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Foreword by Agustín Carstens

The global surge of inflation that started in 2021 took most observers by surprise. It threatened to thrust the world back into an inflationary environment that we thought we had finally escaped decades ago.

It may be tempting to ascribe the surprise entirely to unforeseen shocks. No doubt the unique post-pandemic circumstances played a key role, as did the subsequent outbreak of war as Russia invaded Ukraine. The enormous monetary and fiscal policy stimulus unleashed at the height of the pandemic proved hard to calibrate in the face of unprecedented circumstances and also contributed to higher inflation. But surely there is more to it than this. The models – ie the analytical frameworks and their quantitative translations – used to interpret the forces at work and to chart the future inflation path turned out to be wanting.

In the 2022 BIS Annual Economic Report, we offered an alternative view of the inflation process that seeks to overcome some of these limitations. This view sees the inflation process as two regimes – a low- and a high-inflation regime – with potentially self-reinforcing transitions from the low to the high one. The focus on regimes highlights how the behaviour of inflation is quite different at low and high levels. Critically, the self-stabilising properties of the inflation rate when it settles at a low level vanish once it moves to a higher one. And the focus on transitions highlights how the risk of higher inflation becoming entrenched should not be underestimated. In other words, just as water transitions across states – frozen, liquid and gas – inflation changes as its temperature rises.

This study develops the analysis presented in the BIS Annual Economic Report. It seeks to dig deeper, to present more systematic evidence in order to enrich our understanding of a phenomenon that may be as old as the economy itself, but which still remains beyond our full grasp. Above all, it hopes to provide insights that will help policymakers tackle the inflationary challenges they face today, and prevent their re-emergence in the future.

Agustín Carstens
BIS General Manager

The two-regime view of inflation

Claudio Borio, Marco Lombardi, James Yetman and Egon Zakrajšek

Abstract

This study provides a view of the inflation process that is complementary to the one captured in standard models, such as those based on the Phillips curve. It characterises the process as two regimes – a low- and a high-inflation regime – with self-reinforcing transitions from the low- to the high-inflation one. The study documents the stylised facts describing the two regimes and the transitions between them based on disaggregated price dynamics and the joint behaviour of wages and prices. Two implications for monetary policy stand out. First, the desirability of conducting monetary policy in a flexible manner in a low-inflation regime, tolerating moderate, even if persistent, deviations from narrowly defined targets. Second, the importance of being pre-emptive when the risk of a transition to the high-inflation regime increases, even though assessing this transition in real time remains challenging.

Keywords: inflation, disaggregated price dynamics, wages and prices, monetary policy.

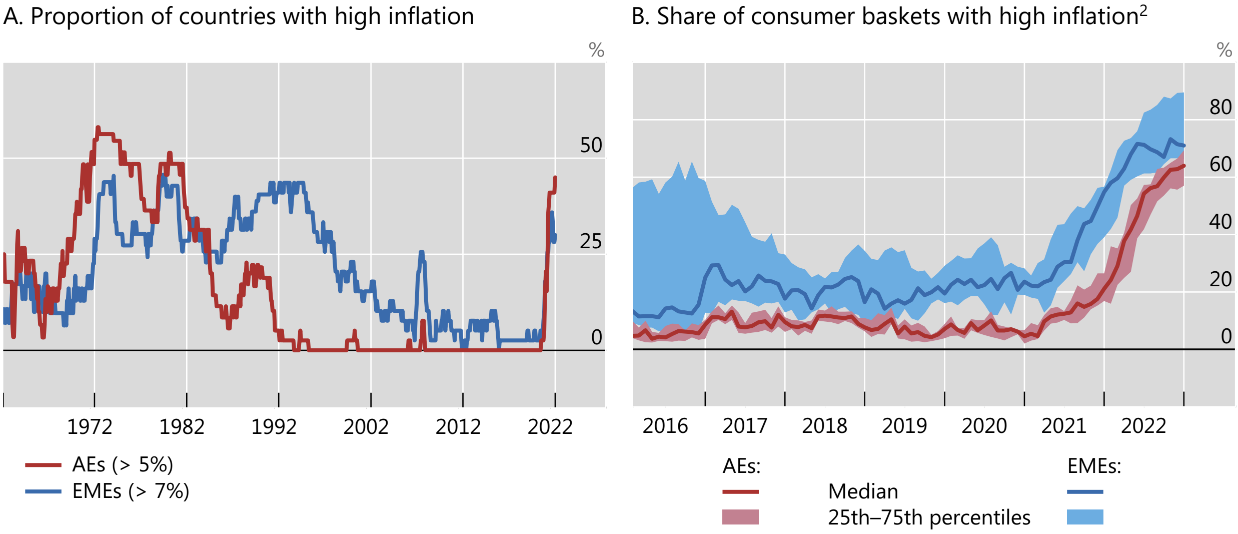
JEL classification: E31, E58.

Contents

Introduction

Few had anticipated the rapid return of inflation, and even fewer had foreseen its vigour and persistence. Once it flared up, initially most observers took it as transitory, but reading after reading turned out stronger than expected. And as time passed, the surge gathered speed and became more broad-based, across both countries and categories (Graph 1). After hibernating for decades – as if over a long winter – inflation was back with a vengeance.

An unanticipated surge in global inflation[1] Graph 1



[1] AEs: AU, CA, CH, GB and SE. EMEs: AR, BR, CL, CO, HU, ID, IL, IN, KR, MX, MY, PE, PH, RU, SA, SG, TH, TR and ZA. [2] High inflation corresponds to a 12-month percent change in an item's price above 5%.

Sources: IMF; OECD; Datastream; national data; authors' calculations.

While the debate has yet to be settled, prevailing models of inflation arguably did not prove fit for purpose.[1] They were too aggregated to capture the subtleties of the pandemic-induced shifts in demand patterns. In addition, by construction, they generally assumed that inflation would return to central banks' targets, and that the underlying model parameters would remain invariant even as inflation surged. To be sure, shocks, by definition, cannot be anticipated. And shocks there were aplenty, not least the spike in food and energy prices sparked by the war in Ukraine. That said, changes in the inflation process were already well under way.

Against this backdrop, the BIS Annual Economic Report published in June 2022 (BIS (2022)) provided a view of inflation which complements that of standard models. This view plays up the features that these models play down – disaggregated price dynamics and behavioural adjustments to the evolution of inflation itself. We term this the "two-regime view" of inflation – with one regime characterised by low inflation and the other by high inflation, and with self-reinforcing transitions from low to high.

[1] See eg Reis (2022b) for a discussion of possible explanations for the recent inflation surge.

Why two regimes? Because empirical evidence indicates that inflation behaves very differently in the two. In a low-inflation regime, ie when inflation has settled at a low level, measured inflation mostly reflects sector-specific price changes that are only loosely correlated with each other. Thus the component of price changes that is common across different goods and services is small. Those price changes tend to leave only a temporary imprint on the inflation rate itself. Equally important, wages and prices, which are at the very core of the inflation process, are only loosely linked with each other. As a result, inflation tends to be self-stabilising. By contrast, a high-inflation regime has no such properties. The importance of the common component of price changes is much greater, wages and prices are more tightly linked, and inflation is especially sensitive to changes in salient prices, such as those of food and energy, as well as to fluctuations in the exchange rate. Thus, while in a high-inflation regime the *inflation rate* is not self-stabilising, *the regime itself* is self-entrenching, just as is its low-inflation counterpart.

