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Inflation and economic activity in the United States: the return of the Phillips curve?

The dynamics of US inflation post-Covid have rekindled questions about the link between inflation and the business cycle (known as the Phillips curve, 1958). Supply chain disruptions, the rebound in demand following the lockdowns and labour shortages in some sectors all adversely affected inflation dynamics. To illustrate these mechanisms and the resulting uncertainties, we estimate several Phillips curves with different inflation and business cycle metrics, with and without supply chain constraints. On average, we find a slight increase in the sensitivity of inflation to the business cycle, even when supply constraints are included. A projection exercise shows the important role of the easing of supply constraints, alongside monetary policy, in the fall in inflation in 2023 and 2024. The "last mile" in bringing inflation back to the Fed's target by the end of 2025 is likely to depend on developments in the labour market, and in particular a reduction in job vacancies.

Nicolas Chatelais and Annabelle de Gaye
International Economic Affairs and Cooperation Directorate

JEL Codes
E24, E31,
E32, E58

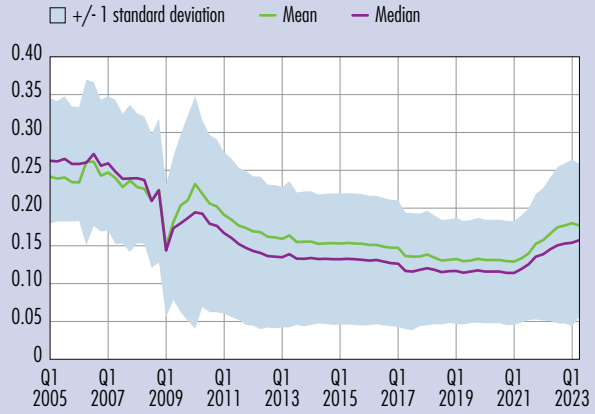
30%
the proportion of core inflation explained by supply constraints between 2021 and 2023

+0.5 percentage point
the increase in "long-term inflation" between 2019 and 2023

1% of the labour force
the labour shortage in the United States at end-2023

Sensitivity of US inflation to the business cycle

(percentage points)



Sources: Banque de France; authors' calculations.
NB: For the mean estimate, an increase of 1 percentage point (pp) in the output gap (or equivalent measure) leads to a rise in annual inflation of 0.18 pp if the Covid period is included.

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EUROSYSTÈME

The ten years preceding the pandemic saw low inflation volatility in the advanced countries, particularly the United States. This period prompted a number of academic studies on the flattening of the Phillips curve (which describes the positive relationship between actual inflation and past economic activity). Some have gone so far as to claim that this relationship no longer exists (the "dead Phillips curve" – see Ratner and Sim, 2022). The sharp rise and persistence of inflation post-Covid has called into question previous analyses, raising the issue of whether recent trends are structural or temporary. This article looks at the dynamics of inflation and its potential determinants. It also sets out some aspects of the debate surrounding the Phillips curve, illustrating them with estimates.

1 Highly unsettled US inflation dynamics after the pandemic

Asynchronous dynamics in the prices of goods and services

In the year and a half following the pandemic, US inflation soared. Measured by the consumer price index (CPI), it rose from 1.3% to 9% between December 2020 and June 2022. This 7.7 percentage point (pp) increase was accompanied by a 5 pp rise in core inflation, which reached 6.3% (see Chart 1a). Since then, both headline and core inflation have fallen, to 3.4% and 3.9% respectively in December 2023.

Post-Covid, goods inflation rose faster than services inflation, due to supply chain disruptions in the goods sector (and their impact on symptomatic segments such as the used car market) and the distortion of consumption in favour of goods. Inflation in services then followed, pushing up core inflation (see Chart 1b) and doing so more persistently. In 2023, the dynamics reversed: goods inflation fell back to 0% by the end of 2023, due to the end of supply chain problems, but services inflation persisted at 5.3%, partly due to rents. Excluding rents, services inflation fell back to 3.4% by December, 1.3 pp above its pre-Covid 2010-19 average.

The much-debated causes of inflation: between supply and demand factors and pressures on the labour market

