, nous obtenons que le principal moteur de l'inflation post-pandémique a d'abord été les chocs des prix de l'énergie, suivis par les chocs des prix des produits alimentaires. Les conditions du marché du travail ont initialement joué un rôle mineur dans l'inflation, bien que l'importante augmentation de l'inflation salariale observée entre le T4 2021 et le T2 2023 puisse être attribuée principalement au resserrement du marché du travail. Enfin, nous effectuons des simulations conditionnelles de l'inflation des salaires et des prix sur la base de scénarios alternatifs de resserrement du marché du travail.

Mots-clés : prix, inflation, salaires, anticipations de l'inflation, courbe de Phillips

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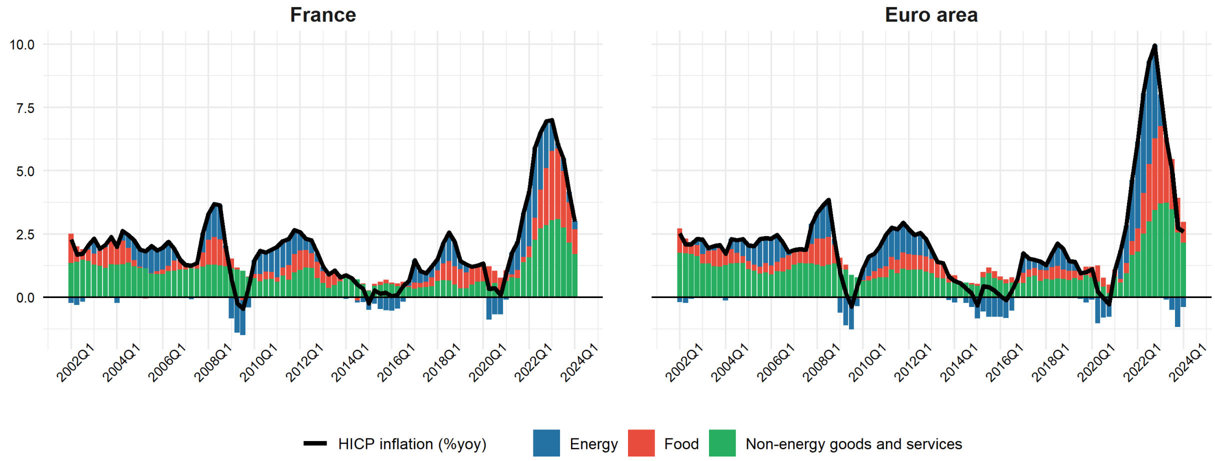
1 Introduction

In France, as in most countries and in the euro area, inflation soared in 2021-2023 to levels unprecedented since the early 80's (Figure 1). A set of factors have likely contributed to this persistent burst of inflation: the global disruption of supply chains in the post-pandemic recovery, the increase in energy and food prices following the Russian invasion of Ukraine, the tightening of the labour market. "Accounting" decompositions such as the one shown in Figure 1, while useful, do not provide a causal explanation of inflation. For example, energy price shocks directly impact headline inflation through the prices of energy goods, but they also have indirect effects on other components. This occurs because energy is an input for the production of non-energy goods, and rising energy costs and inflation can lead workers to negotiate higher wages to preserve their purchasing power, which in turn drives up the prices of services. To sort out the factors contributing to inflation using a formal model is in order.

Figure 1: Headline inflation (Harmonised Index of Consumer Price, HICP) and contributions of major sub-components in France and the euro area (2002Q1-2024Q1)



Sources: Eurostat and Insee.

To study the observed increase in US inflation, Bernanke and Blanchard (2023, forthcoming, BB, henceforth) proposed a semi-structural model that jointly determines wage, price inflation and both short- and long-run inflation expectations, depending in particular on labour market slack (as measured by the vacancies-to-unemployed ratio), energy and food prices, supply-chain disruptions and trend productivity. They estimated the model on quarterly data from 1990Q1 to 2023Q1. Based on the model results, they found that the inflation burst in the US beginning in 2021 was mostly explained by shocks to prices given wages, resulting from increases in commodity prices, and sectorial price spikes resulting from supply-chain disruptions. While the labour market tightness had not been a primary driver of inflation up to 2023Q1, they concluded that the effects of an overheated labour market could materialise later, given the higher persistence of shocks to wage inflation compared to shocks to good and services prices. As a consequence, they argued that "the last mile" in order to reach the central bank's inflation target at 2% could be harder and require a restrictive macroeconomic policy, from both monetary and fiscal authorities.

Following their initial work on US data, an international joint project was launched in July 2023, also involving the Bank of England (Haskel et al., 2023), the Bank of Japan (Nakamura et al., 2024), the Bank of Canada (Bounajm and Zhang, 2023), the ECB (Arce et al., 2024), the Bundesbank (Menz, 2024), the Banque de France, Banca d'Italia (Pisani and Tagliabracci, 2024), Banco de España (Ghomi et al., 2024), the Banque Nationale de Belgique (de Walque and Lejeune, 2024) and De Nederlandsche Bank (Bonam et al., 2024). Bernanke and Blanchard (2024a,b) summarises the results of this joint project. The joint project aims at investigating, by applying the Bernanke and Blanchard model, whether conclusions regarding the US post-pandemic inflation hold for other 10 major advanced economies. Strikingly similar results emerge among the 11 economies studied. Price inflation is mostly attributed to commodity prices and supply-chain disruption shocks across countries. The Phillips curve is generally found to be flat, which partially explains the limited role of labour market shocks in explaining post-pandemic inflation. At the same time, this implies that a substantial labour market tightening would be required to bring back inflation toward the 2% target, in the absence of any other disinflationary forces.[1]

This paper presents the contribution by the Banque de France team to this international joint project. We estimate the BB model using quarterly data from early 1990's to mid-2023 to study the causes of post-pandemic inflation in France. We follow a similar methodology and do not substantially depart from the original specification for the sake of comparability across countries. As other teams from the joint-project, we estimate all model equations up to early 2023. While we attempt to use as much as possible similar data, some differences arise between the original application on US data and our work, in particular regarding wage measurement and inflation expectations.

Overall, our results align with the main broad messages from Bernanke and Blanchard (2024a) in the case of France. Firstly, the inflation burst in 2021-2022 was mainly triggered by energy and food price shocks. This is explained by the model properties which display a short-lived response to commodity price shocks and a modest effect of supply-chain disruption shocks. Secondly, no price-wage spiral ensued, reflecting a low degree of wage indexation as well as a strong degree of anchoring of expectations. By contrast, the model is characterised by a gradual persistent inflation response to labour market slack, measured by the vacancies-to-unemployed ratio. Compared to other (in particular euro area) economies, the increase in inflation in France was more gradual, and the inflation peak was lower. These specific patterns are linked to the energy price shield policy, which limited the price increases as shown by Lemoine et al. (2024). Our estimates also point to a less acute role of supply-chain disruptions than in others countries. Finally, we run conditional simulations, using the most recent data, up to 2024Q1. Looking forward, this exercise points towards a baseline scenario in which inflation goes back to the ECB target. However, four scenarios also illustrate an upside risk for inflation persistence, in particular if the labour market would stay tight. Overall, these simulations are not worrisome regarding inflation persistence. Disinflation is well underway in the baseline scenario where the labour market stays at its 2019Q4 tightness level; the inflation rate would not increase above 2% in the medium run. In scenarios in which labour market tightness goes back to its historical average (or below), headline inflation would even decrease to 1%-1.5% per year.

These results are fairly robust to several alternative specifications. Firstly, instead of using the vacancies-to-unemployed (v/u) ratio, we estimated the model using the unemployment rate as a measure of the labour market slack. Results are broadly in line with the v/u specification, in particular regarding the historical decomposition of price inflation. Secondly, estimating the model over a pre-Covid sample yields similar results. Finally, we modified the model when performing conditional simulations in order to add an explicit anchor for inflation expectations to the central bank target. Looking forward, explicit anchoring of inflation expectations does not alter much the convergence toward the 2% target, as inflation is already close to 2% in 2024Q1 and the pass-through of inflation expectations to price inflation through wages is very gradual.

Related literature. Several papers studied the causes of the burst in inflation following the pandemic, usually using Vector AutoRegressive (VAR) models with various specifications. Focusing on energy price shocks in euro-area countries, Corsello and Tagliabracci (2023) show that, in the first nine months of 2022, energy inflation accounted for more than 60 per cent, on average, of headline inflation in the euro area, either directly or indirectly. Looking at individually at the four largest countries in the euro area, the conclusion remains the same with some quantitative differences – France displays the lowest contribution of energy prices to headline inflation in the beginning of 2022. With a different specification for their Bayesian structural VAR model, Ascari et al. (2024) show that shocks to global supply chain pressures were the dominant driver of euro area

[1] However, as we will develop in the paper, other channels could be at play to bring back inflation toward the 2% target: stronger disinflation or even deflation in the goods market, higher productivity growth and an explicit anchoring of inflation expectations on the 2% target.

inflation in 2022, and that these shocks have a highly persistent and hump-shaped impact on inflation. Alternatively, Bańbura et al. (2024) used a VAR model for the euro area to decompose past core inflation including global oil supply, oil demand, gas prices, supply chains pressures, domestic supply, domestic demand, foreign demand and labour market slack in their analysis. They find that core inflation in the euro area was largely driven by supply-side shocks during the post-pandemic recovery with energy-related shocks playing a prominent role while shocks to global supply chain pressures and to gas prices made a much larger contribution than in past inflation episodes. Bergholt, using a Bayesian structural VAR, find that demand and supply factors contributed more or less equally to the recent inflation surge in the euro area, with a more prevalent role for demand factors in 2022. While supply factors played a role only until mid-2022 in the US, they explain a substantial share of inflation in the euro area also in the latest part of the sample.

Using various empirical models (including VAR models, time-varying Phillips curves and dynamic factor models), Neri et al. (2023) show that the contribution of energy price shocks to headline inflation in the euro area is estimated to be around 60 per cent in the fourth quarter of 2022, while that to core inflation to range from 20 to 50 per cent, depending on the model. With a broader scope (21 advanced and emerging market economies), Dao et al. (2024) explains the evolution of core inflation with two factors: the strength of macroeconomic conditions – measured by the unemployment gap, the output gap, and the ratio of job vacancies to unemployment — and the pass-through into core inflation from past headline shocks. The paper concludes that the international rise and fall of inflation since 2020 largely reflected the direct and pass-through effects of headline shocks while macroeconomic conditions generally played a secondary role.

The recent burst in inflation has also triggered a new set of work on inflation expectations. In the case of France, Gautier and Montornès (2022) conducted a new survey of household inflation expectations and find that in the 2020-2021 period, inflation expectations were positively correlated to realised inflation but also the expected unemployment rate. D'Acunto et al. (2024) also find that consumers' medium and longer-term expectations may deviate noticeably from central bank targets and, in contrast with expert expectations, are often very susceptible to shorter-term inflation news. By testing for expectation de-anchoring, our paper relates to this literature.

Following this introduction, Section 2 of this paper presents the model, Section 3 describes the data set used for the estimation. Section 4 through to Section 6 report the simulation results, the impulse response functions and the historical decompositions. Section 7 provides various robustness checks while Section 8 showcases conditional simulations with different labour market slack scenarios and Section 9 concludes. An Appendix details additional information on the data used to estimate the model and various robustness checks.

2 The Bernanke and Blanchard model

This section presents our specification, i.e. the empirical model proposed by Bernanke and Blanchard (2023, forthcoming) to study wage-price dynamics. Beforehand, we recall the stylised analytical model also presented by BB, highlighting the properties of the set-up. The Bernanke-Blanchard model shares some similarities with larger scale semi-structural models, such as Banque de France's FR-BDF model (Lemoine et al., 2019). However, it features less details in terms of the price wage loop and the modelling of expectations, and lacks the full dynamics and feedback included in the aggregate demand block of the model. While using a larger scale model to decompose past inflation and run conditional simulations would be a valuable exercise, a main advantage of the Bernanke and Blanchard model is that we are able to compare our results to those of other countries, relying on a parcimonious and transparent set-up. A limitation is that the role of fiscal and monetary policies remains implicit, and is indirectly captured, presumably mainly through the dynamics of labour market tightness.

2.1 A stylised analytical model

BB propose a partial-equilibrium semi-structural model for wage-price determination. The analytical model is composed of four equations determining nominal wages w_t, prices p_t, and short-run ($p_t^e - p_{t-1}$) and long-run (π_t^*) inflation expectations.

First, the aggregate wage equation is similar to an expectations-augmented wage Phillips curve:

$$w_t - w_{t-1} = (p_t^e - p_{t-1}) + \alpha(p_{t-1} - p_{t-1}^e) + \beta(x_t - \alpha x_{t-1}) + z_t^w \quad (1)$$

where wage inflation depends on short-term expected price inflation, a catch-up term ($p_{t-1} - p_{t-1}^e$), labour-market slack x_t and other factors affecting wage determination such as trend labour productivity. The catch-up term, present if $\alpha \neq 0$, captures that wage earners will achieve to compensate for past lost purchasing power due to unexpected inflation. As nominal wage changes depend one-to-one on short-run expected inflation, the wage Phillips curve is vertical in the long run.

The aggregate price-setting equation is derived from a mark-up price-setting model:

$$p_t - p_{t-1} = (w_t - w_{t-1}) + (z_t^p - z_{t-1}^p) \quad (2)$$

where price inflation depends on nominal wage inflation and a few non-labour factors z_t^p (e.g. energy and food prices and supply-chain disruptions).

Finally, the model ends with two equations relating short- and long-run inflation expectations. Short-run inflation expectations are a weighted average of long-run expectations and realised inflation, where δ represents the degree of anchoring:

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

Long-run inflation expectations are a weighted average of last period long-run expectations and realised inflation, with λ being the degree of anchoring:

$$\pi_t^* = \lambda\pi_{t-1}^* + (1 - \lambda)(p_{t-1} - p_{t-2}) \quad (4)$$

A few properties of the model are worth highlighting. First, the degree of persistence of inflation after a shock will depend on the parameters. As illustrated by simulations in Bernanke and Blanchard (2023, forthcoming), whenever inflation expectations are well anchored (high δ) and/or if catch up is low (low α), the inflationary impact of shocks will be a smaller and less persistent.