Why are the transitions from low- to high-inflation regimes self-reinforcing? For one, inflation moves out of the zone of "rational inattention", where it is hardly noticed by economic agents, and snaps into sharp focus. In addition, it becomes more representative of the change in the price indices that individual agents care about: as prices increase, price changes across different goods and services become more similar and synchronised. As a result, inflation plays more of a coordinating role in the behaviour of economic agents. In addition, as inflation increases, so do the costs of lagging profit margins or falling living standards, which heighten agents' incentives to catch up. All this increases the likelihood of wage-price spirals – or, equivalently, price-wage spirals – which lie at the heart of the inflation process.

The main value added of the two-regime view of inflation is precisely to highlight the elements that prevailing approaches downplay. In fact, elements of this view are strewn across the existing economic literature, if sometimes only in passing. Our analysis brings them together into a coherent whole, stressing their similarities and complementarities. And while the very idea of two regimes is a simplification, it has the merit of putting the spotlight on that elusive zone in which inflation begins to have a material impact on economic agents' behaviour. After all, both Volcker (1983) and, subsequently, Greenspan (1996) defined price stability as a situation in which the inflation rate does *not* have a significant influence on behaviour – broadly analogous to our low-inflation regime.

The rest of the study lays out this perspective on the inflation process, elaborating on the analysis already provided in the BIS Annual Economic Report. Section 1 documents in detail the differences in price dynamics in high- and low-inflation regimes. Section 2 zeroes in on the link between prices and wages. Section 3 interprets the findings and explores the implications for transitions across regimes. Section 4 turns to monetary policy.

1. Price dynamics in the two regimes: stylised facts

A look at disaggregated price dynamics at different levels of inflation points to the usefulness of characterising the inflation process in terms of two regimes.[2] What follows considers, sequentially, how the inflation regime affects the degree of price co-movements, the pass-through of individual price changes along the "price chain" and the response of the inflation rate to especially salient prices, such as those of energy or the exchange rate – the price of one currency in terms of another. The analysis of disaggregated price changes is based on the granular sector-specific prices that compose the consumer price indices in a large sample of advanced and emerging market economies.

Co-movements of sector-specific price changes

One simple way to characterise the commonality across price developments in different sectors is to look at the first principal component of sectoral (log) price changes. Such a "common component of inflation" is a weighted average of sectoral price developments, in which weights are chosen to be maximally representative of all sector-specific price changes. We illustrate this using two countries with sufficient histories of available detailed sectoral price data: the United States[3] (covering 131 personal consumption expenditure (PCE) sectors from January 1959) and Mexico (76 sectors underlying the consumer price index (CPI) from January 1980).

In the high-inflation regime, disparate sectoral price changes are approximated remarkably well by the first principal component.[4] Graph 2 shows the percentage of the total variance of sectoral price developments that it explains. For the United States (panel A), this is around 60% of the total variability in sectoral PCE price changes during the high-inflation years, ie up to around the mid-1990s. That percentage subsequently drops to between 20% and 30%, as we enter the low-inflation regime. This pattern also holds for each of the three major subcomponents: durable goods, non-durable goods and services. For Mexico (panel B), the results are even starker: the common component explains around 80% of total volatility in sectoral CPI price changes when the moving window includes periods of high inflation, but it falls to 20% when these drop out. Each of the three major subcomponents display similar changes in the explanatory power of the common component over time, even though the levels differ systematically.

This decline in the relevance of the common inflation component is also at the root of another well documented stylised fact: the significant decrease in the volatility of inflation as inflation falls.[5] To be sure, as it does so, the volatility of individual price

[2] Two-regime models have been used elsewhere in the past to examine how the level of inflation interacts with different aspects of the economy. Bianchi (2013) argues that changes in the monetary policy rule, reflecting the dominance of "doves" versus "hawks", are the key driver of transitions between high- and low-inflation regimes, while Chang and He (2010) explore how the level of inflation affects inflation uncertainty and output growth.

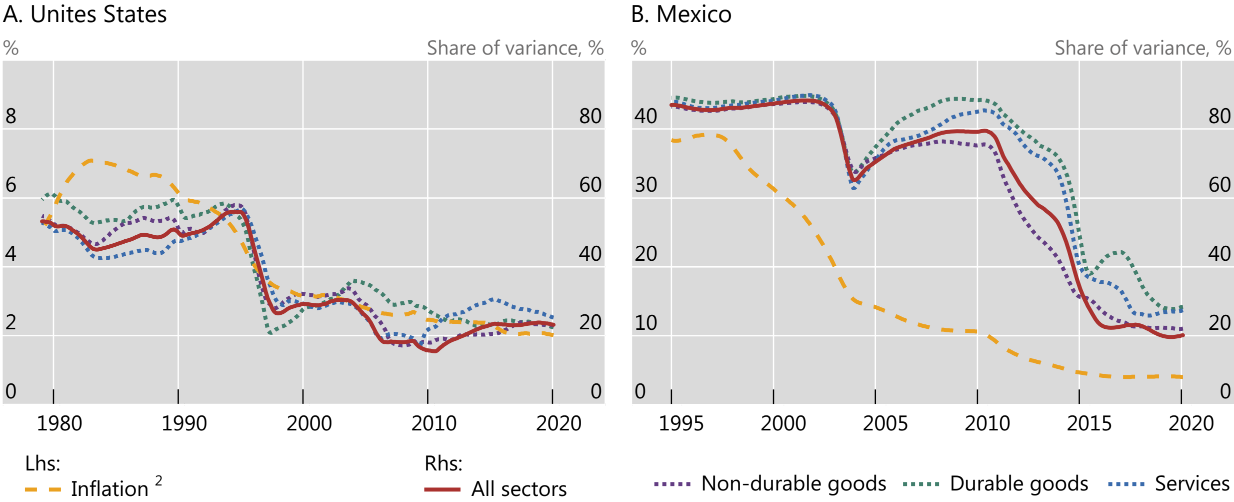
[3] For a more detailed discussion of the US case, see Borio et al (2021).

[4] See also Altissimo et al (2009) and Reis and Watson (2010) for similar analyses.

[5] While the positive association between inflation and its volatility is generally accepted, the direction of causality between them is less clear; see eg Kim and Lin (2012) and Hartmann and Herwartz (2012).

changes declines as well. However, this is dwarfed by the decline in the covariance between them.[6]

The importance of the common factor underlying price changes has fallen[1] Graph 2



[1] Time-varying fraction of total price-change variance due to the common component of 12-month percent changes in prices across all sectors and within each specified subsector, estimated using a 15-year moving window. [2] Fifteen-year moving average of 12-month headline inflation.

Sources: National data; authors' calculations.

To show this, we compute, for each country, the cross-sectional variance of aggregate 12-month inflation, as measured by the weighted average of the 12-month log-difference of underlying sectoral prices.[7] Such a variance can be decomposed into the portion attributable to two components: the variances of sectoral price differences and the covariances between them. This decomposition, displayed in Graph 3, shows that the decline in overall variance associated with the attainment of a low-inflation regime is mainly explained by the reduced covariance across sectors (blue areas). This highlights that a defining feature of a low-inflation regime is a lower degree of co-movement in price changes across sectors.