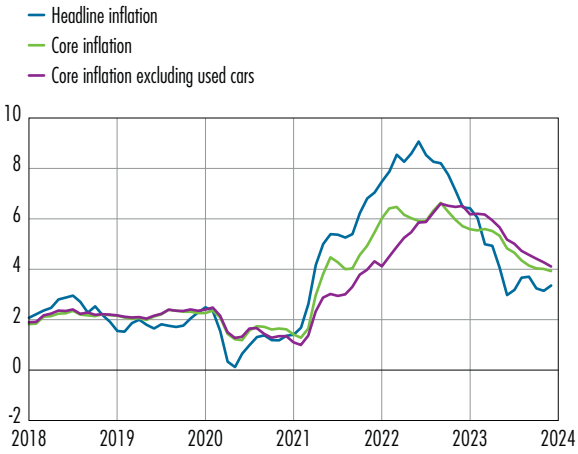
A study by Bernanke and Blanchard (2023) concludes that the post-Covid surge in inflation (between the third quarter of 2020 and the second quarter of 2022) was primarily the result of shocks to the goods market rather than pressures on the labour market. According to this study, the shocks on the goods market were due on the one hand to the sharp rise in energy and food prices, and on the other to shortages linked to supply difficulties coupled with a change in the composition of demand. This finding contrasts with that of Benigno and Eggertsson (2023), who interpret recent inflation movements as the result of labour market pressures alone.

The main difference between these two studies lies in the formulation of the relationship between inflation and the

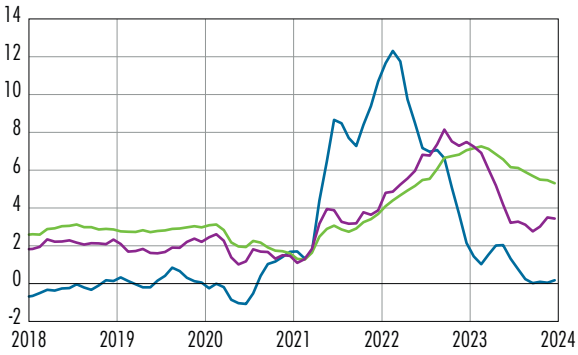
C1 Measures of inflation in the United States

(%, year-on-year)

a) Headline inflation, core inflation and core inflation excluding used cars



b) Inflation in goods, services and services excluding housing



Sources: US Bureau of Labor Statistics (BLS), data as at December 2023; authors' calculations.
Note: Inflation is measured by the consumer price index (CPI). Core inflation corresponds to inflation excluding energy and food.

business cycle (Phillips curve). Bernanke and Blanchard use a linear relationship, but combine it with a model of wages and inflation expectations. Conversely, Benigno and Eggertsson use a non-linear relationship, as they consider that the relationship between inflation and the business cycle is structurally stronger when unemployment is low, as was the case in 2022-23 in the United States.

These divergent studies and findings highlight the uncertainty surrounding the determinants of inflation: supply or demand factors, high sensitivity to the business cycle or not, and the degree of tightening in the labour market. Finally, another factor cited to explain rising inflation is the increase in corporate profit margins; but the contribution of this factor remains difficult to quantify (not least because of the multitude of measures of profit margins).

2 Quantifying the current state of the business cycle can be complex

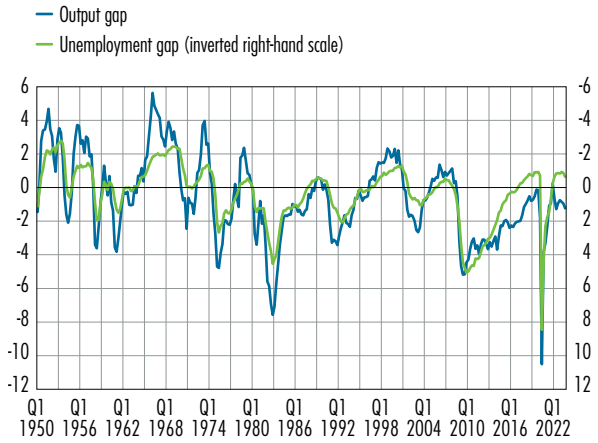
Indicators specific to the labour market have predominated in most analyses

According to estimates by the Congressional Budget Office (CBO), the state of the business cycle, as measured by the difference between actual GDP and potential GDP (the output gap), has mainly been negative since the financial crisis of 2008 (with the exception of the fourth quarter of 2021), despite the post-Covid rebound. However, the unemployment rate fell rapidly after the exceptional rise seen during the period of lockdown. The unemployment rate, as measured by the US Bureau of Labor Statistics (BLS; U3, see Appendix) rose from 3.6% in the fourth quarter of 2019 to almost 13% in the second quarter of 2020. It then gradually declined, to 4.2% and 3.7% in the fourth quarters of 2021 and 2023 respectively. As a result, the unemployment rate fell below the structural rate from the fourth quarter of 2021 (see Chart 2 a), indicating a tightening of the labour market, while the output gap estimated by the CBO was still in negative territory. However, two points should be underscored:

C2 Measures of the business cycle in the United States

a) Difference between actual and potential GDP (output gap) and the actual unemployment rate and the structural rate (unemployment gap)