Second, as long as the forcing variables are considered exogenous, the model has a unit-root. This can be easily seen for instance the polar case assuming $\delta = \alpha = 0$:

$$p_t - p_{t-1} = (p_{t-1} - p_{t-2}) + \beta x_t + z_t^w + (z_t^p - z_{t-1}^p) \quad (5)$$

Thus forces that may bring back inflation to target (such as monetary policy) remain implicit. Relatedly, any transitory shock to x_t, z_t^w or z_t^p will have – all else being equal - a permanent impact on inflation $p_t - p_(t-1)$, as the latest equation is akin to a random walk.

Finally, the model has the natural rate property: assuming z_t^w is stationary and centered, there is no long run trade-off between inflation and unemployment (or other labour market indicator), and only the 'equilibrium' value $x_t = 0$ is compatible with a stable inflation rate.

2.2 Empirical model

In order to confront this model to the data, BB have built an empirical model akin to a structural vector auto-regression (SVAR) model approach. Restrictions are applied directly to the lagged endogenous variables so that the empirical model shares the same general properties as the analytical model.

The **empirical wage inflation equation** includes four lags of nominal wage growth Δw_t, four lags of 1-year-ahead inflation expectations $\pi_t^{e,1yr}$, four lags of labour-market slack (measured by the job-vacancies-to-unemployment rate $(v/u)_t$), "catch-up" or unexpected inflation $\hat{\pi}_t = \sum_{i=1}^{4} \pi_{t-i} - \pi_{t-4}^{e,1yr}$ and also depends on lagged trend labour productivity growth $\bar{a}_{t-1}$:

$$\Delta w_t = \alpha_{w,0} + \sum_{k=1}^{4} \theta_{w,k} \Delta w_{t-k} + \sum_{k=1}^{4} \alpha_{w,k} \pi_{t-k}^{e,1yr} + \sum_{k=1}^{4} \beta_{w,k} (v/u)_{t-k} + \sum_{k=1}^{4} \kappa_{w,k} \hat{\pi}_{t-k} + \eta_w \bar{a}_{t-1} + \theta_{2020Q2} D2020Q2 + \theta_{2020Q3} D2020Q3 + \epsilon_{w,t} \quad (6)$$

They apply a homogeneity constraint on the parameters $\sum_{k=1}^{4}(\theta_k + \alpha_k) = 1$, so that the long-run wage Phillips curve is vertical. When estimating the model on post-pandemic data, the wage equation also includes dummy variables for 2020Q2 and 2020Q3, to capture the effects of the 2020 lockdown and the following reopening.

The **empirical price inflation equation** shares a similar structure and includes four lags of quarter-on-quarter price inflation π_t, and current value and four lags of wage inflation Δw_t, relative energy inflation $\Delta(e/w)_t$ and relative food inflation $\Delta(f/w)_t$ (with respect to wage), a measure of supply bottlenecks (i.e. shortages) based on Google Trends s_t and also depends on current labour trend productivity $\bar{a}_t$:

$$\pi_t = \alpha_{\pi,0} + \sum_{k=1}^{4} \theta_{\pi,k} \pi_{t-k} + \sum_{k=0}^{4} \alpha_{\pi,k} \Delta w_{t-k} + \sum_{k=0}^{4} \beta_{\pi,k} \Delta(e/w)_{t-k} + \sum_{k=0}^{4} \kappa_{\pi,k} \Delta(f/w)_{t-k} + \sum_{k=0}^{4} \mu_{\pi,k} s_{t-k} + \eta_w \bar{a}_t + \epsilon_{\pi,t} \quad (7)$$

A homogeneity constraint is applied such that the long-run pass-through of wage inflation to price inflation is unitary, i.e. $\sum_{k=1}^{4}(\theta_{\pi,k} + \alpha_{\pi,k} = 1$.

The **short-run inflation expectation equation** includes four lags of its own, and depends on current and four lags of actual price inflation and long-run inflation expectations:

$$\pi_t^{e,1yr} = \sum_{k=1}^{4} \alpha_{\pi^e,k} \pi_{t-k}^{e,1yr} + \sum_{k=0}^{4} (\beta_{\pi^e,k} \pi_{t-1}^{*} + \gamma_{\pi^e,k} \pi_{t-k}) + \epsilon_{\pi^e,t} \quad (8)$$

A homogeneity constraint $\sum_{k=1}^{4} \alpha_{\pi^e,k} + \sum_{k=0}^{4}(\beta_{\pi^e,k} + \gamma_{\pi^e,k}) = 1$ is imposed, such that a permanent increase in the actual inflation rate would result in a permanent increase in inflation expectations.

Finally, **long-run inflation expectation equation** includes four lags of its own and depends on current and four lags of actual price inflation:

$$\pi_t^{*} = \sum_{k=1}^{4} \alpha_{\pi^*,k} \pi_{t-k}^{*} + \sum_{k=0}^{4} \gamma_{\pi^*,k} \pi_{t-k}) + \epsilon_{\pi^*,t} \quad (9)$$

with a homogeneity constraint $\sum_{k=1}^{4}(\alpha_{\pi^*,k} + \gamma_{\pi^*,k}) = 1$.

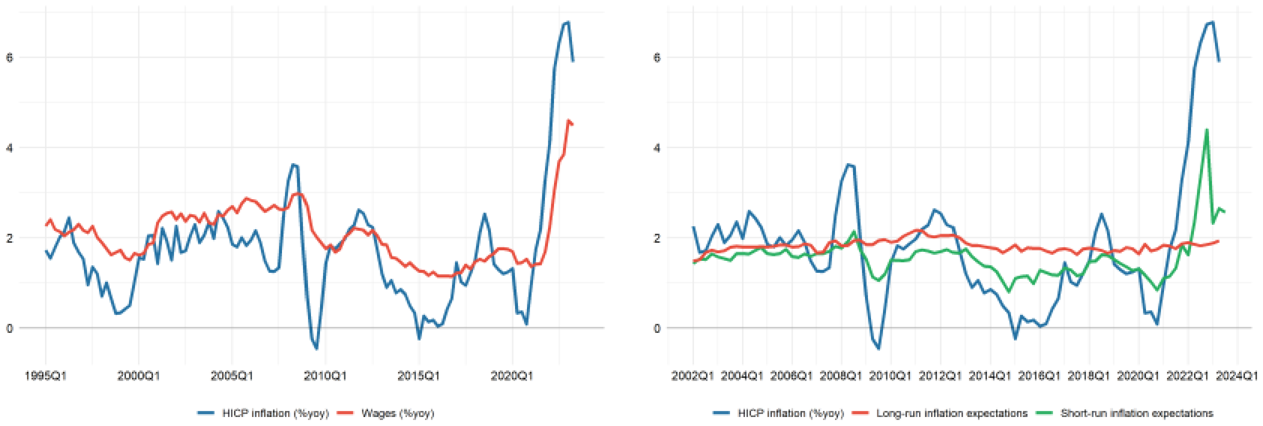
3 Dataset

Applying this model to French data implies that the data sources and series are not the strict counterparts to those of BB. Table 6 in the appendix provides the definitions, samples and sources, for all endogenous and exogenous variables.

Price inflation is measured by the annualised quarterly log-difference of total Harmonised Index of Consumer Prices (i.e. $gcpi = 400 \times \Delta logHICP$). Figure 2a plots inflation in year-on-year terms. Similarly, we define relative energy and relative food inflation by the annualised quarterly log-difference of HICP energy

Figure 2: Inflation, wages and inflation expectations

(a) HICP inflation and wages growth **(b)** HICP inflation, short- and long-run inflation expectations



Source: see Table 6 in appendix.

and food sub-components, relative to a wage index.

Wage inflation is measured by the annualised quarterly log-difference of the French Basic Monthly Wage ("*Salaire Mensuel de Base*" or SMB, i.e. $gw = 400 \times \Delta logSMB$), see Figure 2a also. This measure differs from total compensation or wages per employee. It corresponds to an employee's gross wage before deduction of any form of contributions [2] and it does not include bonuses or pay received for overtime (for full-time employees) or additional hours (for part-time employees). Compared to the other two measures, the base wage (SMB) is less subject to short-term fluctuations and better captures the underlying trend of wage inflation considered (see Figure 14 in the appendix). In practice, it facilitates the estimation of the wage equation. Arce et al. (2024) made a similar choice when estimating the wage equation on euro area data, by using negotiated wages rather than total compensation per employee.

Short- and long-run inflation expectations come from the Consensus Forecast (CF), see Figure 2b. Short-run inflation expectations are the year $y+1$ inflation forecast at a given quarter q of year y. Hence, the forecast horizon varies with the quarter (from $q+8$ to $q+4$). Unfortunately, the CF does not provide us with quarterly forecasts with fixed (n-quarters ahead) horizons, but only forecasts for annual (calendar year) inflation at quarterly frequency, from 2002Q1 to 2023Q2. Before 2002Q1, we backcast short-run inflation expectations using a 12-quarter moving average of realised inflation. Finally, long-run inflation expectations are the year $y+5$ to $y+10$ inflation forecast at a given quarter, available from 1995Q1 to 2023Q2.

For exogenous variables, we follow a similar approach. First, we measure relative energy and food inflation as the annualised quarterly inflation rate of energy and food price, using HICP energy and food components, relative to wages.

Second, we use the job-vacancies-to-unemployed rate as a measure of labour market slack. Figure 3a shows the job-vacancies-to-unemployed rate in France. The red dashed line is the adjusted series as the original time series (from the Dares - the Ministry of Labour) has several breaks and missing observations due to changes in survey methodology, which we overcome using interpolation. Yet, we do not have a sufficient historical length, as the data start in 2003Q2. Consequently, over the period 1992Q1 to 2003Q1, we backcast that series relying on an indicator taken from the Insee's short-run outlook survey: namely, the share of businesses for which activity is limited because of a shortage of staff. Figure 3b shows a variant of the traditional Beveridge curve, plotting the standardised v/u ratio against the unemployment rate. The Beveridge curve shifted upwards in France before 2015, implying a deterioration in labour market matching, but has remained fairly stable since. In particular, we do not observe a deterioration in labour market matching since the Covid pandemic, even though the French economy has moved to the left along the Beveridge curve.

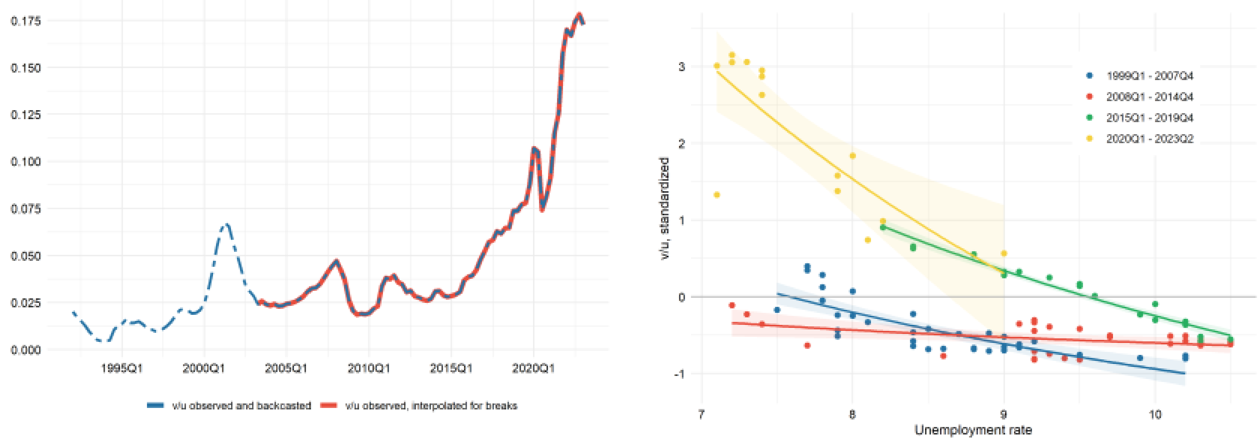
Third, we measure supply-chain disruptions, using Google searches (Figure 4). We average Google search

[2] Contributions include those related to social security, unemployment insurance, supplementary pension, provident fund, CSG, CRDS.

Figure 3: Labour market tightness and the Beveridge Curve

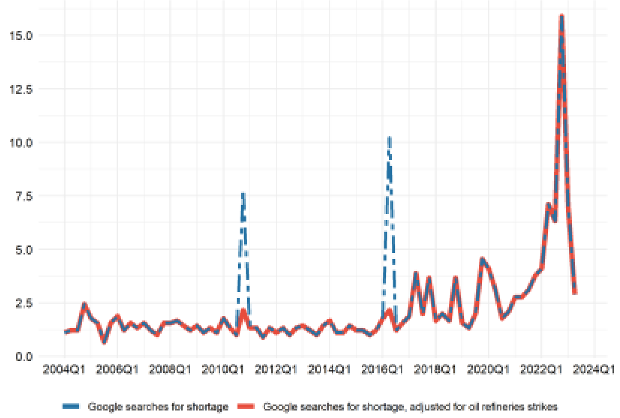
(a) Vacancies-to-unemployed ratio (v/u)

(b) Evolution of the Beveridge curve in France (1999Q1-2023Q2)



Source: see Table 6 in appendix, authors' calculations.

Figure 4: Average number of Google search indexes for shortage in France



Source: see Table 6 in appendix, authors' calculations.

indexes for words "*pénurie*", "*pénuries*" and "*approvisionnement*". However, in 2010Q4 and 2016Q2, two major strikes in oil refineries strongly impact these searches but do not indicate generalised supply-chain disruptions as the ones experienced in the post-Covid period. Hence, we include dummies in the regression with to adjust the data for these two events. Finally, as in BB, we assume the shortage series is equal to its historical mean before 2004Q1, due to missing data.

Finally, as in BB, we use a measure of the trend in labour hourly productivity in market branches using an annualised 8-quarter moving average of productivity (see Figure 15). Although we adjust hours for the steep fall observed during the Covid period by interpolation, our measure for the trend in labour productivity remains volatile during the Covid period.

4 Baseline estimation results

In this section, we present the baseline estimates of the empirical model on the full sample. Specifications (6)-(9) are estimated equation-by-equation using constrained least squares, until 2023Q2. We add dummy variables for 2020Q2 and 2020Q3 to the original specification, to take into account the effects of Covid lockdowns and re-openings in 2020. We also use standardised v/u and shortage variables; consequently coefficients associated to those variables cannot be immediately compared to those estimated by BB on US data.