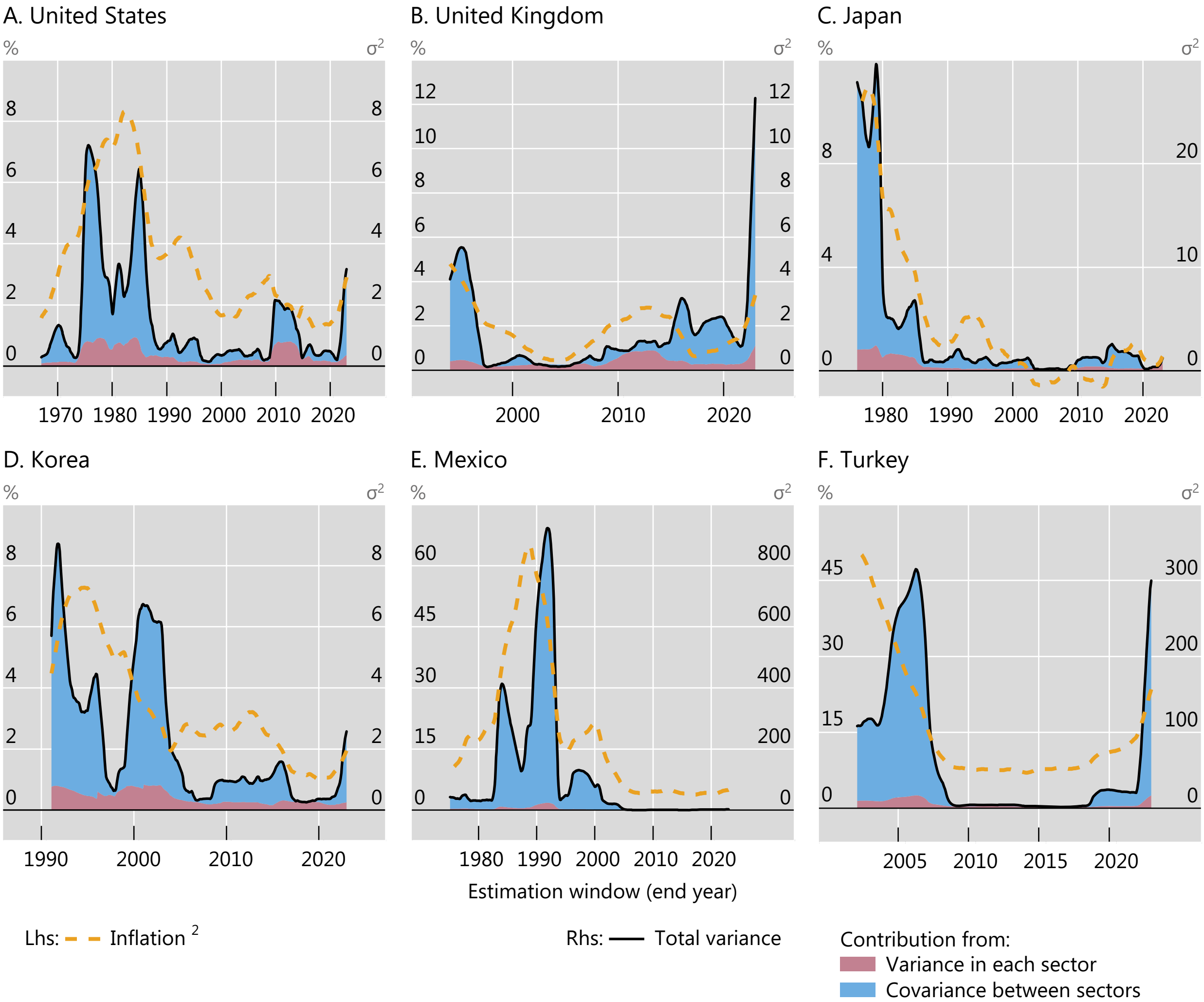
When inflation is low, then, sectoral price changes continue to display variation, but these changes are generally idiosyncratic and independent of each other. In other words, they tend to reflect *relative* price changes, rather than broad-based changes in the underlying price level – the component that better approximates the theoretical notion of "true" inflation.[8] As we will see, this disconnect between individual and aggregate price changes occurs even if, overall, sectoral price changes fail to cancel each other out so that measured inflation is affected, since any effect tends to be short-lived rather than persisting through time.

[6] This mirrors what is known about portfolio returns: changes in the volatility of the return on a portfolio of securities are fundamentally driven by changes in the covariance of the returns on individual securities, not in their variance.

[7] The weights are given by a geometric average of sectoral expenditure shares in months $t-12$ and t.

[8] See Humpage (2008) and also Reis and Watson (2010), who take this argument and measurement further.

Volatility falls in low-inflation regimes as price co-movements drop[1] Graph 3



[1] Consumer price inflation, except for US (PCE deflator). Calculated using sector-level data over a five-year rolling window. [2] Five-year moving average of 12-month headline inflation.

Sources: National data; authors' calculations.

Spillovers across sectoral price changes

As inflation falls, the decline in the co-movement of sectoral price changes goes hand in hand with another key feature – a decline in price spillovers across sectors. These smaller spillovers help to keep a lid on inflation, in part by reducing its persistence, thereby reinforcing the low-inflation regime.

Broad-based inflation ultimately depends on both sector-specific price increases (discussed above) and the transmission of those increases across sectors. Without transmission, increases in the price level due to price shocks in one sector will tend to die out over time rather than leading to sustained inflation.

One way to assess price spillovers is to look at how idiosyncratic shocks of each sectoral price index affect the variability of other sectoral price indices within a given horizon.[9]

Box A

Measuring sectoral price spillovers

To measure the extent of the transmission of individual price changes across different sectors, we look at indices of spillovers borrowed from the literature on financial and international business cycle linkages.① The underlying idea is to jointly model price changes across sectors through a Bayesian VAR, and then use the estimated coefficients to look at the generalised forecast error variance decomposition over given horizons. Off-diagonal elements of that matrix represent the shares of variance in the price changes of each sector that is explained by changes in the prices in other sectors.