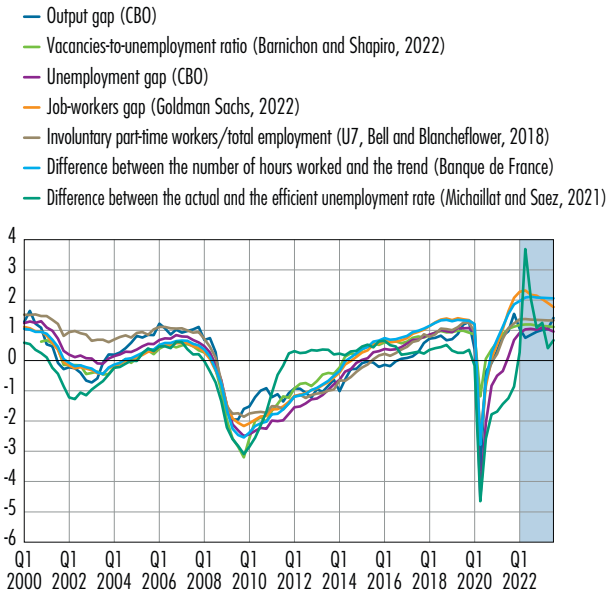
(percentage points, z-score)



Sources: Congressional Budget Office (CBO) and US Bureau of Labor Statistics (BLS); data as at Q3 2023.

b) Measures of labour market pressures in the United States

(%)



Sources: The main data come from the Congressional Budget Office (CBO), July 2023 projections, GDP in Q3 2023. This chart also uses several sources from institutions and researchers who have aggregated the data (see references in brackets in the captions).
Notes: The business cycle indicators are set out in the Appendix. The job-workers gap is calculated as the difference between the number of jobs (filled and vacant) and the number of workers (employed and unemployed) relative to the number of workers.

- The CBO's projections may seem conservative[1] and contrast with those of the International Monetary Fund (IMF), which estimated a positive output gap in its October 2023 projections.

- The fall in the unemployment rate below its structural level masks a particular dynamic in the labour force participation rate. For a long time, it remained below pre-Covid levels, due in particular to the early retirement of older workers (aged 55 and over) after the pandemic, but estimates of the structural unemployment rate have not been significantly revised.

The small changes in the unemployment rate in 2022 and 2023 have prompted observers to look at other indicators, the most popular being the ratio between the number of job vacancies and the number of unemployed. This ratio, which stood at 1.2 in December 2023, had reached a high of 1.8 in March 2022, i.e. almost two vacancies for one unemployed person, whereas it has historically been less than one. An alternative indicator looks more broadly at the difference between the number of jobs (filled and vacant) and the number of workers (employed and unemployed) relative to the number of workers (the job-workers gap). This indicator also shows historically very high levels in 2022-2023 (see below part 4, section "A faltering return of inflation to its target linked to the labour market", last paragraph). Overall, when all of the indicators mentioned below are normalised, they all point to an overheating economy over the period (see Chart 2 b), but with different amplitudes.

3 Has the sensitivity of inflation to the business cycle changed post-Covid?

It remains unclear which is the appropriate indicator to describe the state of the business cycle. But the sensitivity of inflation to the business cycle may be even more difficult to quantify. In the interests of robustness, we set out below a range of estimates that illustrates the uncertainty surrounding this parameter, but also displays some common trends across the estimates.

Estimation of "non-accelerationist" Phillips curves shows a slight increase in the sensitivity of inflation to the business cycle

We estimate an equation linking US inflation to a measure of the business cycle and to supply shocks, representing the external factors that can affect inflation (traditionally import prices). In this specification, we model inflation and not the changes in inflation (it is a "non-accelerationist" Phillips curve, see Appendix). Supply chain disruptions were observed, which did not necessarily pass through fully to import prices. To take account of this, we have included a variable capturing these supply pressures: the Global Supply Chain Pressure Index (GSCPI),[2] which is compiled by the New York Fed. This indicator is also affected by the shock to demand for goods, especially durable goods, in the United States. Finally, to include the different dynamics of inflation and business cycle measures, we estimate this equation in turn with four measures of inflation (CPI) and seven measures of the business cycle (i.e. 28 variants; see Appendix for more details), and in a recursive manner (starting from the window going from the second quarter of 1998 to the fourth quarter of 2004, and adding quarters until we reach the entire period from the second quarter of 1998 to the third quarter of 2023).

Result 1: Slight increase in the slope of the Phillips curve

Charts 3a and 3b show the range of estimates of the "slopes" of the Phillips relationship (value of the coefficient associated with the regression of inflation on the cycle) according to the different measures used for inflation and the business cycle. The estimates underlying Chart 3a include only the business cycle and import prices, while those in Chart 3b also include the GSCPI. This exercise shows that the estimated slopes tend to be higher when the recent period is included, i.e. from the third quarter of 2021 ("mean" and "median" lines), but with a widening of the range of estimates. This increase in the slope is less marked in the variants with the GSCPI. This variable therefore seems to capture part of the explanatory power

1 The output gap is negative on average over the long term, according to CBO estimates (-0.5% over the period 1950-2019). In its projections, the CBO converges the output gap towards a target of -0.5% after ten years (rather than zero as might be expected over the very long term).