4.1 Wage inflation

Table 1 reports estimation results for the wage equation (6) from 1995Q1 to 2023Q2. It gives the estimate of the sum of coefficients associated to each explanatory variable and the relevant statistical significance and the p-value for the joint test that all lags are insignificant.

Table 1: Wage growth regression, dependent variable gw

Independent variables	gw	v/u	catch-up	cf1	magpty
Lags	-1 to -4	-1 to -4	-1 to -4	-1 to -4	-1
Sum of coefficients	0.781	0.056	0.061	0.219	0.032
p-stat (sum)	0.000	0.552	0.510	0.113	0.531
p-stat (joint)	0.000	0.000	0.969	0.011	0.531
R-squared			0.75		
No. observations			114		
Sample			1995Q1 - 2023Q2		

Note: p-stat (sum) is the p-value for the null hypothesis that the sum of coefficients is zero, p-stat (joint) is the p-value for the joint hypothesis that each of the current and lag coefficients separately equals zero.

Results indicate that nominal wage growth is quite persistent with a positive – close to one – and significant sum of coefficients on its own lags. The slope of the Phillips curve is small but positive, although imprecisely estimated, and yet individual coefficients are jointly significant. More precisely (see Table 7 in appendix), the first and second lags are positive but non-significant at the 10% level while the third and fourth lags are negative, with the third lag being significant at 10%. We find no significant evidence of a catch-up effect of unexpected inflation on wages; in other words, we find no evidence of a strong wage-price spiral. Finally, the sum of coefficients for long-term productivity is positive but not significant.

The non-significant catch-up effect is to some extend surprising as the minimum wage in France is formally indexed to inflation Gautier et al. (2022, e.g.). However, several reasons may explain this finding. First, minimum wage apply to a limited fraction of wage earners (17.3% of employees as of January 2023 – a high value by historical standards).[3] Second, the indexation rule is non-linear, which may induce some mild misspecification of our specification. The minimum wage is raised in proportion with realised year-on-year inflation (indexed to measured inflation for 20% households with the lowest incomes) plus half of the gain in purchasing power of average hourly wage of workers and employees. Increases take place once a year (decreases are precluded): on each January 1st since 2010 (each July 1st before 2010). The indexation rule features some threshold effects, for instance an additional increase is triggered if the consumer prices index has increased by more than 2% since the last increase. Finally, changes in the minimum wage can include an additional discretionary boost decided by the government.

A relevant question is whether the homogeneity assumption (i.e. that the Phillips curve is vertical in the long run) holds in the data. We estimated an unconstrained version of the wage equation, in order to test for the homogeneity constraint. In that case, the sum of coefficients on the lags of wages growth and short-term inflation expectations is equal to 0.876, but non-significantly different from 1. Therefore, we cannot reject the hypothesis that the wage Phillips curve is vertical in the long run, although the sum of coefficients is smaller than 1. This motivates our choice to keep those theoretical constraints imposed on coefficients.

In Section 7, we explore an alternative specification with the unemployment rate rather than v/u, to test whether the unemployment rate has a larger explicative power than the vacancies-to-unemployed ratio in the wage Phillips curve.

4.2 Price inflation

Table 2 reports estimation results for the price equation 7 from 1995Q1 to 2023Q2. Due to the homogeneity constraint, the sum of coefficients for past price inflation and wage growth sum to one. Similarly to the wage

[3] See Dares Résultat No. 71, https://dares.travail-emploi.gouv.fr/publication/la-revalorisation-du-smic-au-1er-janvier-2023.

equation, price inflation is somewhat persistent. There is a contemporaneous pass-through from wage inflation to prices: while only the coefficient for current wage inflation is significant (see Table 6 in appendix), the sum of coefficients (0.564) is strongly significant. This pass-through of wage inflation to prices is similar to that of Bernanke and Blanchard (2023, forthcoming) for the United States (0.665) but higher than that of Arce et al. (2024) for the euro area (0.313). Pass-through of relative energy and food prices are both strong and significant: the long-run impact of a +1% increase in relative food prices on price inflation is around +0.12pp and the long-run impact of a +1% increase in relative food prices is +0.17pp, close to the respective weights of these components in total HICP. Supply-chain disruptions ("shortage") does not appear to have a significant effect on price inflation, in contrast with results for both the US and the euro area. Finally, trend labour productivity negatively affects price inflation, as expected from economic theory.

Table 2: Price growth regression, dependent variable gcpi

Independent variables	**gcpi**	**gw**	**grpe**	**grpf**	**shortage**	**magpty**
Lags	-1 to -4	-1 to -4	-1 to -4	-1 to -4	0 to -4	0
Sum of coefficients	0.436	0.564	0.066	0.095	0.183	-0.106
p-stat (sum)	0.002	0.000	0.000	0.022	0.186	0.005
p-stat (joint)	0.001	0.000	0.000	0.000	0.773	0.005
R-squared			0.94			
No. observations			129			
Sample			1991Q2 - 2023Q2			

Note: p-stat (sum) is the p-value for the null hypothesis that the sum of coefficients is zero, p-stat (joint) is the p-value for the joint hypothesis that each of the current and lag coefficients separately equals zero.

By testing the homogeneity constraint, we reject the null hypothesis that the sum of coefficients for past price inflation and wage is equal to 1. The unrestricted sum of coefficients is equal to 0.90 in this case, with a p-value above but close to the 10% level.

4.3 Short-run inflation expectations

Table 3 reports estimation results for the short-run inflation expectations equation eq:EmpiricalSTInflExpectEquation from 1996Q1 to 2023Q2, under the homogeneity assumption that all coefficients sum to 1. First, short-run inflation expectations are not anchored on long-run inflation expectations, with a sum of coefficients non-significant and very close to zero. This results renders long run inflation expectations irrelevant for actual inflation dynamics in our set-up. Short-run expectations rather depend on realised inflation, (in contrast with findings for the US but close to that of the euro area) with a lot of inertia however. The degree of persistence of short-run inflation expectations is also larger than in the US, hence short-run expectations react relatively slowly to realised inflation shocks. As for other equations, a test of the homogeneity constraint does not reject the homogeneity constraint, based on an unrestricted specification of equation 3.

Table 3: Short-run inflation expectations, dependent variable cf1

Independent variables	**cf1**	**cf10**	**gcpi**
Lags	-1 to -4	0 to -4	0 to -4
Sum of coefficients	0.805	-0.013	0.208
p-stat (sum)	0.000	0.752	0.000
p-stat (joint)	0.000	0.6941	0.000
R-squared		0.83	
No. observations		110	
Sample		1996Q1 – 2023Q2	

Note: p-stat (sum) is the p-value for the null hypothesis that the sum of coefficients is zero, p-stat (joint) is the p-value for the joint hypothesis that each of the current and lag coefficients separately equals zero.

4.4 Long-run inflation expectations

Table 4 reports estimation results for the long-run inflation expectations equation 9. Results are really close to those obtained for the US by Bernanke and Blanchard (2023, forthcoming) and the euro area by Arce et al. (2024): long-run inflation expectations are strongly persistent and very slowly react to realised inflation shocks. The homogeneity constraint also holds in the data, as for short-run expectations.

Table 4: Long-run inflation expectations, dependent variable cf10

Independent variables	**cf10**		**gcpi**
Lags	1 to -4		0 to -4
Sum of coefficients	0.989		0.011
p-stat (sum)	0.000		0.054
p-stat (joint)	0.000		0.032
R-squared		0.86	
No. observations		110	
Sample		1996Q1 - 2023Q2	

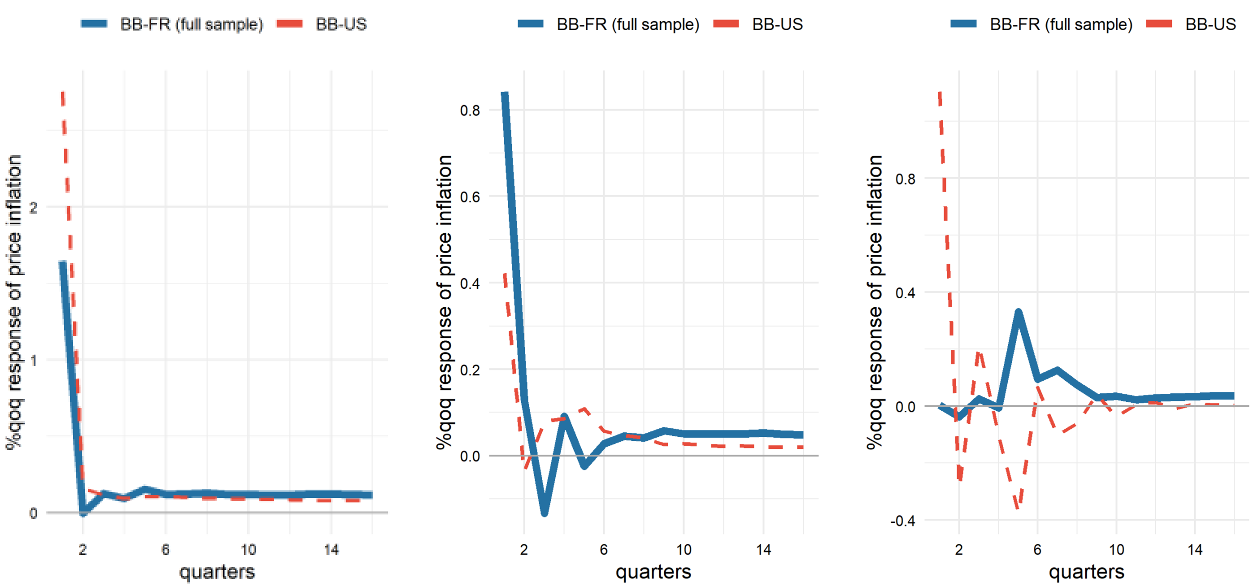
Note: p-stat (sum) is the p-value for the null hypothesis that the sum of coefficients is zero, p-stat (joint) is the p-value for the joint hypothesis that each of the current and lag coefficients separately equals zero.

5 Impulse response functions

Using the set of estimates, we simulate impulse response functions (IRFs) of the semi-structural model composed of equations 1-4 to four shocks: a relative energy price shock, a relative food price shock, a temporary supply-chain disruption shock and a permanent v/u shock. The impulse responses describe the dynamic properties of the empirical model.

Figure 5: Impulse response functions of price inflation to commodity and supply shortage transitory shocks

(a) Energy price shock **(b)** Food price shock **(c)** Supply-chain disruptions shock

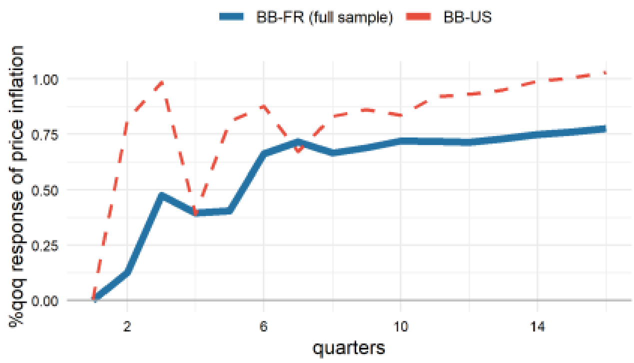


Source: see Table 6 in appendix, authors' calculations.
Note: The figures show the full model's dynamic responses of inflation to a one standard-deviation positive shock to relative energy prices, relative food prices, and the shortage variable. Price inflation is the annualised quarter-on-quarter growth rate of HICP. The dashed red line reports the baseline IRFs of Bernanke and Blanchard (2023, forthcoming) for the US economy.

Figure 5 shows the impulse response functions to transitory energy and food prices shocks and supply-chain disruption ("shortage") shocks. Responses to commodity prices shocks are quite short-lived. Supply-chain disruption shocks (defined as a one standard-deviation shock to the series of Google searches for "shortage") have a modest effect on inflation, +0.3pp on price inflation at the 5th quarter after the shock. Similarly to BB for the US, it features a small (non-significant) catch-up effect (i.e. real wage rigidity), but short-run and long-run inflation expectations are relatively well anchored, to the extent that they react very slowly to realised inflation shocks. The response of price inflation to energy price shocks is smaller in France compared to that of the US, but larger for food price shocks. Supply-chain disruption shocks have a small and delayed impact in France, in contrast with findings for the US.

Figure 6 shows the response of price inflation to a persistently tighter labour market, defined as a permanent one standard-deviation shock to the vacancy-to-unemployment (v/u) rate. Price inflation gradually increases after the shock, reaching +0.7pp after 2 years, which is similar, albeit slightly lower, than that of BB for the US. Inflation does not converge back to its baseline level and even follows an ever-increasing path. Because the labour market stays permanently tighter, wages growth persistently increases and transmits to prices through the price-setting equation 2. Ever-increasing wage inflation would then transmits, through price inflation, to short- and long-run inflation expectations, and finally feeding a self-sustained wage-price spiral. It is important to recall that this analytical exercise assumes no feedback on v/u stemming from persistently higher inflation. In the medium to long-run, in reality, such persistent inflation burst would likely weigh on aggregate demand. This may occur either due to a decline in competitiveness and diminished real net exports, depressed households' purchasing power and real consumption, or as a result of the monetary policy responding to rising inflation.