More formally, let us start by specifying a VAR model with p lags for the month-on-month price changes in the N sectors of PCE, x_t:

$$x_t = \sum_{i=1}^{p} \Phi_i \, x_{t-i} + \Psi w_t + u_t,$$

where w_t is a vector of exogenous explanatory variables and the shocks u_t are normally distributed with mean zero and variance-covariance matrix Σ. Such a VAR can be expressed in $MA(\infty)$ form as:

$$x_t = \sum_{i=0}^{\infty} \mathrm{A}_i \, u_{t-i} + \sum_{i=0}^{\infty} \mathrm{G}_i \, w_{t-i},$$

where $A_0=I$, $A_i=\Phi_1 A_{i-1}+ \Phi_2 A_{i-2}+\ldots+ \Phi_p A_{i-p}$, $A_i=0$ for $i<0$ and $G_i=A_i\Psi$. Following Koop et al (1996) and Pesaran and Shin (1998), we define the generalised impulse response function (GIRF) to a shock in variable j by integrating out the effects of other shocks. Under the assumption that shocks are normally distributed, this can be done analytically, so that the GIRFs at horizon h can be written as:

$$\gamma_j(h) = E_{t-1}\left(x_{t+h} \middle| u_{j,t} = 1\right) - E_{t-1}(x_{t+h}) = \sigma_{jj}^{-1/2} A_h \Sigma e_j,$$

where e_j is a selection vector with unity as its j-th element and zeros elsewhere. Single entries of the GIRF vector can be extracted, so that $\gamma_{ij}(h)$ would denote the response of the i-th variable in the system to a shock to the j-th variable over a horizon h. The GIRFs can be used to construct a generalised forecast error variance decomposition (GFEVD), whose elements are given by:

$$\lambda_{ij}(h) = \sum_{l=0}^{h} \gamma_{ij}(h)^2 / \sum_{j=1}^{N} \sum_{l=0}^{h} \gamma_{ij}(h)^2.$$

The entries of the GFEVD matrix represent the share of h-periods-ahead error variance of variable i (rows) that is explained by shocks to variables j (columns). Note that, unlike what happens with orthogonal factorisation of the covariance matrix, the shocks here are not perfectly orthogonal, so the rows do not sum necessarily to one. If one employs the normalisation:

$$\tilde{\lambda}_{ij}(h) = \lambda_{ij}(h) / \sum_{r=1}^{N} \lambda_{ir}(h),$$

rows sum to one so that the total sum of the elements of the GFEVD matrix is N.

An index of total spillovers can be constructed by summing the off-diagonal elements of the GFEVD matrix. These represent the amount of variance pertaining to each variable of the system which is not explained by its own shocks, but instead by the transmission of shocks to other prices, working through the lag structure of the VAR. More formally, the index of total spillovers is defined as:

$$S(h) = 100 \times \sum_{i,j=1, i\neq j}^{N} \tilde{\lambda}_{ij}(h) / N.$$

9 For the technical details, see Box A. The first step is to model the joint dynamics of prices over time. We use a very general Bayesian VAR, in which sector-specific price changes react to their own lags, as well as to those in other sectors. We then consider the generalised impulse responses to sector-specific shocks (Pesaran and Shin (1998)) and use them to construct the generalised forecast error variance decomposition (GFEVD) matrix. This measures the share of the variance of each PCE sector (the rows) explained by shocks to each of the sectors (the columns) at the chosen horizon. We focus on a horizon of 12 months.

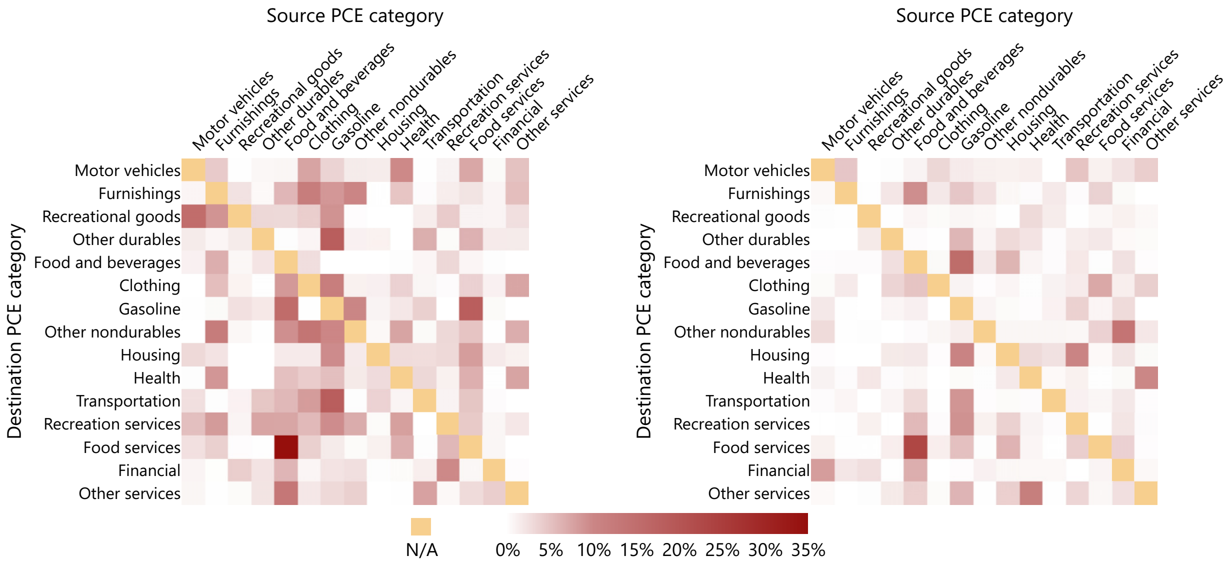
Slicing the GFEVD across different dimensions conveys additional useful information. For example, summing the off-diagonal elements by row yields a measure of the extent to which each sector is an "importer" of price spillovers from the others. Conversely, summing the off-diagonal elements of the GFEVD by column measures how much shocks to a given sector are liable to transmit to the others – a measure of "exported" spillovers.

Looking at the spillover indices at different horizons also conveys useful information. At horizon $h = 0$, the GFVED coincides with the covariance matrix of the innovations. Hence, its off-diagonal elements represent the extent to which the initial shocks are correlated. As the horizon grows, so does the role played by the transmission of the individual shocks through the lag structure of the VAR system. The ratio between the indices of total spillovers at horizon 0 and at horizon h can thus be thought of as a measure of the degree of coincidence in the shocks across sectors.

① See Diebold and Yilmaz (2009), Yilmaz (2015) and Lombardi et al (2013).

Bilateral price spillovers across US PCE categories[1] — Graph 4

A. Sample period: Jan 1969–Dec 1984 | B. Sample period: Jan 1991–Dec 2019



[1] Share of the variance of sectoral price changes over a horizon of 12 months explained by shocks to prices in other sectors. See Box A for details.