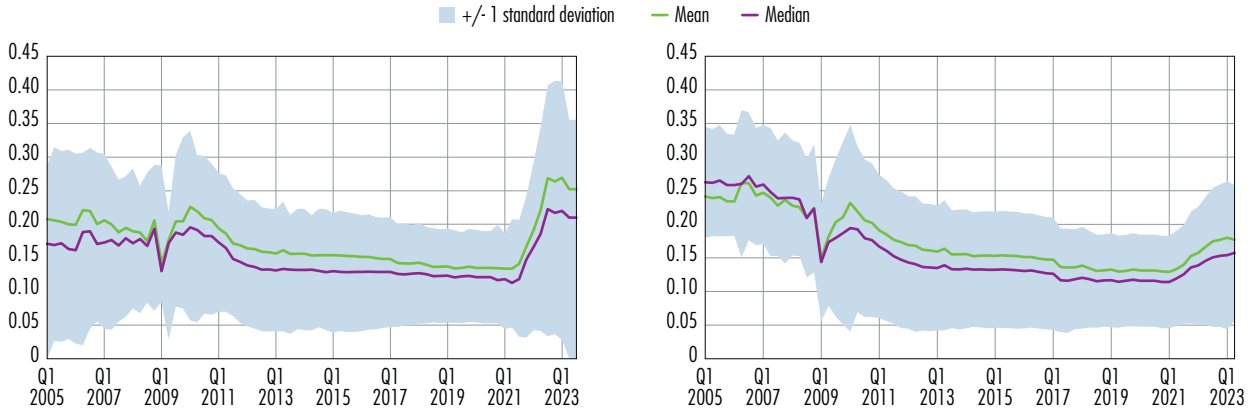
2 See Appendix for the methodology used to construct this indicator.

C3 Estimation of the sensitivity of inflation to the business cycle using different specifications

(percentage points, range of estimated slopes of the Phillips curve based on several measures of inflation and the business cycle)

a) Slope of the Phillips curve with import prices and different measures of inflation and the business cycle

b) Slope of the Phillips curve with import prices, the GSCPI and different measures of inflation and the business cycle



Sources: data from seven different sources cited in the Appendix; authors' calculations.
Notes: charts a) and b) plot the mean, median and standard deviation of the 28 slope coefficients estimated on four measures of inflation and seven measures of the business cycle (see Appendix).
GSCPI: Global Supply Chain Pressure Index.
The data in charts a) and b) go up to Q3 2023.

of the equation, thereby demonstrating the important role of supply problems and the demand shock in inflation dynamics in recent years. In addition, the range of estimates appears narrower when the GSCPI is included, indicating that this factor helps to reduce the uncertainty surrounding the estimates. In concrete terms, a 1 pp increase in the output gap (or the equivalent measure of labour market pressures using the Okun coefficient for the purposes of comparison) led to an average increase in annual inflation of 0.13 pp before the Covid period, but of 0.18 pp when the 2020-23 period is included.

Result 2: Slight rise in "long-term inflation"

In the estimated equations, the constant (divided by the deviation of the inflation lag coefficient from 1) reflects the level towards which inflation converges when the deviation of the business cycle from its potential is zero, import and domestic prices move in the same way and there are no supply chain pressures (GSCPI at zero). In a sense, therefore, it reflects long-term inflation, which we would expect to be close to the Fed's inflation target. Our estimates show a fairly wide range of uncertainty around the estimation of this parameter, but one that narrows somewhat between 2015 and 2021. Indeed, the median of the estimated parameters fluctuates between 2.5% and 2.7%, i.e. levels close to the Fed's target, taking into account the average historical differential of 0.3 pp to 0.5 pp between the Personal Consumption Expenditures Price Index (PCE)[3] and the CPI (see Chart 4a).