Figure 6: Impulse responses functions of price inflation to a permanent v/u shock



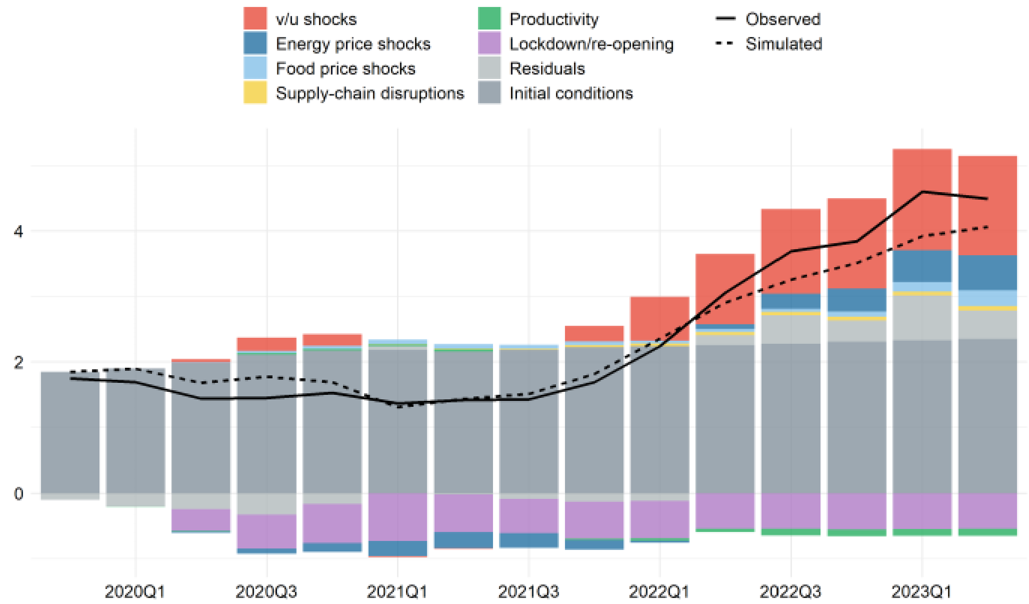
Source: see Table 6 in appendix, authors' calculations.
Note: The figure shows the full-model, dynamic responses of inflation to a positive one standard-deviation permanent shock to vacancies-tounemployed ratio. Price inflation is the annualised quarter-on-quarter growth rate of HICP. The dashed red line reports the baseline IRFs of Bernanke and Blanchard (2023, forthcoming) for the US economy.

6 Historical decompositions

A first valuable application of the empirical model of BB is to perform a historical decomposition of wage and price inflation, given observed dynamics of relative energy and food prices, labour market tightness, supply-chain disruptions, productivity and Covid lockdowns/re-openings (dummy variables). Following BB, we calculate each shock as the deviation of the associated exogenous variable from its baseline level.[4]. Finally, historical decompositions will make appear the contribution of "initial conditions". As explained in Arce et al. (2024), the contribution of initial conditions represent a counterfactual scenario for wage and price inflation in absence of observed shocks between 2020Q1 and 2023Q2, according the model (including the contribution of the intercept).

[4]Following BB, we make the following assumptions regarding baseline level of exogenous variables. Labour productivity baseline growth is set to 0.6% (i.e. the pre-Covid sample mean) Standardised shortage variable is set to zero. Relative energy and food prices are set to zero. The standardised v/u ratio is set to the pre-Covid value. And finally, dummy variables baseline values are set to zero.

Figure 7: Historical decomposition of wage inflation



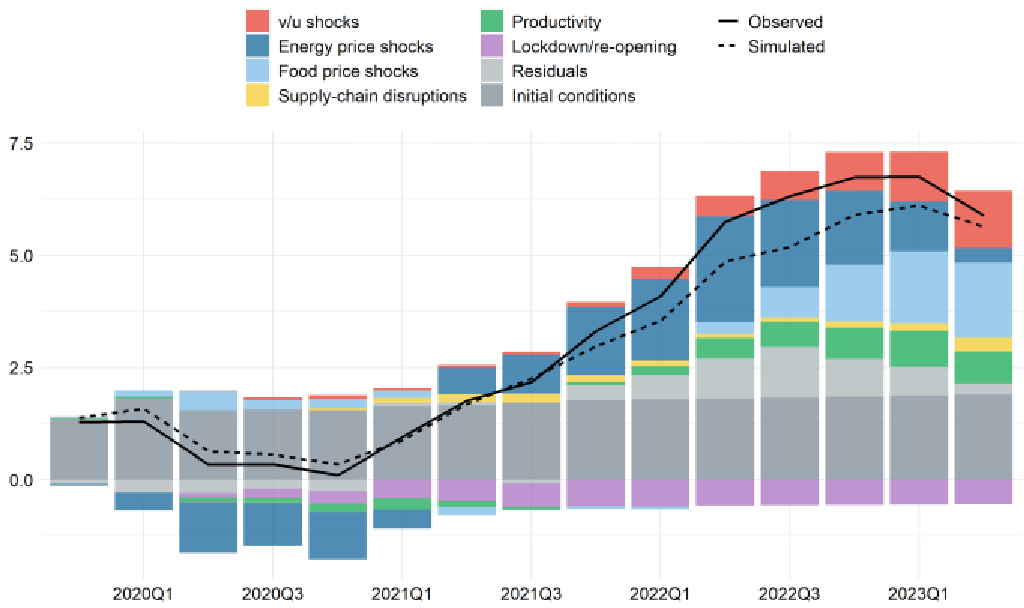
Source: see Table 6 in appendix, authors' calculations.
Note: The figure shows a decomposition of the sources of wage inflation YoY, 2019Q4 to 2023Q2, based on the solution of the full model and the implied impulse response functions. The continuous line shows actual wage inflation and the total net heights of the bars are the model's decomposition of wage inflation in each period and per shocks. Coloured segments of each bar show the dynamic contribution of each exogenous variable, including residuals of all equations, to wage inflation in that period, as implied by the full system of estimated equations. The dashed line represents the dynamic simulation of the model, conditional on observed exogenous variables except unexplained residuals.

In Figure 7, we decompose wage inflation during the Covid period up to 2023Q2. Initially, wage inflation increased from around 1.75% year-on-year in 2019Q4 to 4.5% year-on-year in 2023Q2, reaching a peak at 4.6% year-on-year in 2023Q1. According our baseline model, the substantial increase observed between 2021Q4 and 2023Q2 can be attributed predominantly to the tightening of the French labour market and, to a lesser extent, to energy price shocks. The relatively small contribution of energy and food price shocks to wage inflation is mostly driven by the endogenous transmission of commodity price shocks to realised inflation and short-run inflation expectations and very marginally by a catch-up effect (see 3). Conversely, the enduring impacts of Covid lockdowns and re-openings exert downward pressures on wage inflation.[5] Overall, wage inflation in France appears relatively well-explained by the empirical model. The unexplained part of wage inflation is limited over the period, concentrated from 2022Q2 to 2023Q2, with a positive contribution of residuals (i.e. the effect of unexplained shocks to wage inflation, price inflation and inflation expectations).

Similarly, Figure 8 displays the historical decomposition of price inflation based on the path of the exogenous variables. The empirical equation fits the data well, with a limited contribution from the residuals, as expected from the estimation results in 2. The inflationary episode began in 2021Q2 and peaked in 2023Q1, largely driven by the energy price shocks that started in 2021Q1 and peaked in 2022Q2. Subsequently, the food price shocks took over from the energy price shocks, during the second half of 2022. As Bernanke and Blanchard (2023, forthcoming) found for the US, the tightening of the labour market in France does not appear to be the main driver of the post-pandemic inflation, with a limited contribution of vacancies-to-unemployed ratio shocks to inflation. Finally, the positive contribution of productivity to price inflation stems from the drop in trend productivity (visible in Appendix Figure 15), a pattern extensively discussed by Devulder et al. (2024). A question remains whether the observed drop in productivity will be permanent, and push up inflation, or if some catch-up can be expected.

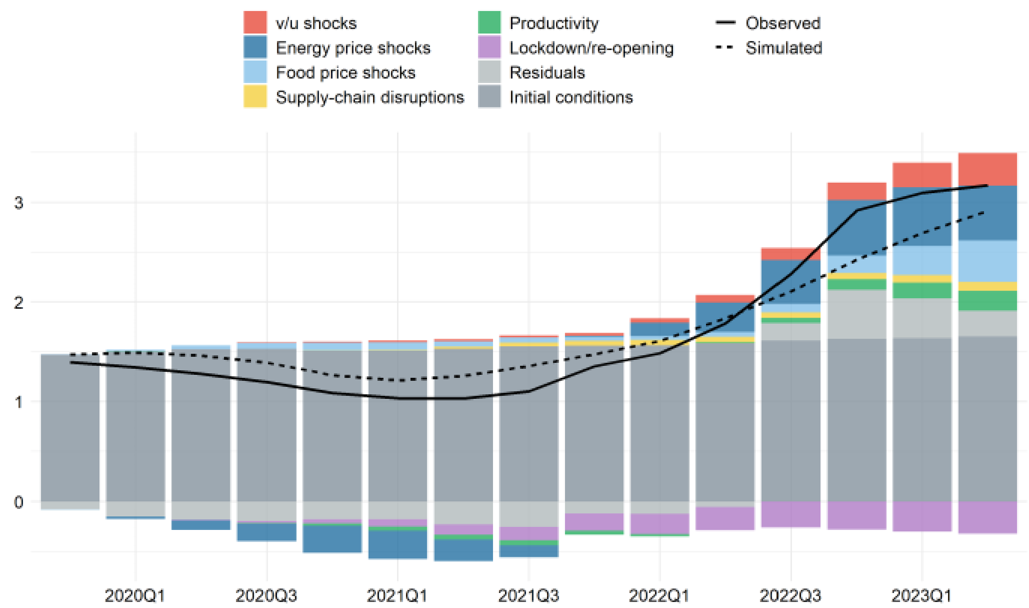
[5] The persistent negative effect on wage and price inflation of Covid lockdowns/re-openings in 2020Q2 and 2020Q3 results from the model having a unit root, which implies that even transitory shocks have a permanent effect on inflation (see Section 2.1). This property would unlikely hold in a model in which it the unit root pattern disappears (for example, if inflation expectations were explicitly anchored in the long run or if the model included a monetary policy rule).

Figure 8: Historical decomposition of price inflation



Source: see Table 6 in appendix, authors' calculations.
Note: The figure shows a decomposition of the sources of price inflation YoY, 2019Q4 to 2023Q2, based on the solution of the full model and the implied impulse response functions. The continuous line shows actual price inflation and the total net heights of the bars are the model's decomposition of price inflation in each period and per shocks. Coloured segments of each bar show the dynamic contribution of each exogenous variable, including residuals of all equations, to price inflation in that period, as implied by the full system of estimated equations. The dashed line represents the dynamic simulation of the model, conditional on observed exogenous variables except unexplained residuals.

Figure 9: Historical decomposition of short-run inflation expectations



Source: see Table 6 in appendix, authors' calculations.
Note: The figure shows a decomposition of the sources of short-run inflation expectations, 2019Q4 to 2023Q2, based on the solution of the full model and the implied impulse response functions. The continuous line shows actual short-run inflation expectations and the total net heights of the bars are the model's decomposition of short-run inflation expectations in each period and per shocks. Coloured segments of each bar show the dynamic contribution of each exogenous variable, including residuals of all equations, to short-run inflation expectations in that period, as implied by the full system of estimated equations. The dashed line represents the dynamic simulation of the model, conditional on observed exogenous variables except unexplained residuals.

Figure 9 displays the historical decomposition for short-term (1-year ahead) inflation expectations. As anticipated from the estimation results, short-term inflation expectations are well anchored and react in an inertial manner to realised inflation. However, there is a noticeable increase in short-term inflation expectations, which is similar to the decomposition of price inflation (mostly driven by energy and food price shocks and to a lower extent by labour market tightness shocks). Finally, long-run inflation expectations hardly increased during the same period and their dynamics are almost entirely attributed to initial conditions (see Figure 16 in the appendix).

Comparing these results with those obtained in Bernanke and Blanchard (2024a) for the 10 advanced economies, we find many common features. The surge in inflation was mostly driven by shocks to commodities (energy price first, then food prices) and only marginally by overheating labour markets —although the contribution of v/u shocks seems to be larger in France compared to other advanced economies. A first difference, in particular compared to other euro area countries, is mostly related to the role of fiscal policy. The energy price shield implemented in France substantially limited the increase in headline inflation in 2022. In absence of the energy price shield, Lemoine et al. (2024) estimate headline inflation would have been 8.5% on average in 2022, against only 5.9%. This largely contributes to explain the discrepancy between the euro area where inflation peaked at 10% in 2022Q4, and France where it peaked only at 7.0% in 2023Q1. Another difference is related to supply-chain disruptions, as captured by the Google trends for "shortages", which have a much smaller role in France compared to other countries.

7 Robustness checks and extensions

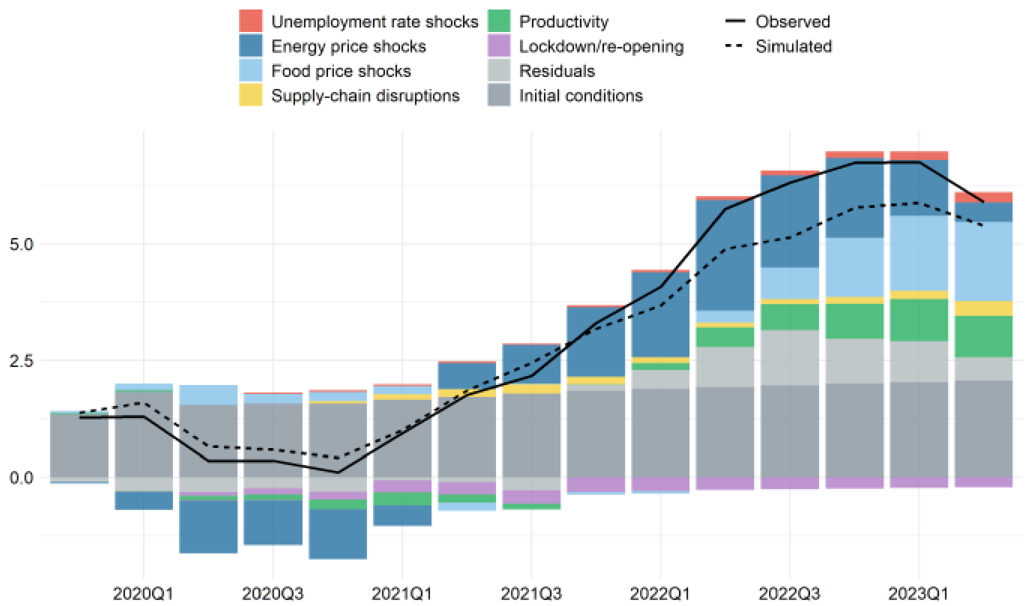
In this section, we conduct several robustness checks and explore extensions to our baseline model. We consider three variants of the Bernanke and Blanchard (2023, forthcoming) model. First, we estimate a model using the unemployment rate rather than v/u to see whether it would perform better than the baseline specification. Second, we test whether results are robust or not to the exclusion of the Covid pandemic era. Finally, we consider an alternative specification where inflation expectations are explicitly anchored in the long run, which we will use as a robustness check in Section 8 about conditional simulations.