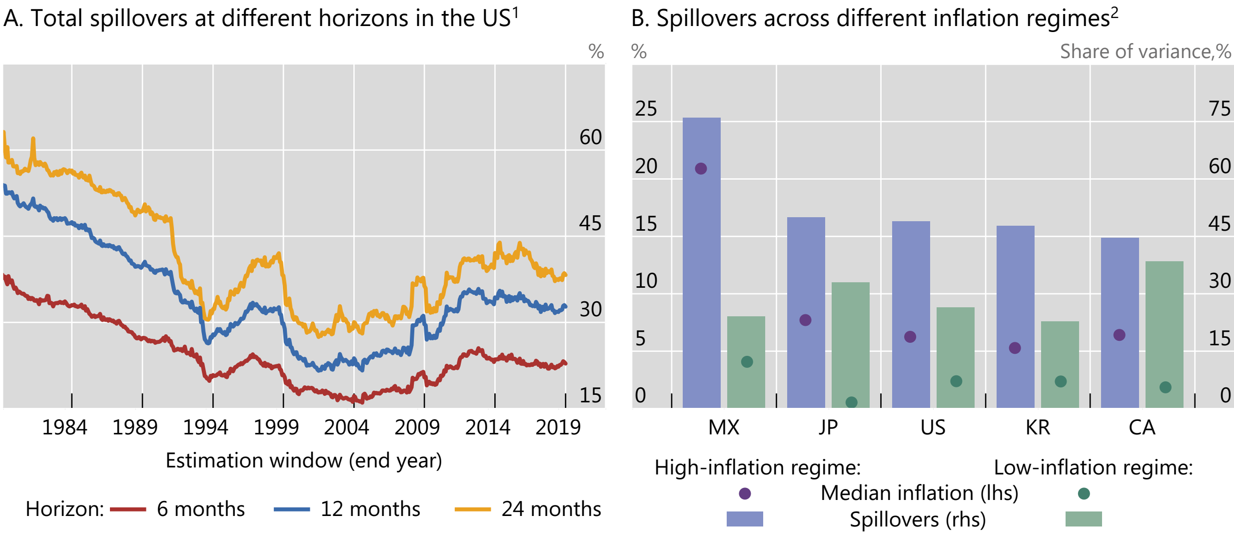
Sources: Board of Governors of the Federal Reserve System; FRED; World Bank; Datastream; national data; authors' calculations.

Graph 4 displays these price volatility spillovers as a heat map for two subsamples based on US data. Darker shades of red indicate greater spillovers from the sector on the horizontal axis to the sector on the vertical axis. Consider, for example, the dark red square in the row "Food services" corresponding to the column for "Food and beverages": it indicates that the bilateral spillovers from the former to the latter are sizeable, as one might expect.[10] More generally, the graph shows the decline in the intensity of spillovers across the two sample periods. The shading is, on balance, considerably darker in panel A, the sample period that includes the Great Inflation of the 1970s, than in panel B, which covers the 1991 – 2019 period of low and stable inflation.

[10] The diagonal elements of the matrix (shaded in yellow) are excluded since these are "own" shocks and do not correspond to spillovers across sectors.

To examine the evolution of US price spillovers more carefully, we estimate the BVAR on rolling 20-year samples and generate an index of spillovers by summing all the off-diagonal elements of the GFEVD matrix for each sample. Results, dated according to the final observation of the rolling window, are shown in Graph 5.A. These point to a steady decline in the spillover index until the mid-1990s, a moderate increase thereafter, followed by another decline after 2000.[11] Spillovers have since increased somewhat, notably in the wake of the Great Financial Crisis (GFC), but were again moderating in the years immediately preceding the Covid-19 pandemic.

Spillovers of sectoral price changes declined as a low-inflation regime prevailed — Graph 5



[1] Share of the variance of sectoral price changes over the specified horizon explained by shocks to prices in other sectors. See Box A for details. [2] Based on quarterly CPI data, for CA, JP, KR and MX; monthly PCE deflator data for US. High-inflation regime samples: CA, Q4 1971–Q4 1990; JP, Q4 1970–Q4 1979; KR, Q4 1985–Q4 1997; MX, Q1 1983–Q4 2002; and US, Jan 1969–Dec 1984. Low-inflation regime samples: CA, Q1 1991–Q4 2019; JP, Q1 1980–Q4 2019; KR, Q1 1998–Q4 2019; MX, Q1 2003–Q4 2019; and US, Jan 1991–Dec 2019.

Sources: Board of Governors of the Federal Reserve System; FRED; OECD; World Bank; CEIC; Datastream; national data; authors' calculations.

It is not only in data for the United States that the decline in spillovers is visible. This is illustrated in Graph 5.B, where we show that the index of total spillovers has generally declined as inflation subsided across a sample of countries.[12]

The pass-through of relative price changes into inflation

The decline in the intensity of price spillovers across sectors documented above reflects a broader and very important property of low-inflation regimes: they are self-stabilising. In a low-inflation regime, individual price changes are generally unlikely to have consequences for underlying inflation.

One way to show this is to look at whether headline inflation tends to converge to core, or vice-versa. When headline converges to core, the historically volatile price changes associated with food and energy tend to dissipate over time; by contrast,

[11] This decline is mostly due to the loss of observations from the late 1970s from the estimation window.

[12] A period of high inflation is defined here as one in which the five-year moving average of inflation exceeds 5%. We use this classification for most of the analysis that follows.

when core converges to headline, those price changes tend to drag core inflation away with them, indicating potentially powerful second-round effects (see, eg Cecchetti and Moessner (2008)).

To formally examine this hypothesis, we estimate the following two regressions using US monthly data:

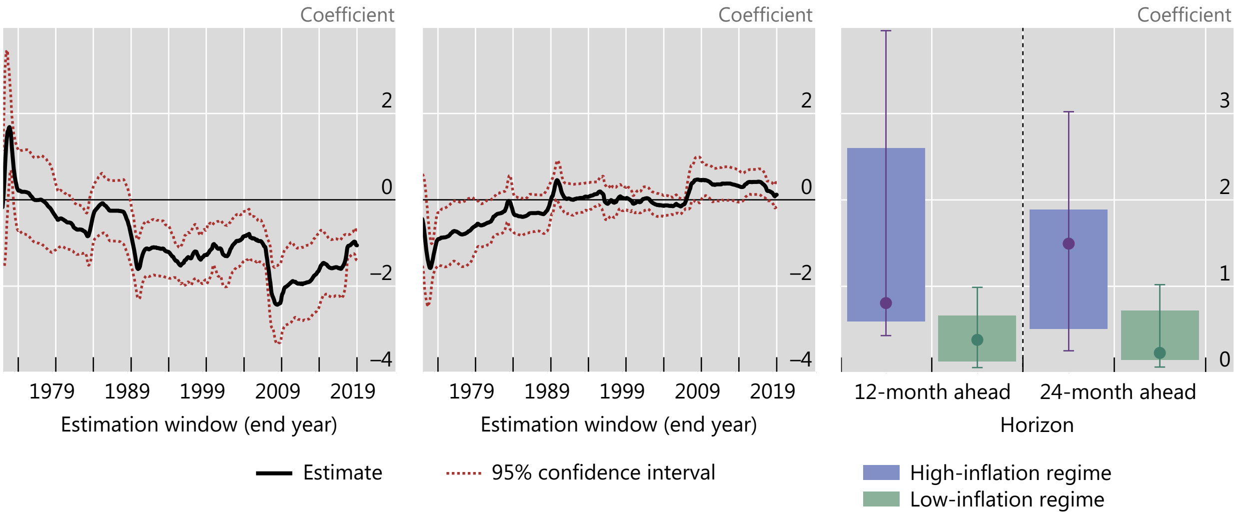
$$\Delta^{12}p^H_{t+12} - \Delta^{12}p^H_t = \alpha_0 + \alpha_1(\Delta^{12}p^H_t - \Delta^{12}p^C_t) + \alpha_3\hat{u}_{i,t} + \epsilon^H_{t+12};$$

$$\Delta^{12}p^C_{t+12} - \Delta^{12}p^C_t = \beta_0 + \beta_1(\Delta^{12}p^C_t - \Delta^{12}p^H_t) + \beta_3\hat{u}_{i,t} + \epsilon^C_{t+12},$$

where $\Delta^{12}p^H_t$ and $\Delta^{12}p^C_t$ denote the 12-month headline and core PCE inflation between months $t-12$ and t, respectively, and $\hat{u}_{i,t}$ is the unemployment gap (ie the deviation of the unemployment rate from its natural rate), which controls for the cyclical state of the economy.[13] The coefficients of interest in this exercise are α_1 and β_1, where α_1 measures the extent to which deviations of headline inflation from the core – and the opposite in the case of β_1 – dissipate over time; note that $\alpha_1 = \beta_1 = -1$ implies that such deviations dissipate fully over the subsequent 12 months.