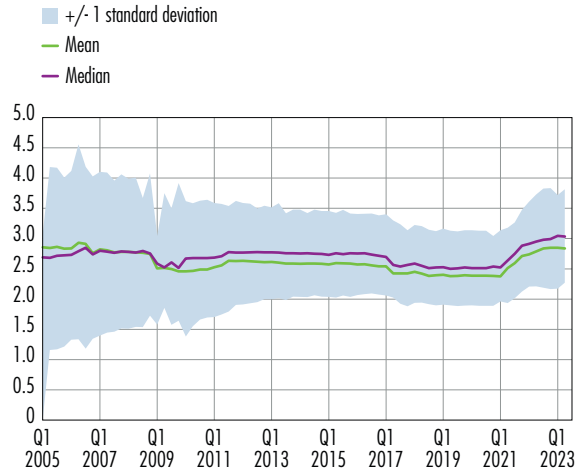
The inclusion of the post-Covid period in the estimates raises this parameter slightly, to a median estimate of 3% for the period from 2022 to the third quarter of 2023. This increase could be interpreted as a rise in long-term inflation expectations. By comparison, inflation expectation indicators derived from surveys or the financial markets have been rising slightly since the start of 2022, to between 2.5% and 3% (see Chart 4b). Another explanation could be a change in the post-Covid inflation thanks environment not captured by our estimates, for example non-linearity in the Phillips curve and therefore a more pronounced steepening than that estimated, which might stem from the fact that when cost shocks are large, they pass through more quickly to prices (see Gautier, Le Bihan and Lippi, 2023).

3 The Fed has a target of 2% for PCE inflation (Personal Consumption Expenditures Price Index).

C4 Measures of long-term inflation and inflation expectations

a) Phillips curve constant (divided by the deviation from 1 of the coefficient of the lagged inflation variable)

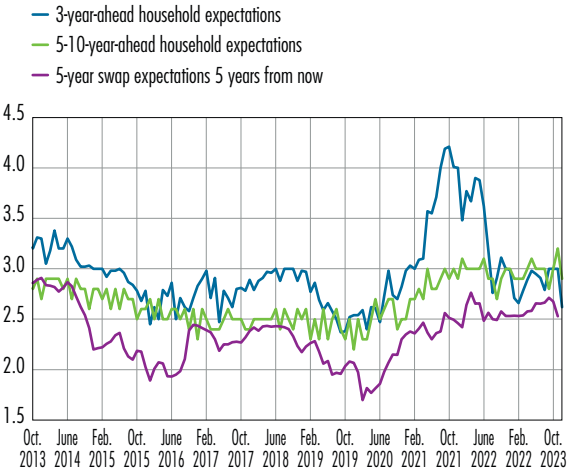
(mean: year-on-year; %)



Sources: data from seven different sources cited in the Appendix; authors' calculations.
Note: data go up to Q3 2023.

b) Inflation expectations based on household surveys and derived from inflation-linked swaps

(%)



Sources: New York Fed (3-year-ahead household expectations), University of Michigan (5-10-year-ahead household expectations), Datastream (inflation-linked swaps; 5-year swap expectations 5 years from now).
Note: data go up to Q4 2023.

4 What is the outlook for inflation in 2024 and 2025?

The already observed easing of supply constraints explains a large part of the fall in inflation in 2023

We use the Phillips curve estimate that we judge to be the most robust of the 28 models estimated on the sample for the period going from the third quarters of 1998 to 2023 to decompose and project inflation levels according to changes in the labour market and external factors. More specifically, we use the equation with core CPI inflation, the job-workers gap, relative import prices and the GSCPI. According to this decomposition (see Chart 5b below), we find that the price variations between the second quarter of 2020 and the first quarter of 2021 resulted partly from changes in the labour market and supply constraints (which can also capture demand shocks – see Appendix for a discussion). In the second quarter of 2021, inflation rose sharply for reasons unexplained by the model in this analysis (this period coincided with the last Biden post-Covid support plan and the sharp rise in corporate profit margins). From the third quarter of 2021 onwards, it was primarily supply constraints (as well as their persistence) that explained the movements in inflation (see the green histogram bars in chart 5b). During the first half of 2023, the role of supply constraints became zero and then negative in the third and fourth = quarters of 2023. The role of the labour market (see the orange histogram bars in chart 5b) was very small.

We project core inflation using this equation by fixing supply chain constraints (the GSCPI) at their latest point (i.e. a contribution that remains slightly negative over the entire projection) as well as the job-workers gap (0.9 in the fourth quarter of 2023). Thus, without any change in the labour market and with supply constraints remaining as they are, core CPI inflation, which stood at 4% in the fourth quarter of 2023, is projected to fall gradually to 3% by the end of 2024, and then to 2.9% in 2025.

A faltering return of inflation to target linked to the labour market

With the easing of supply constraints in 2023 contributing substantially to the fall in inflation, the "last mile" to reaching the Fed's 2% target appears to depend, all other things being equal, on developments in the labour market.