7.1 A wage Phillips curve using the unemployment rate

We estimate the wage equation 6 but rather than using v/u as a measure of labour market slack, we use the unemployment rate. Table 8 reports the full-sample estimates of the wage Phillips curve using the unemployment rate. First, the equation does not appear to perform better than the specification with v/u, with an R-squared of 0.70 versus 0.75 in the baseline specification. Second, individual coefficients are not jointly significant nor is the sum of coefficients (as in the baseline, see Table 1). Third, we find the effect of short-run inflation expectations is significant and markedly stronger and no evidence of a catch-up effect.

Figures 10 and 17 (in the appendix) show the historical decompositions of price and wage inflation using this alternative wage equation and leaving the rest of the model, i.e. equations 7-9, unchanged. First, as expected from the estimation results and the lower R-squared of the equation using the unemployment rate, the contribution of the residuals to wage inflation is somewhat larger compared to the baseline results shown in Section 4 and Figure 7. Yet, both models explain relatively well the increase in inflation observed in 2022-2023. Second, the absence of a significant catch-up effect combined with relatively well-anchored short-run inflation expectations, as in the baseline model, explains why energy and food price shocks do not contribute to the increase in wages through short-run inflation expectations. As a consequence, the historical decomposition of HICP inflation in Figure 10 shows a small contribution of labour market conditions shocks compared to the baseline model using the vacancies-to-unemployed ratio and a larger contribution of residuals. On the contrary, the unemployment wage Phillips curve specification performs less to explain wage inflation as shown in Figure 17 compared to the v/u specification.

Figure 10: Historical decomposition of price inflation based on the alternative wage Phillips curve equation (full-sample estimates)



Source: see Table 6 in appendix, authors' calculations.
Note: see Figure 8. This historical decomposition of price inflation (YoY) is made using the unemployment rate rather than v/u.

We also estimated both specifications, using v/u or the unemployment rate, restricting to a pre-Covid sample (1995Q1-2019Q4). On this subsample, the unemployment rate specification yields better results, in terms of parameters significance, than the v/u specification.[6] Yet, the model would certainly not perform better during the Covid period. This can be explained by the fact that the v/u ratio peaked during the Covid period in France (see Figure 3a). Benigno and Eggertsson (2023), using US data since the 1960's, found that the Phillips curve appears to be non-linear: when v/u is below 1, the slope of the Phillips curve is almost flat and, on the contrary, it steepens when v/u is above 1 – as it was the case during the Vietnam war as well as before and after the Covid crisis. Unfortunately, French data does not allow us to go back as far and the v/u series only displays one major peak. Consequently, we cannot conclude whether a threshold for non-linearity exists in France.

In a nutshell, most of the main results of the Bernanke and Blanchard (2023, forthcoming) model remain valid when using the unemployment rate specification: the increase in inflation was mostly driven by shocks to prices given wages, not by overheating labour market and, implicitly, strong aggregate demand. Depending on the specification however, the labour market tightening is either found to have contributed to the increase in inflation (according to the baseline specification with v/u) or to nearly not have contributed (according the unemployment rate specification). On the one hand, the v/u specification features slightly better performance in terms of dynamic simulations of prices and, clearly better performances regarding wages. Yet, the good performance of the v/u specification might also reflect the simple correlation between the inflation peak and the increase of v/u. We cannot confidently conclude that one variable has a higher predictive power than the other.

7.2 Robustness to the estimation sample

In this section, we estimate whether the baseline model properties are robust to the estimation sample, in particular when excluding the Covid period. Detailed estimates are reported in Table 10, in appendix.

Table 5 reports estimations results for the wage growth equation on the pre-Covid sample. The sum of coefficients on v/u is negative and non-significantly different from zero, in contrast with the full-sample estimates

[6] In particular, we obtain a significant negative sum of coefficients associated to the unemployment rate, while the specification with v/u does not yield a significant and positive sum of coefficient associated to v/u (see Section 7.2)

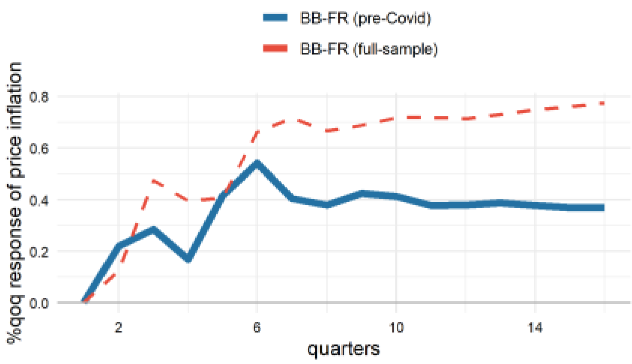
shown in 1. This might be worrying for the dynamic properties of the model after a shock to v/u, yet we will show that, because of the homogeneity constraint and a positive short-run coefficient on v/u, the model still display a positive, persistent response of wage inflation to a permanent v/u shock. We also find a larger catch-up effect, but non-significant. Table 9 (in the appendix) reports the price growth regressions estimates on the pre-Covid sample. Results are fairly similar to the full-sample estimates shown in 2. Similarly, for the short- and long-run inflation expectations, excluding the Covid period does not substantially change the results.[7]

Table 5: Wage growth regression, pre-Covid sample, dependent variable gw

Independent variables	gw	v/u	catch-up	cf1	magpty
Lags	-1 to -4	-1 to -4	-1 to -4	-1 to -4	-1
Sum of coefficients	0.776	-0.003	0.143	0.224	0.089
p-stat (sum)	0.000	0.985	0.132	0.095	0.224
p-stat (joint)	0.000	0.130	0.504	0.390	0.224
R-squared			0.63		
No. observations			100		
Sample			1995Q1 - 2019Q4		

Figure 18 shows the impulse response functions of price inflation (QoQ) to commodity and supply shocks for the pre-Covid version of the model compared to the full-sample version. Responses to energy and food price shocks are very similar, as expected from results in Table 9. Responses to supply-chain disruption shock are relatively different in the very-short run (being alternatively positive and negative), but the long-run responses are relatively similar.

Figure 11: Impulse responses functions of price inflation to a permanent v/u shock

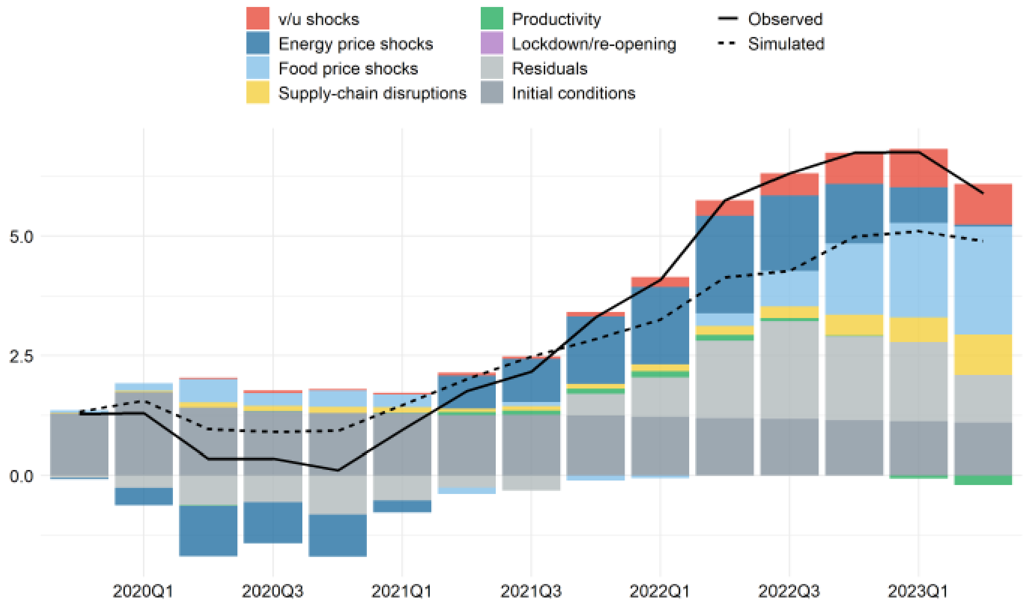


Source: see Table 6 in appendix, authors' calculations.
Note: The figure shows the full-model, dynamic responses of inflation to a positive one standard-deviation permanent shock to vacancies-to-unemployed ratio. Price inflation is the annualised quarter-on-quarter growth rate of HICP. The dashed red line reports the baseline IRF for the full-sample version of the model estimated on French data.

Figure 11 displays the impulse response function of price inflation (QoQ) to a permanent v/u shock. The pre-Covid and the full-sample estimates of the wage Phillips curve differ markedly. With the pre-Covid estimates of the model, price inflation stays persistently higher after a permanent tightening of the labour market but does not persistently *increase*, as in the full-sample version of the model. Two effects are at play. On the one hand, the fact the sum of coefficients associated to v/u is zero implies no long-run response of wage growth *in partial equilibrium*. Consequently, it breaks the self-sustained wage-price spiral at play in the full-sample model and described in Figure 6. On the other hand, the first lag of v/u is positive (see Table 10) and hence the wage growth reacts positively to a shock to v/u, in the very short run. Given the model's homogeneity assumptions and the unit-root it implies (see Section 2), the transitory increase in wages transmits to price inflation and then, after some periods, to wage inflation through short-run inflation expectations.

[7]Results are available upon request.

Figure 12: Historical decomposition of price inflation based on the pre-Covid model



Source: see Table 6 in appendix, authors' calculations.
Note: see Figure 8. This historical decomposition of price inflation (YoY) is made using the pre-Covid version of the model.

Figure 12 shows the historical decomposition of HICP inflation (YoY) and Figure 19 reports the historical decomposition of wage inflation based on the pre-Covid version of the model. As in the baseline model (Figure 8), the surge in inflation remains mostly explained by energy price shocks (from 2021Q2 to 2022Q3) and then food price shocks (from 2022Q4 to 2023Q2). In contrast with the baseline full-sample model, we find a larger contribution of residuals and a smaller contribution of v/u shocks, as expected from the lower sum of coefficients on the latter. Although the unexplained parts of HICP inflation and wage inflation are larger than those obtained with our baseline, full-sample model, the main conclusions remain. The post-pandemic inflation was mostly caused by energy and food prices; supply-chain disruptions played a limited role in France. The biggest difference is, again, the effect of the labour market tightening on wage and price inflation after the Covid.

7.3 Explicit anchoring of inflation expectations

Based on our baseline estimates (see Section 4), we could question whether inflation expectations are really anchored and to what extent it drives conditional simulations we will present in Section 8.

On the one hand, inflation expectations are highly inertial, implying a slow, gradual transmission of realised inflation shocks. In *that sense*, inflation expectations are anchored in the short run. On the other hand, both short- and long-run inflation expectations are not explicitly anchored to an inflation target (e.g., the 2% target), and the model does not feature long-run anchoring in the usual sense.[8] Hence, in the case of a permanent increase of labour market tightness, inflation expectations could contribute to a wage-price spiral, although the Phillips curve is relatively flat (see Figure 6).

A possible alternative specification would add an explicit anchoring on the 2% inflation target, to both empirical specifications of long- and short-run inflation expectations. In that case, we expect the model would not have a unit-root, as inflation expectations would not move one-to-one with realised inflation in the medium run. Hence, the response of wage and price inflation to a vacancies-to-unemployed ratio would likely be less persistent. On the contrary, this alternative specification would unlikely and significantly change historical decompositions – to the extent the coefficients on realised inflation are fairly robust to the inclusion of the 2% target in those equations.

[8] In addition, the fact that short-run inflation expectations are not significantly anchored on long-run expectations (see 3) also lowers the degree of anchoring.

In Section 8, devoted to conditional simulations, we will consider a slightly modified version of the Bernanke and Blanchard (2023, forthcoming) model to have long-run explicit anchoring on the 2% inflation target. In this variant, inflation expectations equations 8-9 are replaced by the following equations 10-11:

$$\pi_t^{e,1yr} = \sum_{k=1}^{4} \alpha_{\pi^e,k} \pi_{t-k}^{e,1yr} + \sum_{k=0}^{4} (\beta_{\pi^e,k} \pi_{t-1}^* + \gamma_{\pi^e,k} (\alpha^S \pi_{t-k} + (1-\alpha^S)\pi^*)) + \epsilon_{\pi^e,t} \tag{10}$$

$$\pi_t^* = \sum_{k=1}^{4} \alpha_{\pi^*,k} \pi_{t-k}^* + \sum_{k=0}^{4} \gamma_{\pi^*,k} (\alpha^L \pi_{t-k} + (1-\alpha^L)\pi^*) + \epsilon_{\pi^*,t} \tag{11}$$

where $\alpha^S = 0.4$, $\alpha^L = 0.02$ and $\pi^* = 2\%$. At this stage, both α^S and α^L are calibrated apart from the model, using AR(1) simplified specifications of equations 8-9.