The pass-through of headline inflation and outsize price changes to core inflation — Graph 6

A. Convergence of headline to core inflation — B. Convergence of core to headline inflation — C. Distribution of the pass-through coefficients[1]



[1] Box plots show median, minimum, maximum and interquartile range of the statistically significant (at the 5% level) positive pass-through coefficients at the specified horizon.

Sources: National data: authors' calculations.

Graph 6 shows the time-varying estimates of the coefficients α_1 and β_1 based on rolling 10-year windows. During the high and volatile inflation era of the late 1960s and the 1970s, headline inflation did not converge to core inflation, as evidenced by the estimates of α_1, which are statistically indistinguishable from zero (panel A). During this period, instances when core inflation exceeded headline inflation were generally followed by a sustained rise in core inflation (panel B). However, as the Fed's 1979–82 "war on inflation" started to bear fruit, the coefficient α_1, governing the

[13] In computing the unemployment gap $\hat{u}_{i,t}$, we estimate the time-varying natural rate of unemployment using the modified Hamilton filter; see Hamilton (2018) and Quast and Wolters (2022).

speed of reversion of headline inflation to core, began to move lower and since 1990 has been statistically indistinguishable from –1. At the same time, the tendency of core inflation to revert to headline inflation, which persisted through the mid-1980s, has vanished completely.

Another manifestation of the self-stabilising properties of a low-inflation regime is that the pass-through of individual price changes into inflation tends to become much more muted and less pervasive. This is true even for particularly large relative price changes – those that, due to their magnitude, are most likely to attract the attention of economic agents.

To show this, we follow the two-step procedure of Borio et al (2021). We first estimate the following regression for each US PCE sector:

$$\Delta p_{i,t} = \mu_i + \lambda_i PC_t + \epsilon_{i,t},$$

where $\Delta p_{i,t}$ is the monthly log-difference of the price index in sector i and PC_t is the first principal component of $\Delta p_{i,t}$, estimated across all sectors. We estimate PC_t and the associated sector-level regressions separately for two subsamples – corresponding to high- and a low-inflation regimes – and then cumulate the estimated residuals within each sector to construct (log) relative price indices, denoted by $rp_{i,t}$. These relative prices are, by construction, uncorrelated with the common component of inflation PC_t. "Large" relative price *increases* (in per cent) are then defined as:

$$\Delta rp_{i,t}^{(+)} = 100 \times \max\{0, rp_{i,t} - rp_{i,t}^{*}\},$$

where $rp_{i,t}^{*} = \max\{rp_{i,t-1}, rp_{i,t-2}, \dots, rp_{i,t-12}\}$ is the largest (log) relative price over the previous 12 months.[14]

In a second step, we estimate for each subsample the regression:

$$\Delta^h p_{t+h}^C = \mu + \beta_i^{(+)} \Delta rp_{i,t}^{(+)} + \gamma \hat{u}_{i,t} + \sum_{s=0}^{h-1} \rho_s \, \Delta p_{t-s}^C + \epsilon_{t+h},$$

where $\Delta^h p_{t+h}^C$ denotes the (annualised) core PCE inflation from month t to month $t+h$, and $\hat{u}_{i,t}$ is the unemployment gap that again controls for the cyclical state of the economy. For each sector i and horizon h, these regressions yield estimates of the coefficient $\beta_i^{(+)}$, measuring the pass-through of large relative price increases in month t to core inflation over the subsequent h months. This exercise tests the idea that consumers may change their behaviour in response to a relative price increase – which in turn could influence the pass-through of such price increases to core inflation – only if the increase is "large" relative to the recent past, in our case the past 12 months. We expect that this phenomenon should be much less pervasive and muted in the low-inflation regime.

Graph 6.C shows the distributions of the statistically significant positive pass-through coefficients at various horizons for the low- and high-inflation subsamples. At both 12- and 24-month horizons, the distribution of the pass-through coefficients is significantly tighter and closer to zero in the low-inflation regime. The distributions in the high-inflation regime also feature a much thicker right tail, indicating the presence of many sectors in which large relative price spikes were associated with economically large and persistent subsequent increases in core PCE inflation.

14 This transformation was introduced by Hamilton (2003) to study the asymmetric effects of changes in oil prices on real economic activity.

This finding also holds for price changes in sectors that are generally important sources of spillovers, like gasoline (Graph 4) and other fuel products. Their pass-through into higher inflation is weaker in a low-inflation regime.

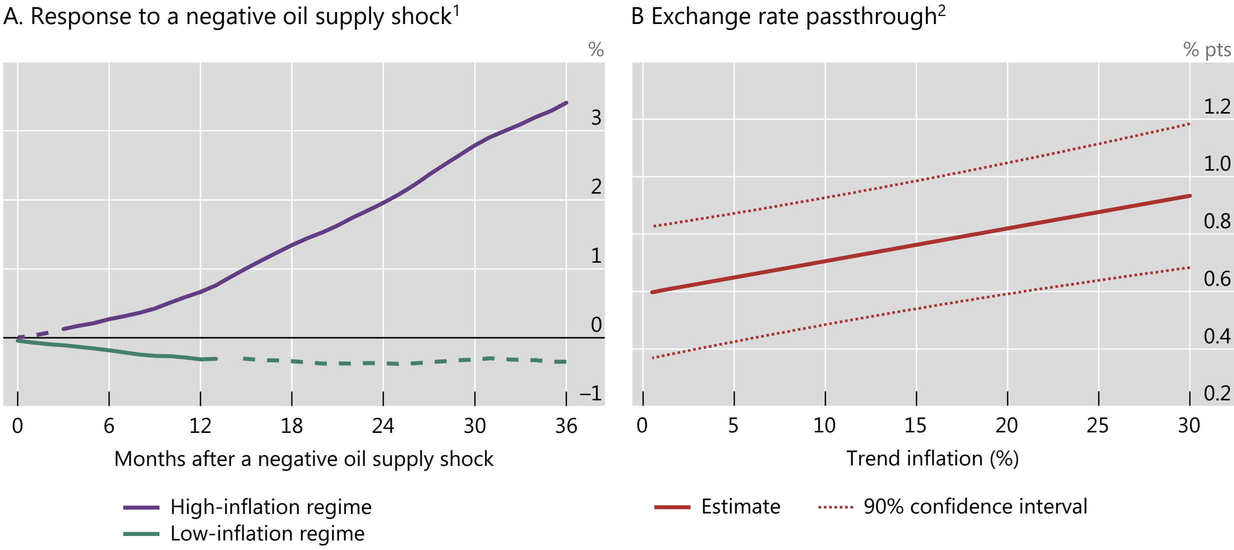
Oil provides a case in point. To formally assess this, we consider oil supply shocks, as identified by Baumeister and Hamilton (2019). We use these in a local projection regression of inflation for a set of advanced and emerging market economies over a sample spanning from 1975 to 2019, which encompasses both high- and low-inflation regimes. In particular, we estimate the following panel regression:

$$p_{i,t+h} - p_{i,t-1} = \beta_1^h s_t^{(-)} + \beta_2^h s_t^{(-)} \times \mathcal{I}_{i,t-1} + \gamma_1^h s_t^{(+)} + \gamma_2^h s_t^{(+)} \times \mathcal{I}_{i,t-1} + \sum_{l=1}^{12} \rho_l^h \Delta p_{i,t-l} + \eta_i^h + \epsilon_{i,t+h},$$

for horizons h=1,...,36, measured in months. In this specification, $p_{i,t}$ is the log of the consumer price index, and $\mathcal{I}_{i,t}$ is a 0/1-indicator variable that takes a value of one if the five-year moving average of 12-month inflation ($\tilde{\pi}_{i,t}$ henceforth) exceeds 5% in country i in month t; and $s_t^{(-)}$ and $s_t^{(+)}$ are, respectively, *negative* oil supply shocks that push oil prices higher, and *positive* oil supply shocks that push oil prices lower.

A low-inflation regime dampens the pass-through of oil price and exchange rate changes

Graph 7



[1] The sample covers AT, AU, BE, BR, CA, CH, CL, CN, CO, CZ, DE, DK, ES, FI, FR, GB, HK, HU, ID, IE, IL, IN, IT, JP, KR, MX, MY, NL, NO, NZ, PL, PT, RU, SE, SG, TH, TR, US and ZA. High (low) inflation regime corresponds to five-year inflation moving average above (below) 5%. The solid lines indicate horizons where the inflationary response is statistically significant at the 10% level. [2] The sample covers AT, AU, BE, BR, CA, CH, CL, CN, CO, CZ, DE, DK, ES, FI, FR, GB, HK, HU, ID, IE, IL, IN, IT, JP, KR, MX, MY, NL, NO, NZ, PL, PT, RU, SE, SG, TH, TR, US and ZA over Mar 1973–Dec 2019. Effect of a 1% exchange rate depreciation in month *t* on annualised headline inflation from month *t*–1 to month *t*+2. Trend inflation is defined as a five-year moving average of 12-month headline inflation.

Sources: Baumeister and Hamilton (2019); Federal Reserve Bank of St Louis, FRED; IMF; national data; authors' calculations.

Graph 7.A plots the estimates of the relationship between negative oil supply shocks (ie exogenous positive oil price increases) and subsequent inflation in low-inflation regimes (β_1^h) and high-inflation regimes ($\beta_1^h + \beta_2^h$) respectively. Their statistical significance (at the 10% level) is indicated by solid (rather than dashed) lines.[15] Estimates suggest that the impact of negative oil supply shocks is strongly

[15] Statistical significance is based on standard errors clustered across countries and time.

inflationary in a high-inflation regime, with an influence that builds up steadily over time. In contrast, in a low-inflation regime, their impact on inflation is even (mildly) negative, possibly due to the contractionary effects that higher oil prices have on economic activity.[16]

In a similar vein, a low-inflation regime is also a better safeguard against imported inflation in the face of exchange rate depreciations: the pass-through to inflation is lower when inflation is lower. To assess the role played by the level of trend inflation on the pass-through of exchange rate changes, we estimate the following panel regression:

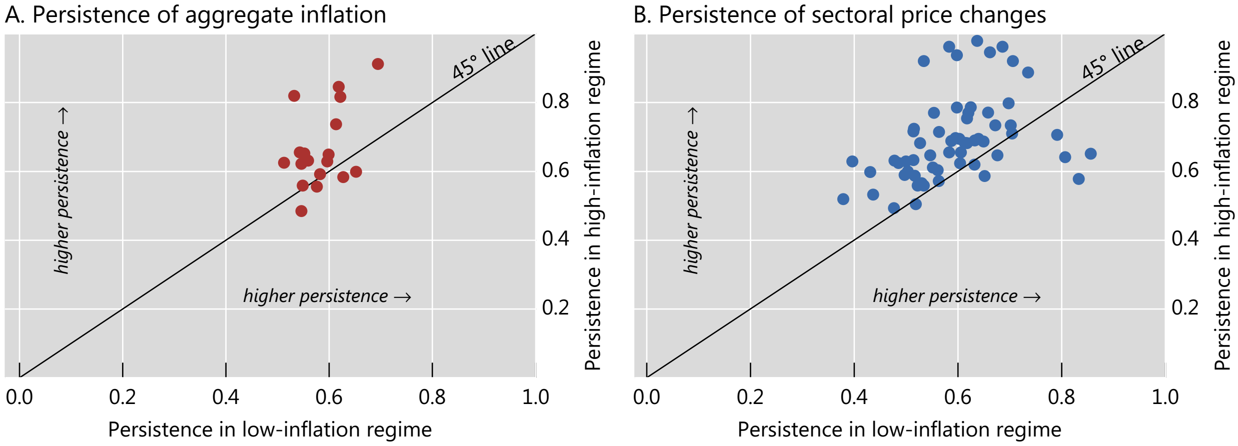
$$p_{i,t+2} - p_{i,t-1} = \beta_1 \Delta e_{i,t} + \beta_2 \Delta e_{i,t} \times \tilde{\pi}_{i,t-1} + \sum_{l=1}^{12} \rho_l \Delta p_{i,t-l} + \kappa FXR_{i,t-1} + \eta_i + \lambda_t^A + \lambda_t^E + \epsilon_{i,t+2},$$

where $\Delta e_{i,t}$ denotes the log-difference of country i's exchange rate against the US dollar, $FXR_{i,t}$ is the exchange rate regime indicator (Reinhart and Rogoff (2004)) in country i prevailing at time t and λ_t^A and λ_t^E are time fixed effects for, respectively, advanced and emerging market economies. The pass-through coefficient as a function of the level of underlying trend inflation ($\beta_1 + \beta_2\tilde{\pi}$) is plotted in Graph 7.B and demonstrates a clear positive relationship between the level of inflation and exchange rate pass-through.[17]

Inflation persistence

The more limited pass-through of relative price changes into inflation in low-inflation regimes is also consistent with yet another well-known stylised fact: the persistence of inflation falls with the level of inflation.

Low-inflation regimes: price changes are less persistent[1] Graph 8



[1] Persistence of one-month log price changes computed using sector-level data. Measure of persistence based on Días and Marques (2010). High-inflation regime samples: CA, Dec 1971–Dec 1990; JP, Dec 1970–Dec 1979; KR, Dec 1985–Dec 1997; MX, Jan 1983–Dec 2002; US, Jan 1965–Dec 1985. Low-inflation regime samples: CA, Jan 1991–Dec 2019; JP, Jan 1980–Dec 2019; KR, Jan 1998–Dec 2019; MX, Jan 2003–Dec 2019; and US, Jan 1986–Dec 2019.

Sources: CEIC; Datastream; national data; authors' calculations.