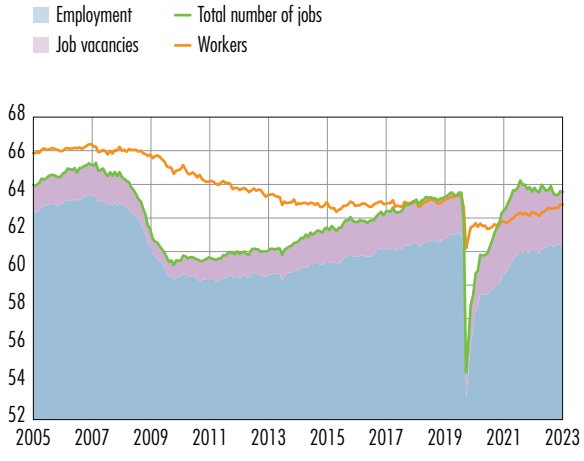
In terms of the dynamics observed, we should note that the post-Covid period saw a strong rebound in employment (chart 5a, blue area) and job vacancies (mauve area), while the labour force participation rate (orange curve) struggled to return to its pre-Covid level. Over the course of 2023, the participation rate rose to make up for most of the fall seen during the Covid crisis. At the same time, employment has stabilised and job vacancies have tended to fall, so that the gap between labour supply and demand (orange and green curves) has gradually narrowed, reaching around 0.6% of the working-age population in December 2023.

We illustrate the impact of employment and job vacancy dynamics on inflation projections up to 2025. The gap between the number of jobs (labour demand) and the number of workers (labour supply) can be reduced in three ways: i) by increasing the number of workers (but here we use the labour force participation rate projections of the CBO,[4] which predict relative stability followed by a slight fall), ii) by reducing the number of vacancies, or iii) by reducing employment. We run two illustrative scenarios based on developments in job vacancies and employment.

All other things being equal, a fall in job vacancies would lead to further disinflation, while keeping employment relatively stable around current levels (see table below). If the number of job vacancies were halved by the end of 2025 (to between 3.5 and 4 million, compared with 7.5 million at the end of 2023), i.e. a return to its long-term average, core CPI inflation would fall to 2.5% (i.e. close to the Fed's target if we consider a historical gap of 0.3 pp

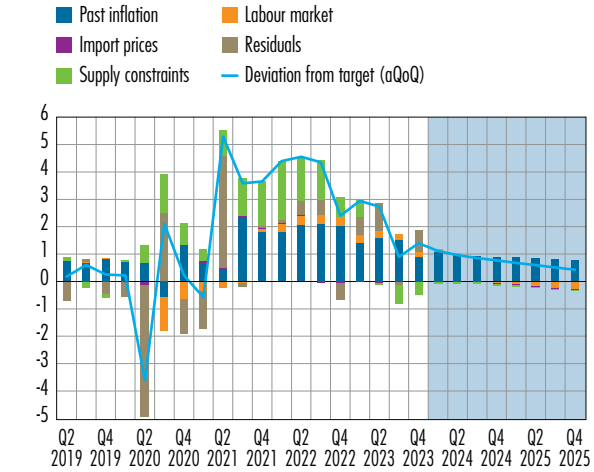
C5 Determinants of inflation

a) Changes in labour supply and demand



Source: US Bureau of Labor Statistics (BLS).
Note: The total number of jobs includes the number of jobs filled (employment) and vacant. It is calculated as a percentage of the total population. The numbers of job vacancies, jobs filled and workers are calculated as a percentage of the population aged 16 and over.
For job vacancies, the data go up to November 2023, and up to December 2023 for employment and workers.

b) Decomposition of quarterly changes in core inflation



Sources: US Bureau of Labor Statistics (BLS), data as at Q4 2023; authors' calculations.
Notes: The blue shading indicates the authors' projections.
AQoQ: Annualised quarter-on-quarter change.

4 July 2023 projections.

with the PCE index targeted by the Fed). The unemployment rate would rise moderately to 5%. Conversely, if the number of job vacancies were to remain stable around current levels, the unemployment rate would have to rise to around 7% in order to bring inflation back close to target[5] (see table).

This exercise highlights i) the importance of the supply shock in explaining inflation trends in 2023 and its future fall, and ii) the respective roles of job vacancies and employment in the convergence of inflation to its target (for "the last mile", see table). This possible disinflation towards the Fed's target via the reduction in job vacancies alone, which we simulate here, is in line with some recent studies (see Rapach, 2024, and Crust, Lansing and Petrosky-Nadeau, 2023).

Projections of core inflation under stylised scenarios for supply constraints and the labour market in Q4 2025

(jobs in millions, rate as a%, year-on-year inflation as a%)

Scenarios	Projections		
	Job vacancies	Unemployment rate	Core CPI inflation
"No change" scenario[a)]	7.8	3.7	2.9
Preferred scenario: "fall in job vacancies, stable employment"	3.9	5.1	2.5
Alternative scenario: "job vacancies unchanged, rising unemployment"	7.8	7.3	2.5

Sources: Banque de France; authors' calculations.
a) The supply chain constraints indicator (GSCPI) and the job-workers gap remain at their levels in Q4 2023 (i.e. -0.13 and 0.9 respectively), and import prices relative to the GDP deflator return to their long-term average (-0.1), i.e. a smaller decline than that observed in Q3 2023.