8 Conditional simulations

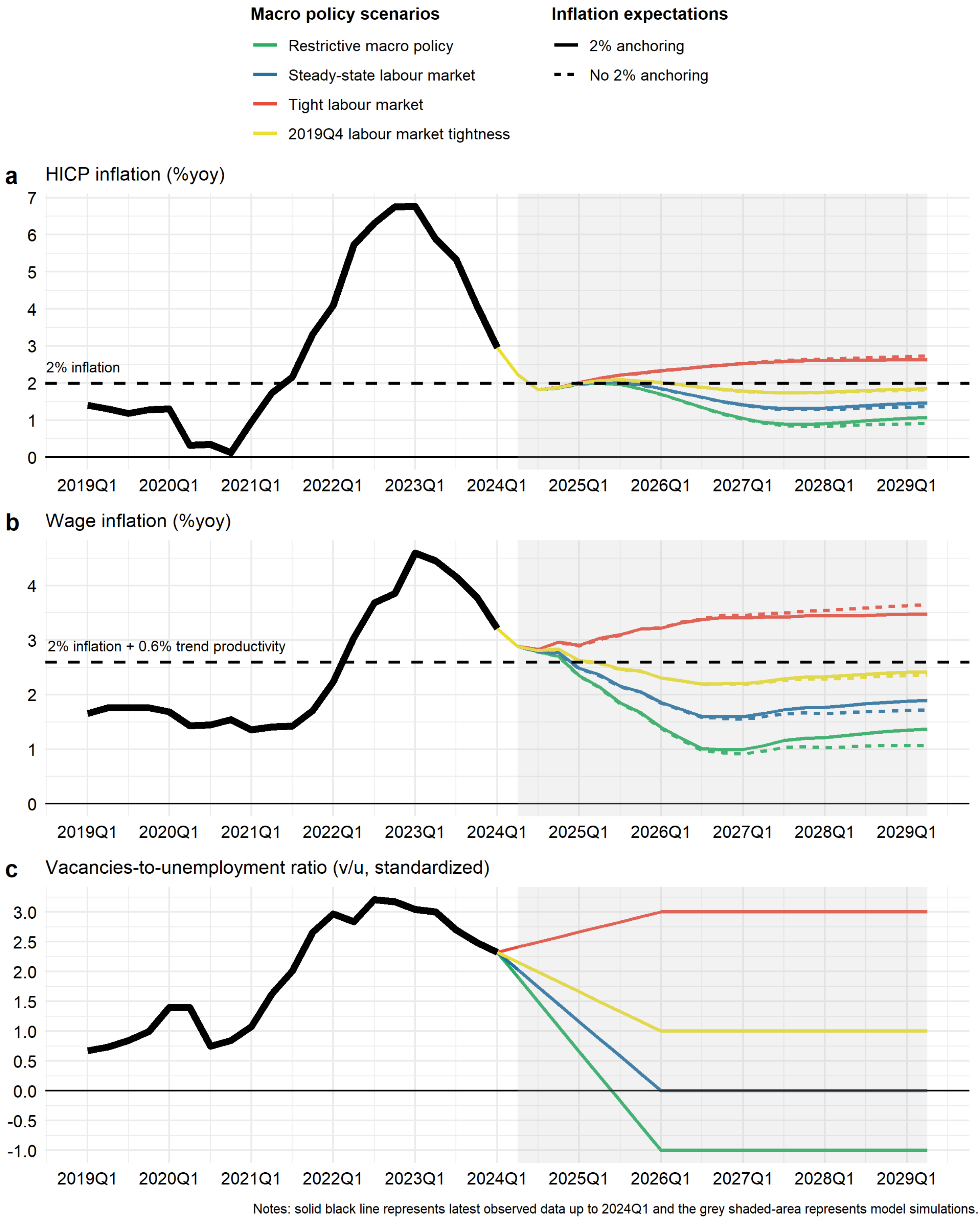
In this section, we use the model estimated on our baseline sample to produce conditional, forward-looking, simulations of HICP inflation and wage growth, based on the most recent data available (up to 2024Q1, at the time of writing).

To run conditional simulations we assume, following Bernanke and Blanchard (2023, forthcoming), a 2% rate of change for energy and food price inflation over the forecast horizon. This contrasts with the original BB methodology, which assumes zero relative energy and food price inflation when making conditional forecasts for price inflation. The assumption for energy and food price is particularly crucial for the simulations, given the strong role of energy and food price in the price equation 7. We also assume that labour productivity grows at 0.6% per year, close to with 2010-2019 average in France, and that supply-chain tensions are back to historical average. Given these maintained assumptions, we proceed to simulate the trajectory of price and wage inflation based on four alternative stylised paths for the vacancies-to-unemployed ratio. Assuming the Beveridge curve is stable since 2015 (see Figure 3b), we can interpret these scenarios in terms of unemployment rate by moving along the curve; yet it does not mean that the curve could not shift, implying a lower v/u for a constant unemployment rate.

- In the 'restrictive macro policy' scenario, we assume that the v/u ratio would decrease by one standard-deviation below its historical average ("steady state") by 2025Q2. This decline is attributed to restrictive macroeconomic policies, which could involve both monetary and fiscal measures. Based on the Beveridge curve, this would translate into an unemployment rate reaching 11% of the labour force in 2026Q1, far above the 7.5% observed in 2024Q1.
- In the 'steady-state labour market' scenario, we consider a straightforward return of the v/u ratio to its historical average. In that case, the unemployment rate would increase to 9.5% of labour force.
- In the 'high v/u' scenario, we assume that the vacancies-to-unemployed ratio would increase and stay persistently high—specifically, three standard-deviations above its historical average, implying an unemployment rate equal or below 7%.
- Finally, we consider a fourth scenario in which v/u decreases for little while, until stabilising at its 2019Q4 level (+1 standard-deviation above its average), implying unemployment would increase up to 8% in 2026Q1. This baseline scenario would be the closest to Banque de France (2024)'s June macroeconomic projections, in terms of unemployment.

Finally, in a robustness exercise, we slightly deviate from the BB model, by considering a model specification in which inflation expectations are explicitly anchored on a 2% target, as described in Section 7. It is essential to emphasise that our various scenarios are highly stylised and should not be interpreted as macroeconomic forecasts. For instance, assuming a 2% inflation rate for HICP energy might be rather conservative, at least too crude assumptions, with respect to current expectations of oil and gas prices.

Figure 13: Conditional simulations based on alternative paths for v/u



Source: see Table 6 in appendix, authors' calculations.

Figure 13 illustrates the results of conditional simulations for wage inflation and HICP inflation, considering the four alternative paths of the vacancies-to-unemployed ratio and whether inflation expectations are explicitly anchored at 2% on in the long run. Note that starting from the most recent data (2024Q1) implies that inflation is already close to the 2% inflation target. A noticeable result is that the BB model projects inflation to decrease below the target in all scenarios, except the tight labour market scenario. In the latter, inflation would first decrease toward 2% before increasing again above 2.5%. In the baseline scenario, where v/u would converge toward its 2019Q4 level, inflation would remain close to the 2% target in the medium run.

It also is noticeable that the explicit anchoring of inflation expectations does not accelerate much the convergence toward the 2% target. Indeed, the pass-through of inflation expectations to price inflation through wages is very gradual, so that the adjustment takes time. In addition, actual inflation is already close to the 2% target in 2024Q1. Hence, adding an explicit anchor to the inflation expectations process does not result in a strong error correction term, i.e. restoring force. All in all, the explicit anchoring of inflation expectations would more likely play a greater role if the starting point of simulation was far from the 2% target.

This last point is confirmed when performing conditional 'out-of-sample' simulations, using estimation data up to 2023Q2, and a starting point for inflation close to 5% in 2023Q2 (see Figure 20 in the appendix). In all scenarios, we observe a stronger restoring force due to inflation being higher than the target at the beginning of simulations. In the baseline scenario and in absence of anchoring, conditional simulations of inflation would converge toward 3.7% in the medium run. In contrast, with explicit anchoring, inflation would converge toward 3.2%, hence a -0.5pp effect of explicit anchoring of inflation expectations. This effect is even larger for the 'tight labour market' scenario, in which inflationary forces are stronger, with a -0.7pp effect on price inflation in the medium run. These simulations illustrate how explicit anchoring of inflation expectations accelerates convergence toward the 2% target.

The same 'out-of-sample' simulations allow us to assess ex-post the performance of the model over the last year. While the vacancies-to-unemployed ratio evolved relatively closely to the baseline scenario ('2019Q4 labour market tightness'), the model has made substantial negative forecast errors in the second half of 2023 in particular regarding wage inflation: inflation was over-estimated by the out-of-sample projections. In retrospect, this exercise alleviates previous concerns regarding 'the last mile', as those expressed by Bernanke and Blanchard (forthcoming) for the US economy. The fact that the model overestimated wage inflation may signal potential misspecifications: a 'structural break' in the wage inflation and v/u relationship, missing channels for monetary policy (forward-looking inflation expectations) or a more general misspecification related to the 'unit-root' in the model (which results into a permanent response of inflation to transitory v/u shocks, see Section 2 and Figures 6 and 11).

9 Concluding remarks

Overall, based on a standardised empirical specification of the price-wage system, Bernanke and Blanchard (2023, 2024a, forthcoming) main broad messages emerge in the case of France. First, the inflation burst in 2021-2022 was mainly triggered by energy and food price shocks. Second, no price wages spiral ensued, reflecting an overall low degree of wage indexation, as well as a quite degree of anchoring of expectations. Differences with other advanced economies are linked to the energy price shield policy: as compared to other (in particular euro area) economies, the increase in inflation in France was more gradual, and the inflation peak was with a less acute. In addition, our estimates also point to a less acute role of supply-side disruptions.

Looking ahead, conditional simulations point towards a baseline scenario in which inflation goes back to the ECB target. They however also illustrate an upside risk if the labour market would become particularly tight. Yet, based on the most recent data, these simulations confirm the outlook for further disinflation under most scenarios. This is in line with results obtained by Bernanke and Blanchard (forthcoming) for the euro area, but contrasts somewhat with the conditional projections for the US. In scenarios where labour market tightness would come back to its historical average (or below), French headline inflation would even decrease to 1%-1.5% per year.

Our findings are fairly robust to mild alterations of the set-up. Using the unemployment rate does not change the core story about headline inflation, but suggests that the contribution of the labour market could even be smaller than what the baseline BB model estimates for France. When excluding the Covid era from the estimation sample, the predictive power of the model worsen but remains quite acceptable.

Our work nevertheless points to specific, open questions for the French economy. One particular issue relates to the role of the vacancies-to-unemployed ratio (v/u). The v/u specification better explains the increase in wage growth between 2022 and 2023 than the unemployment specification. The latter result is interesting since the v/u specification does not perform as well as the unemployment specification if the model is estimated on a pre-Covid sample. This may be explained by the fact that the v/u ratio peaked during the Covid period in France. Benigno and Eggertsson (2023), using US data since the 1960's, found that the Phillips curve appears to be non-linear: when v/u is below 1, the slope of the Phillips curve is almost flat and, on the contrary, it steepens when v/u is above 1 – as it was the case during the Vietnam war as well as before and after the Covid crisis. By contrast, French data does not allow to go back as far and the v/u series only displays one major peak. It is therefore more speculative to infer that a threshold for non-linearity exists in France. Only the accumulation of future data will allow to judge whether labour market tightness as measured by the v/u ratio is a robust indicator, and whether it is non-linearly related to inflation.

Another question relates to productivity growth. Our baseline estimates indicate low productivity growth contributed positively to headline inflation over recent quarters. As discussed by Devulder et al. (2024), part of the observed productivity losses in 2023Q2 are presumably temporary and some catch-up may be expected in the near future. This would add to downward pressures to inflation.

A limitation of our set-up is that the role of monetary (and fiscal) policy remains implicit. Monetary policy has contributed to the fall in inflation after mid-2022 through its effect on activity, but also presumably, by preventing the de-anchoring of expectations (Villeroy de Galhau, 2024). Quantifying the role of monetary policy would require a more complete structural or semi-structural model – see Amatyakul et al. (2023) for such an attempt in the case of the US. We leave this investigation for further research.

References

Amatyakul, Pongpitch, Fiorella De Fiore, Marco Jacopo Lombardi, Benoit Mojon, and Daniel Rees, "The contribution of monetary policy to disinflation," BIS Bulletins 82, Bank for International Settlements December 2023.

Arce, Oscar, Matteo Ciccarelli, Carlos Montes-Galdón, and Antoine Kornprobst, "What caused the euro area post-pandemic inflation?," Occasional Paper Series 343, European Central Bank February 2024.

Ascari, Guido, Dennis Bonam, and Andra Smadu, "Global supply chain pressures, inflation, and implications for monetary policy," *Journal of International Money and Finance*, 2024, *142* (C).

Bańbura, Marta, Elena Bobeica, and Catalina Martínez Hernández, "Shocked to the core: a new model to understand euro area inflation," *Research Bulletin*, 2024, *117*.

Banque de France, "Macroeconomic projections," https://www.banque-france.fr/en/publications-and-statistics/publications/macroeconomic-projections-june-2024 June 2024.

Benigno, Pierpaolo and Gauti Eggertsson, "It's Baaack: The Surge in Inflation in the 2020s and the Return of the Non-Linear Phillips Curve," CEPR Discussion Papers 18116, C.E.P.R. Discussion Papers April 2023.

Bernanke, Ben S. and Olivier J. Blanchard, "What caused the US pandemic-era inflation?," Working Paper Series WP23-4, Peterson Institute for International Economics June 2023.

__ **and** __ , "An analysis of pandemic-era inflation in 11 economies," Working Paper Series WP24-11, Peterson Institute for International Economics May 2024.

__ **and** __ , *Analysing the inflation burst in eleven economies*, CEPR Press,

__ **and** __ , "What Caused the U.S. Pandemic-Era Inflation?," *American Economic Journal: Macroeconomics*, forthcoming.

Bonam, Dennis, Gerbert Hebbink, and Beer Pruijt, "Drivers of Dutch inflation during the pandemic era," Technical Report, De Nederlandsche Bank 2024.

Corsello, Francesco and Alex Tagliabracci, "Assessing the pass-through of energy prices to inflation in the euro area," Questioni di Economia e Finanza (Occasional Papers) 745, Bank of Italy, Economic Research and International Relations Area February 2023.

D'Acunto, Francesco, Evangelos Charalambakis, Dimitris Georgarakos, Geoff Kenny, Justus Meyer, and Michael Weber, "Household Inflation Expectations: An Overview of Recent Insights for Monetary Policy," CEPR Discussion Papers 19167, C.E.P.R. Discussion Papers June 2024.

Dao, Mai Chi, Pierre-Olivier Gourinchas, Daniel Leigh, and Prachi Mishra, "Understanding the international rise and fall of inflation since 2020," *Journal of Monetary Economics*, 2024, p. 103658.

de Galhau, François Villeroy, "Anatomy of a fall in inflation: from a successful first phase to the conditions for a controlled landing," Speech at Paris Dauphine University March 2024.

de Walque, Gregory and Thomas Lejeune, "What caused the post-pandemic era inflation in Belgium? Replication of the Bernanke-Blanchard model for Belgium," Working Paper Research 447, National Bank of Belgium March 2024.

Devulder, Antoine, Bruno Ducoudré, Matthieu Lemoine, and Thomas Zuber, "Explaining productivity losses observed in France since the pre-Covid period," *Bulletin de la Banque de France*, 2024, (251).

Fares, Jean Garry Junior Roc Bounajm and Yang Zhang, "Sources of Pandemic-Era Inflation in Canada: An Application of Bernanke and Blanchard," Staff Analytical Note, Bank of Canada 2023.

Gautier, Erwan and Jérémi Montornès, "Household Inflation Expectations in France: Lessons from a New Survey and the COVID-19 Crisis," *Economie et Statistique / Economics and Statistics*, 2022, (534-35), 3–19.

__ **, Sébastien Roux, and Milena Suarez Castillo**, "How do wage setting institutions affect wage rigidity? Evidence from French micro data," *Labour Economics*, 2022, *78* (C).

Ghomi, Morteza, Samuel Hurtado, and José Manuel Montero, "Analysis of recent inflation dynamics in Spain. An approach based on the Blanchard and Bernanke (2023) model," Occasional Papers 2404, Banco de España March 2024.

Haskel, Jonathan, Josh Martin, and Lennart Brandt, "Recent UK inflation: an application of the Bernanke-Blanchard model," Technical Report, Bank of England 2023.

Lemoine, Matthieu, Anna Petronevich, and Anastasia Zhutova, "Energy tariff shield in France: what is the outcome?," *Bulletin de la Banque de France*, 2024, (253).

__ **, Harri Turunen, Mohammed Chahad, Antoine Lepetit, Anastasia Zhutova, Pierre Aldama, Pierrick Clerc, and Jean-Pierre Laffargue**, "The FR-BDF Model and an Assessment of Monetary Policy Transmission in France," Working Papers no. 736, Banque de France October 2019.

Menz, Jan-Oliver, "Sources of post-pandemic inflation in Germany and the euro area: An application of Bernanke and Blanchard (2023)," Technical Papers 02/2024, Deutsche Bundesbank 2024.

Nakamura, Koji, Shogo Nakano, Mitsuhiro Osada, and Hiroki Yamamoto, "What Caused the Pandemic-Era Inflation?: Application of the Bernanke-Blanchard Model to Japan," Bank of Japan Working Paper Series 24-E-1, Bank of Japan February 2024.

Neri, Stefano, Fabio Busetti, Cristina Conflitti, Francesco Corsello, Davide Delle Monache, and Alex Tagliabracci, "Energy price shocks and inflation in the euro area," Questioni di Economia e Finanza (Occasional Papers) 792, Bank of Italy, Economic Research and International Relations Area July 2023.

Pisani, Massimiliano and Alex Tagliabracci, "What caused the post-pandemic inflation in Italy? An application of Bernanke and Blanchard (2023)," Questioni di Economia e Finanza (Occasional Papers) 851, Bank of Italy, Economic Research and International Relations Area June 2024.

A Appendix

A.1 Data

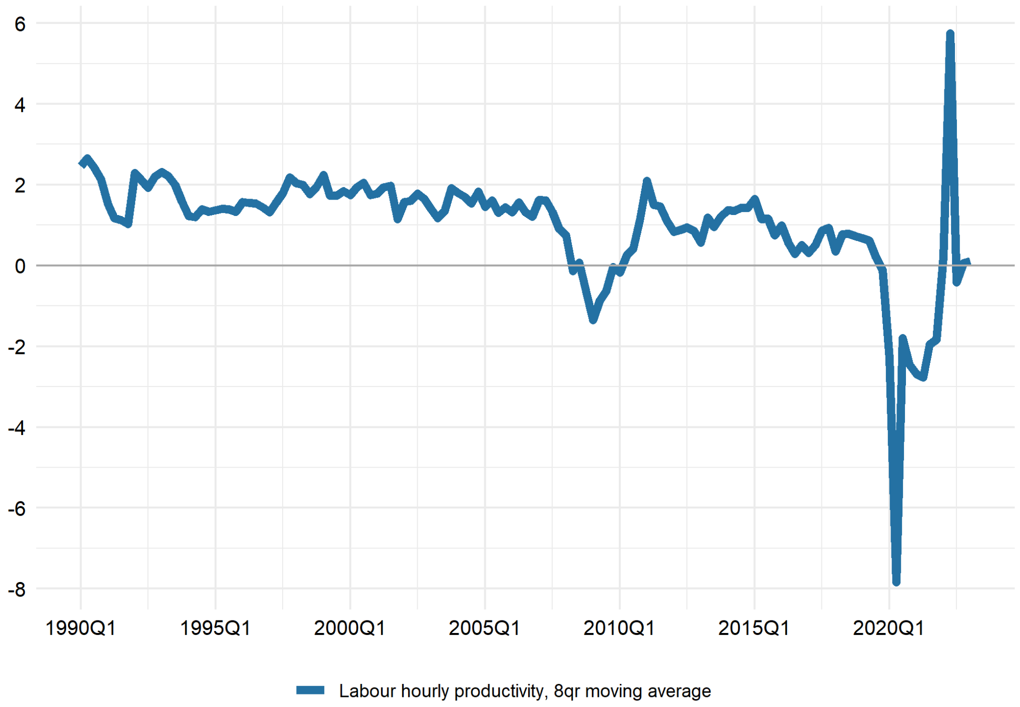
Table 6: Endogenous and exogenous variables definition, sample and source

Variable	Definition	Sources	Sample
gw	SMB (basic monthly wage), seasonally adjusted, annualised quarterly growth rate	Dares, Acemo survey	1989Q1 – 2023Q2
gcpi	Harmonised Index of Consumer Prices, seasonally adjusted, annualised quarterly growth rate	Insee	1990Q2 – 2023Q2
cf1	1yr ahead inflation expectations	Consensus Forecast, from 2002Q1 to 2023Q1	2002Q1 – 2023Q2, backcasted before 2002Q1 using the 12 quarters moving average of HICP inflation
cf10	5 to 10yr inflation expectations	Consensus Forecast	1995Q1 – 2023Q2
grpe	HICP energy inflation rate, seasonally, annualised rate of growth, relative to wage growth	Insee and Dares, Acemo survey for wages	1990Q2 – 2023Q2
grpf	HICP food inflation rate seasonally, annualised rate of growth, relative to wage growth	Insee and Dares, Acemo survey for wages	1990Q2 – 2023Q2
v/u	No. of job vacancies divided by no. of unemployed persons	Dares and Insee	2003Q2 – 2023Q2, backcasted to 1992Q1 – 2003Q1 using Insee outlook survey
shortage	Google searches for words "pénurie", "pénuries" and "approvisionnement", corrected for peaks related to strikes at major oil refineries	Google	2004Q1 – 2023Q2, backcasted to sample average before 2004Q1
magpty	Trend labour hourly productivity, 8qrs moving-average	Insee	1989Q1 – 2023Q2

Figure 14: Alternative measures of wage growth (YoY) in France

Source: see Table 6 in appendix, authors' calculations.

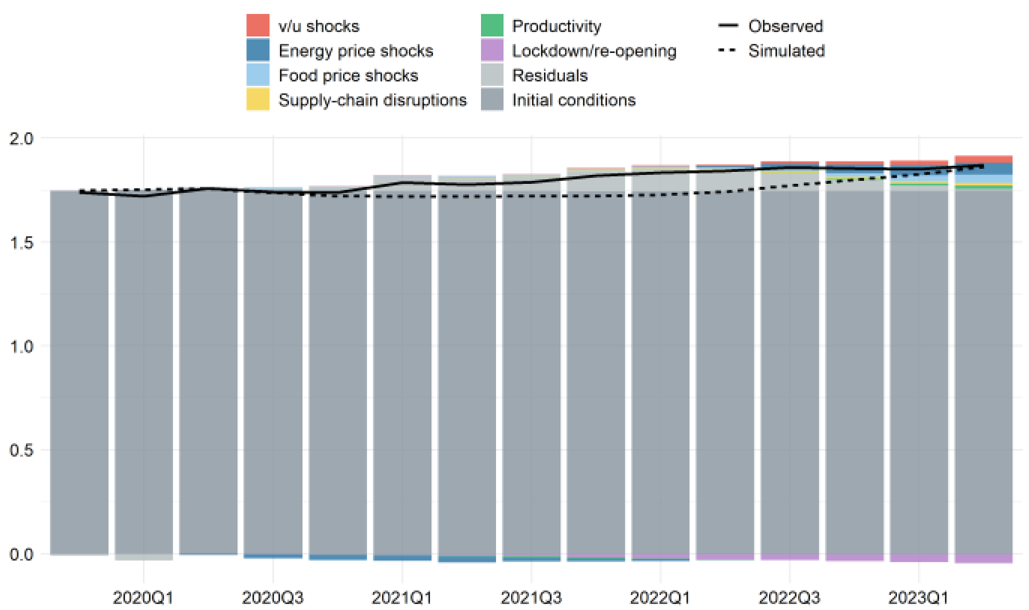
Figure 15: Labour productivity growth since 1990Q1



Source: see Table 6 in appendix, authors' calculations.

A.2 Additional results for the baseline model

Figure 16: Historical decomposition of long-run inflation expectations



Source: see Table 6 in appendix, authors' calculations.
Note: The figure shows a decomposition of the sources of long-run inflation expectations YoY, 2019Q4 to 2023Q2, based on the solution of the full model and the implied impulse response functions. The continuous line shows actual long-run expectations and the total net heights of the bars are the model's decomposition of long-run expectations in each period and per shocks. Coloured segments of each bar show the dynamic contribution of each exogenous variable, including residuals of all equations, to inflation expectations in that period, as implied by the full system of estimated equations.

Table 7: Detailed estimation results, full-sample data

	Eq. (6) Wage inflation (gw)	Eq. (7) Price inflation (gcpi)	Eq. (8) Short-run inflation expectations	Eq. (9) Short-run inflation expectations
L.gw	0.21* (0.11)	0.05 (0.09)		
L2.gw	0.10 (0.12)	-0.05 (0.09)		
L3.gw	0.25** (0.11)	0.15 (0.09)		
L4.gw	0.22** (0.11)	0.10 (0.09)		
gw		0.32*** (0.09)		
L.cf1	0.71*** (0.21)		0.42*** (0.09)	
L2.cf1	-0.59* (0.34)		-0.25 (0.15)	
L3.cf1	0.74 (0.48)		0.02 (0.22)	
L4.cf1	-0.64 (0.39)		0.61*** (0.16)	
L.magpty	0.03 (0.05)			
magpty		-0.11*** (0.04)		
L.vu	0.40 (0.33)			
L2.vu	0.85 (0.55)			
L3.vu	-1.00* (0.52)			
L4.vu	-0.19 (0.33)			
L.diffcpicf	0.04 (0.12)			
L2.diffcpicf	0.03 (0.15)			
L3.diffcpicf	-0.04 (0.15)			
L4.diffcpicf	0.03 (0.11)			
dummy20Q2	-1.31*** (0.48)			
dummy20Q3	-0.46 (0.61)			
L.gcpi		0.26*** (0.10)	0.04* (0.02)	0.02*** (0.01)
L2.gcpi		0.30*** (0.11)	0.10*** (0.02)	-0.01 (0.01)
L3.gcpi		0.00 (0.10)	0.04* (0.02)	-0.01 (0.01)
L4.gcpi		-0.12 (0.10)	-0.02 (0.02)	0.01 (0.01)
gcpi			0.06*** (0.02)	-0.00 (0.01)
grpe		0.10*** (0.00)		
L.grpe		-0.03** (0.01)		
L2.grpe		-0.02** (0.01)		
L3.grpe		0.00 (0.01)		
L4.grpe		0.02 (0.01)		
grpf		0.18*** (0.02)		
L.grpf		-0.02 (0.03)		
L2.grpf		-0.09*** (0.03)		
L3.grpf		0.01 (0.03)		
L4.grpf		0.02 (0.03)		
shortage		0.00 (0.08)		
L.shortage		-0.02 (0.10)		
L2.shortage		0.02 (0.10)		
L3.shortage		-0.00 (0.17)		
L4.shortage		0.18 (0.17)		
cf10			0.38 (0.31)	
L.cf10			-0.61 (0.45)	1.10*** (0.10)
L2.cf10			0.45 (0.46)	-0.54*** (0.14)
L3.cf10			-0.09 (0.45)	0.44*** (0.14)
L4.cf10			-0.14 (0.30)	-0.01 (0.10)
Intercept	0.09 (0.09)	-0.17** (0.08)		
R-squared	0.75	0.94	0.83	0.86
Obs	114	129	110	110
Sample	1995Q1-2023Q2	1991Q1-2023Q2	1996Q1-2023Q2	1996Q1-2023Q2

Note: Clustered standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.0.

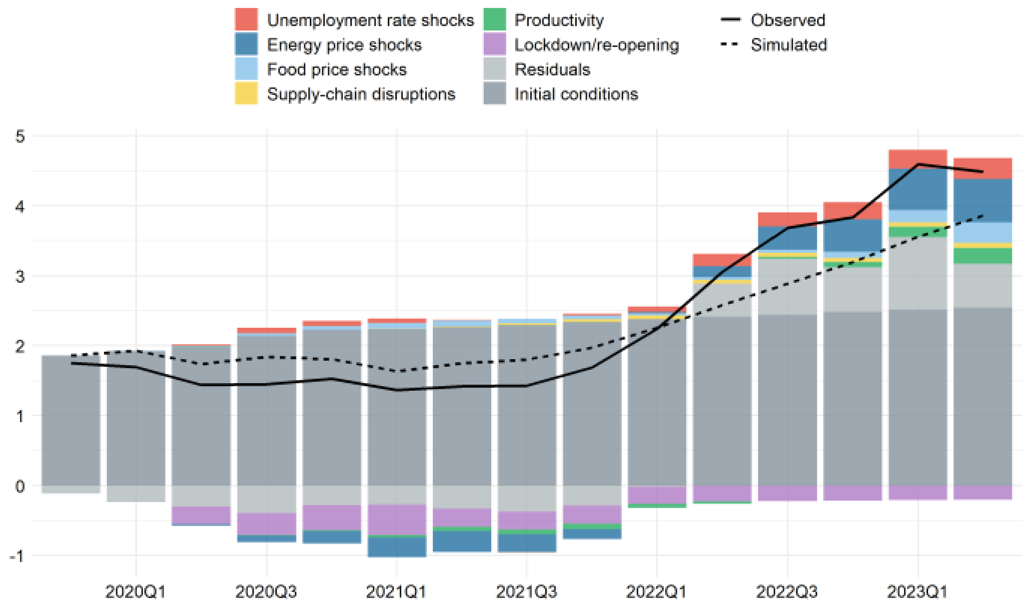
A.3 Alternative wage equation with the unemployment rate

Table 8: Wage growth regression with the unemployment rate, dependent variable gw

Independent variables	**gw**	**u**	**catch-up**	**cf1**	**magpty**
Lags	-1 to -4	-1 to -4	-1 to -4	-1 to -4	-1
Sum of coefficients	0.634	-0.076	0.037	0.366	-0.008
p-stat (sum)	0.000	0.258	0.708	0.019	0.868
p-stat (joint)	0.002	0.297	0.952	0.006	0.868
R-squared			0.70		
No. observations			114		
Sample			1995Q1 - 2023Q2		

Note: p-stat (sum) is the p-value for the null hypothesis that the sum of coefficients is zero, p-stat (joint) is the p-value for the joint hypothesis that each of the current and lag coefficients separately equals zero.