5 We model the CPI here, whereas the Fed targets the PCE index. We need to allow for an average differential of 0.3 pp between CPI and PCE inflation. Furthermore, this projection is based on the average sensitivity of core inflation to the business cycle. Note, however, the importance of the dynamics of rents on the remainder of the disinflation to come, due to their significant weight in inflation indices and the historical adjustment lag of rents. A faster fall in rents on new leases could lead to faster disinflation.

References

Akinci (O.), Benigno (G.), Cesar Heymann (R.), di Giovanni (J.), Groen (J.), Lin (L.) and Noble (A.) (2022)
"The global supply side inflationary pressures", *Liberty Street Economics*, Federal Reserve Bank of New York, January.

Andler (M.) and Kovner (A.) (2022)
"Do corporate profits increase when inflation increases?", *Liberty Street Economics*, Federal Reserve Bank of New York, July.

Ball (L.), Leigh (D.) and Mishra (P.) (2022)
"Understanding U.S. inflation during the Covid era", NBER *Working Paper Series*, No. 30613, October.

Ball (L.) and Mazumber (S.) (2011)
"Inflation Dynamics and the Great Recession", *Brookings papers on Economic Activity*, May, p. 337-405.

Barnichon (R.), Oliveira (L.) and Shapiro (A.) (2021)
"Is the American rescue plan taking us back to the '60s?", *FRSBF Economic Letter*, No. 2021-27, Federal Reserve Bank of San Francisco, October.

Barnichon (R.) and Shapiro (A.) (2022)
"What's the best measure of economic slack?", *FRSBF Economic Letter*, No. 2022-04, Federal Reserve Bank of San Francisco, February.

Bell (D.) and Blanchflower (D.) (2018)
"Underemployment in the US and Europe", NBER *Working Paper Series*, No. 24927, August.

Benigno (P.) and Eggertsson (G.) (2023)
"It's baaack: The surge in inflation in the 2020s and the return of the non-linear Phillips Curve", NBER *Working Paper Series*, No. 31197, April.

Bernanke (B.) and Blanchard (O.) (2023)
"What caused the U.S. pandemic-era inflation?", NBER *Working Paper Series*, No. 31417, June.

Chatelais (N.), de Gaye (A.) and Kalantzis (Y.) (2015)
"Inflation basse en zone euro : rôle des prix d'imports et de l'atonie économique", *Rue de la Banque*, No. 6, Banque de France, May.
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Crust (E.), Lansing (K.) and Petrosky-Nadeau (N.) (2023)
"Reducing inflation along a nonlinear Phillips curve", *FRBSF Economic Letter*, No. 2023-17, Federal Reserve Bank of San Francisco, July.

Gautier (E.), Le Bihan (H.) and Lippi (F.) (2023)
"Pourquoi les prix transmettent plus vite les chocs de grande ampleur", Banque de France, *Bloc-Notes Eco*, No. 324.

Goldman Sachs (2022)
"Taming inflation without a recession: a progress report", Goldman Sachs US economics analyst, *Goldman Sachs Economics Research*, 14 August.

Michaillat (P.) and Saez (E.) (2021)
"Beveridgean unemployment gap", NBER *Working Paper Series*, No. 26474, November.

Phillips (A. W.) (1958)
"The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957", *Economica*, vol. 25, No. 100, November, p. 283-299.

Rapach (D.), (2024)
"Is the last mile more arduous?", *FRBA Policy Hub*, No. 2024-01, Federal Reserve Bank of Atlanta, January.

Ratner (D.) and Sim (J.) (2022)
"Who killed the Phillips curve? A murder mystery", *Finance and Economics Discussion Series*, No. 2022-028, Board of Governors of the Federal Reserve System, Federal Reserve Bank of San Francisco.

Appendix
Empirical methodology

We estimate a Phillips curve augmented by import prices and a supply constraint variable to account for the role of external factors in headline and core inflation. This approach also allows us to distinguish the effects of supply disruptions from domestic factors. For the sake of robustness, we consider alternative measures of inflation, such as the truncated average inflation of most volatile components, as well as alternative measures of business cycles.

A "non-accelerationist" Phillips curve augmented by import prices[1]

We use quarterly data from the first quarter of 1996 to the third quarter of 2023 in the United States to estimate the following Phillips curve augmented by import prices:

$$\pi_t = C + \alpha.\pi_{t-1} + \beta.X_{t-1} + \gamma.M_t + \varepsilon_t$$

where π is a measure of the quarterly change in CPI (consumer price index) inflation[2], X is a measure of the business cycle and M is the quarterly growth rate of the ratio of import prices to the GDP deflator.