Figure 17: Historical decomposition of wage inflation based on the alternative wage Phillips curve equation (full-sample estimates)



Source: see Table 6 in appendix, authors' calculations.
Note: see Figure 7. This historical decomposition of wage inflation (YoY) is made using the unemployment rate rather than v/u.

A.4 Pre-Covid estimates of the baseline model

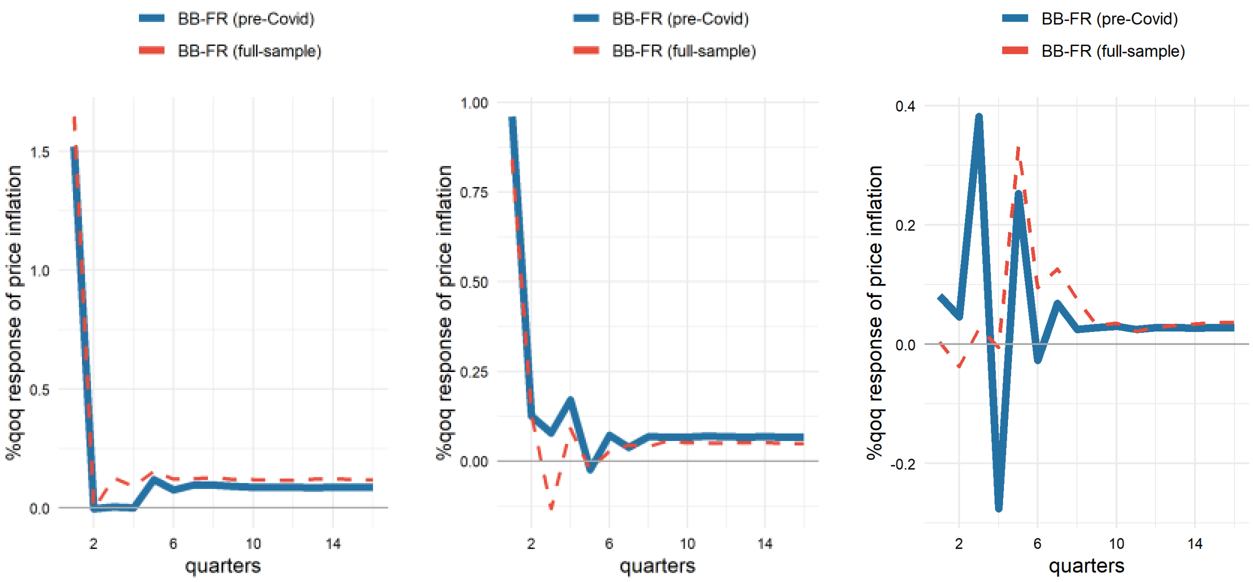
Table 9: Price growth regression, pre-Covid sample, dependent variable qcpi

Independent variables	**gcpi**	**gw**	**grpe**	**grpf**	**shortage**	**magpty**
Lags	-1 to -4	-1 to -4	-1 to -4	-1 to -4	0 to -4	0
Sum of coefficients	0.403	0.597	0.057	0.155	0.164	-0.106
p-stat (sum)	0.002	0.000	0.000	0.000	0.396	0.852
p-stat (joint)	0.005	0.000	0.000	0.000	0.583	0.852
R-squared				0.92		
No. observations				115		
Sample				1991Q2 - 2019Q4		

Note: p-stat (sum) is the p-value for the null hypothesis that the sum of coefficients is zero, p-stat (joint) is the p-value for the joint hypothesis that each of the current and lag coefficients separately equals zero.

Figure 18: Pre-Covid IRFs of price inflation to commodity and supply shortage transitory shocks

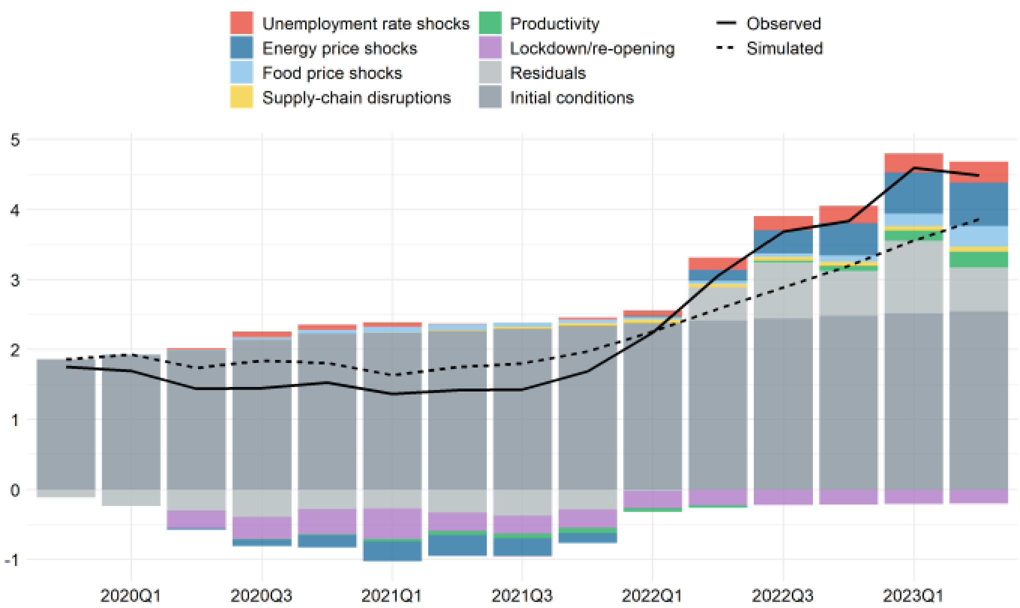
(a) Energy price shock **(b)** Food price shock **(c)** Supply-chain disruptions shock



Source: see Table 6 in appendix, authors' calculations.

Note: The figures show the full-model, dynamic responses of inflation to a one standard-deviation positive shock to relative energy prices, relative food prices, and the shortage variable. Price inflation is the annualised quarter-on-quarter growth rate of HICP. The dashed red line reports the baseline IRFs for the full-sample version of the model estimated on French data.

Figure 19: Historical decomposition of wage inflation based on the pre-Covid model



Source: see Table 6 in appendix, authors' calculations.

Note: see Figure 7. This historical decomposition of wage inflation (YoY) is made using the pre-Covid version of the model.

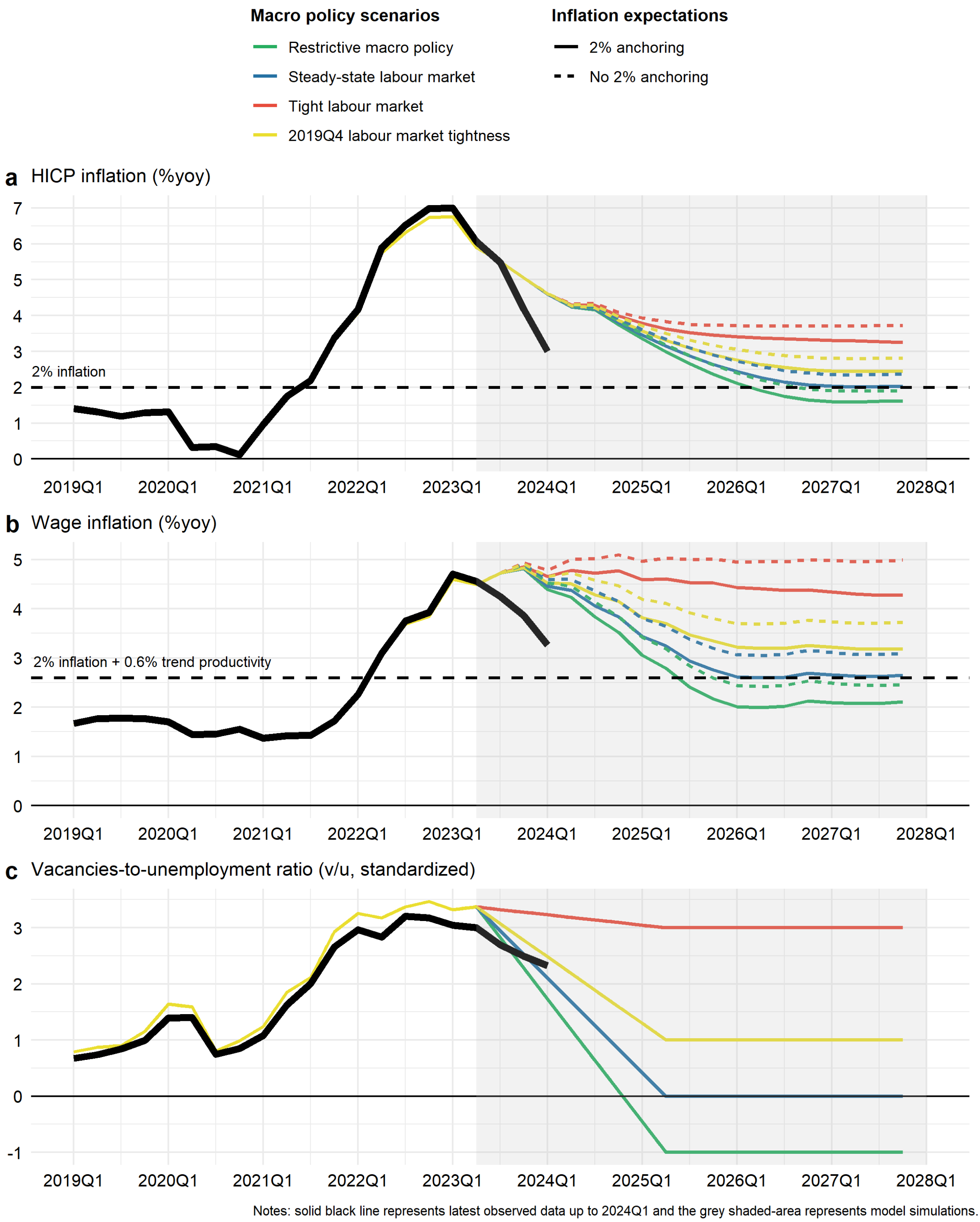
Table 10: Detailed estimation results, pre-Covid data

	Eq. (6) Wage inflation (gw)	Eq. (7) Price inflation (gcpi)	Eq. (8) Short-run inflation expectations	Eq. (9) Short-run inflation expectations
L.gw	0.16	0.05		
	(0.11)	(0.08)		
L2.gw	0.11	0.02		
	(0.11)	(0.08)		
L3.gw	0.27**	0.21**		
	(0.11)	(0.08)		
L4.gw	0.24**	0.10		
	(0.11)	(0.08)		
gw		0.22***		
		(0.08)		
L.cf1	0.46		0.92***	
	(0.42)		(0.11)	
L2.cf1	-0.56		-0.06	
	(0.54)		(0.15)	
L3.cf1	0.36		-0.03	
	(0.53)		(0.15)	
L4.cf1	-0.03		0.11	
	(0.42)		(0.10)	
L.magpty	0.09			
	(0.07)			
magpty		-0.01		
		(0.05)		
L.vu	1.00			
	(0.62)			
L2.vu	-0.31			
	(1.10)			
L3.vu	-1.01			
	(1.10)			
L4.vu	0.31			
	(0.64)			
L.diffcpicf	0.12			
	(0.12)			
L2.diffcpicf	0.07			
	(0.16)			
L3.diffcpicf	-0.07			
	(0.15)			
L4.diffcpicf	0.03			
	(0.11)			
L.gcpi		0.21**	0.02**	0.02***
		(0.10)	(0.01)	(0.01)
L2.gcpi		0.27***	0.00	-0.01*
		(0.10)	(0.01)	(0.01)
L3.gcpi		-0.03	0.03**	0.00
		(0.10)	(0.01)	(0.01)
L4.gcpi		-0.05	-0.03***	0.01
		(0.10)	(0.01)	(0.01)
gcpi			0.04***	0.00
			(0.01)	(0.01)
grpe		0.09***		
		(0.00)		
L.grpe		-0.02**		
		(0.01)		
L2.grpe		-0.03***		
		(0.01)		
L3.grpe		0.00		
		(0.01)		
L4.grpe		0.01		
		(0.01)		
grpf		0.21***		
		(0.02)		
L.grpf		-0.02		
		(0.03)		
L2.grpf		-0.05		
		(0.03)		
L3.grpf		0.03		
		(0.03)		
L4.grpf		-0.01		
		(0.03)		
shortage		0.05		
		(0.17)		
L.shortage		0.02		
		(0.17)		
L2.shortage		0.20		
		(0.17)		
L3.shortage		-0.21		
		(0.17)		
L4.shortage		0.12		
		(0.20)		
cf10			0.17	
			(0.18)	
L.cf10			0.06	1.29***
			(0.30)	(0.11)
L2.cf10			-0.32	-0.89***
			(0.32)	(0.16)
L3.cf10			0.19	0.64***
			(0.30)	(0.16)
L4.cf10			-0.09	-0.07
			(0.18)	(0.11)
Intercept	-0.01	-0.32***		
	(0.10)	(0.11)		
R-squared	0.63	0.92	0.74	0.85
Obs	100	115	96	96
Sample	1995Q1 – 2019q4	1991Q2 – 2019q4	1996Q1 – 2019Q4	1996Q1 – 2019Q4

Note: Clustered standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.0$.

A.5 Out-of-sample conditional simulations

Figure 20: Conditional simulations based on alternative paths for v/u and estimation data



Source: see Table 6 in appendix, authors' calculations.