This specification assumes that inflation expectations are stable and well anchored.[3] We are therefore in the scenario of a "non-accelerationist" Phillips curve. In the reverse case, an accelerationist Phillips curve imposes the restriction $\alpha = 1$, meaning that a positive output gap leads to an acceleration in inflation rather than merely a change in the rate of price changes. From the late 1980s until 2019, inflation and long-term inflation expectations were remarkably stable and the $\alpha = 1$ restriction is clearly rejected by the data. Thus, when the economy reaches its potential and relative import prices are stable, inflation converges to $c / (1 - \alpha)$, corresponding to the long-term inflation rate. The coefficient β is the short-term response of inflation to a deviation of activity from potential, and $\beta / (1 - \alpha)$ corresponds to the "medium-term" slope of the Phillips curve.

A Phillips curve augmented by import prices and supply constraints

To take into account the specificities of the Covid and post-Covid periods, we add two types of variable to our baseline equation ($\pi_t = C + \alpha.\pi_{t-1} + \beta.X_{t-1} + \gamma.M_t + \theta .GSCPI_{t-1}$ + dummy 20Q2 / Q3 + ε_t):

1. a dummy variable in the second and third quarters of 2020 to capture the effects of the closing down and reopening of the economy directly linked to the first wave of Covid;

2. a variable representing supply chain disruptions during the reopening of the economy. To do this, we use the Global Supply Chain Pressure Index (GSCPI) of the New York Fed.

The New York Fed's GSCPI indicator measures the intensity of disruptions to global supply chains. This indicator is calculated using three types of variable: i) the Purchasing Managers Index (PMI); ii) shipping costs; and iii) air freight costs.

We should however note the endogeneity between world trade and bottlenecks (measured by the GSCPI): (–) longer delivery times or higher transport costs constitute negative supply shocks that can reduce trade; (+) when trade increases, this tends to exacerbate bottlenecks due to the rise in demand. For this reason, Akinci et al., (2022) propose a methodology for correcting the indicator for demand effects, in order to isolate the effects linked to supply-side difficulties. However, we do not systematically

1 See Chatelais, de Gaye and Kalantzis (2015) for a discussion of the econometric specification.
2 Quarterly inflation is constructed using a seasonally adjusted price index constructed with the X12-ARIMA method.
3 See the discussion in Ball and Mazumder (2011) on what is sometimes called a non-accelerationist Phillips curve.

observe a negative correlation between the GSCPI and the dynamics of world trade: using data on the volume of world trade from the Central Planning Bureau of Netherlands for Economic Policy Analysis (CPB), we distinguish two periods:

- Between the start of 2020 and autumn 2020, there is a negative relationship between the two variables, which tends to underscore supply-side difficulties.

- From autumn 2020 onwards, the slope of the relationship between the GSCPI and world trade is positive, which tends to indicate that demand effects are dominating the relationship. Thus, the normalisation of the GSCPI from 2022 onwards has accompanied a slowdown in activity, which has helped to ease supply chain constraints.

Estimating a range for the slope of the Phillips curve

In order to take account of the different dynamics of inflation measures and the uncertainty around the correct measure of the business cycle, we estimate several variants of the Phillips curve equation.

More specifically, we use four measures of inflation (CPI): headline and core; and two measures adjusted for volatile segments: trimmed-mean and sticky.

We also use seven measures of the business cycle:

1. the output gap (Congressional Budget Office, CBO);

2. the gap between the unemployment rate (U3, the official unemployment rate counting people who have been unemployed and actively seeking work over the last four weeks) and the structural unemployment rate (CBO);

3. the vacancy-to-unemployment ratio (Barnichon et al., 2021; Barnichon and Shapiro, 2022);

4. the job-workers gap (Goldman Sachs, 2022);

5. the difference between the actual and the efficient unemployment rate (Michaillat and Saez, 2021);

6. a measure of underemployment (U7) defined as the share of involuntary part-time workers in total employment (Bell and Blanchflower, 2018);

7. the difference between the number of hours worked and the trend.

We estimate a total of 28 different coefficients for the slope of the Phillips curve. We summarise the distribution of these coefficients by the simple mean and the median, as well as the standard deviation around the mean, to measure the uncertainty surrounding the measurement of the slope. To aggregate all the coefficients, we apply an Okun coefficient, which measures the relationship between the unemployment rate and the output gap, estimated for each business cycle measure. The coefficients reported can be interpreted as the short-term response of inflation to a 1 percentage point increase in the output gap.

Finally, in order to assess the evolution of the link between inflation and the business cycle, i.e. to assess whether inflation has become more sensitive to the business cycle since Covid, we estimate these equations recursively, starting with the window going from the second quarter of 1998 to the fourth quarter of 2004, and adding one quarter to each estimation window until we reach the entire period from the second quarter of 1998 to the third quarter of 2023.

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