[16] The reaction to positive oil supply shocks mirrors that of negative ones.

[17] This is a well-known result; see eg Choudhri and Hakura (2006) and Devereux and Yetman (2010).

Graph 8 illustrates this property of inflation. We compute the index of persistence by Días and Marques (2010) over a sample of countries for which data are available covering both high- and low-inflation regimes.[18] We then plot the value of the index during the low-inflation regime against its equivalent in the high-inflation regime (panel A). The bulk of the points in the scatter lie above the 45° line, signalling higher persistence in the high-inflation regime. What is perhaps less well known is that this property is even stronger at the sectoral level. When we repeat the exercise by separately estimating the persistence for each sector across the same countries, the results are even more striking (panel B).

2. The wage-price nexus in the two regimes: stylised facts

So far, the analysis has focused on the dynamics of inflation across the two regimes, at both aggregated and disaggregated levels. We now delve more deeply into the dynamics of wages and their relationship to prices. The reason is simple: the engine of sustained inflation is ultimately a self-reinforcing feedback loop between price and wage increases – wage-price spirals, for short.[19] There are limits to how far real wages can fall as inflation takes hold or to how far profit margins can narrow as wages rise.[20]

Just as with price dynamics, the wage-price link varies systematically with the inflation regime. The link is tight in a high-inflation regime, and loose in a low-inflation one. This emerges from statistical exercises that consider the reaction of wages to prices and, separately, of prices to wages. And it becomes even clearer once we explore the joint behaviour of the two variables, including the speed of adjustment to each other. Consider each type of exercise in turn.

To separately evaluate the reaction of wages to prices, and prices to wages, we estimate the following country-level panel regressions over rolling 20-year subsamples:

$$\Delta^4 w_{i,t+4} = \alpha_w \Delta^4 w_{i,t} + \beta_w \Delta^4 p_{i,t} + \gamma_w \hat{u}_{i,t} + \delta_w \Delta^4 l_{i,t} + \eta_i + \lambda_t + \epsilon_{i,t+4};$$

$$\Delta^4 p_{i,t+4} = \alpha_p \Delta^4 w_{i,t} + \beta_p \Delta^4 p_{i,t} + \gamma_p \hat{u}_{i,t} + \delta_p \Delta^4 l_{i,t} + \eta_i + \lambda_t + \epsilon_{i,t+4},$$

where $w_{i,t}$ denotes the (log) level of nominal wages in country i in quarter t; $p_{i,t}$ and $l_{i,t}$ are the corresponding (log) levels of the CPI and labour productivity, respectively; Δ^4 is the four-quarter change in the specified variable; and $\hat{u}_{i,t}$ is the unemployment gap.[21] We estimate the two regressions using a quarterly balanced panel of 14 advanced economies, for which consistent long time series- are available since 1971. Estimates of the coefficients β_w and α_p, together with their 90% confidence bands,

18 The countries included are Canada, Japan, Korea, Mexico and the United States.

19 We use the expression "wage-price" spiral without pre-judging the direction of causality (we could equivalently use the expression "price-wage" spirals, but this is far less common). The original shock may vary, but, fundamentally, causality runs both ways. Similarly, the term "spirals" here does not denote a process that gets out of control, but simply a self-sustaining one.

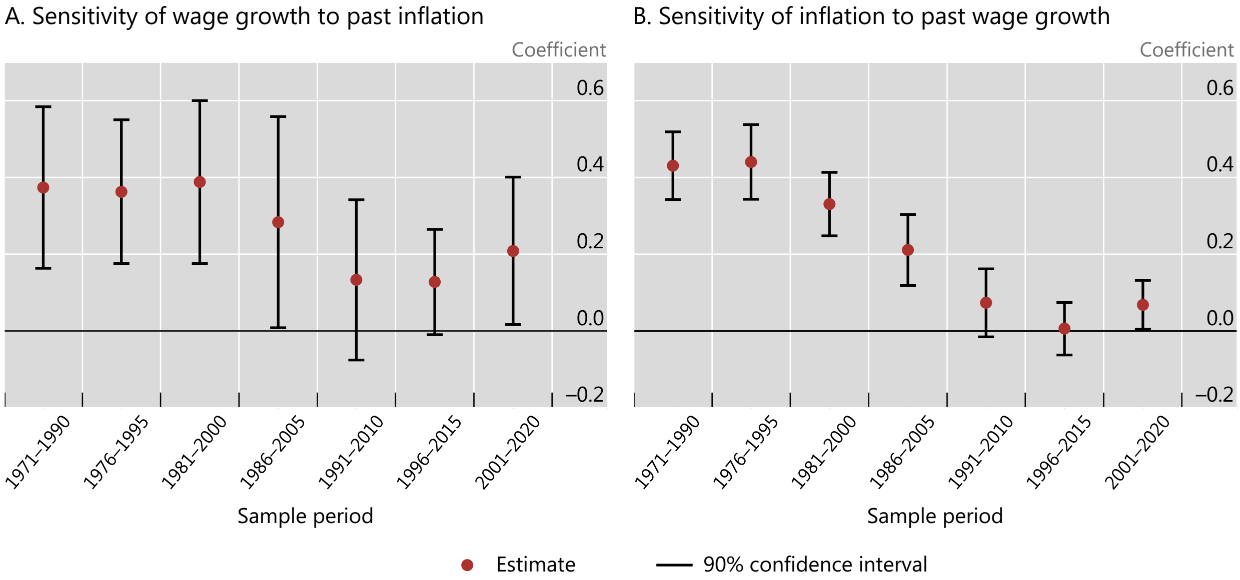
20 For example, Lorenzoni and Werning (2023) characterise a wage-price spiral as a mechanism that increases the size and persistence of the inflationary effects of shocks and is caused by differences in the degree to which wages and prices are sticky. As such, it corresponds to a distributional conflict between workers and firms on who should bear the brunt of a wave of unanticipated inflation. For an earlier elaboration on this idea, see Rowthorn (1977).

21 The unemployment gap is based on OECD estimates of the natural rates of unemployment.

are shown in Graph 9. They highlight how the sensitivity of wages to prices, and even more so prices to wages, has been declining over time, in parallel with the decline in inflation.

Wages have become less sensitive to inflation in AEs[1]

Graph 9



[1] AEs: AU, BE, CA, DE, DK, ES, FR, GB, IE, IT, JP, NL, SE and US.

Sources: OECD; national data; authors' calculations.

We next examine the joint relationship between prices, wages and labour productivity (see Box B for the full details). As these series are non-stationary and trend over time, we do this based on a cointegration model. This allows for a long-run stationary relationship between trending variables and for temporary, but possibly long-lasting, deviations from this relationship. Specifically, our model postulates that wages and prices will tend to hover around a common trend in the long run after adjusting for productivity. This is consistent with the notion that profit shares cannot rise or fall indefinitely.

Box B

A cointegrating model for prices and wages

A joint modelling of the dynamics of prices and wages needs to consider that, since both prices and wages are nominal quantities, they are likely to share a similar long-run trend. If that did not happen, for example because prices grow systematically faster than wages, wages would eventually tend to zero in real terms. Any such long-run relationship needs to also account for labour productivity growth. That said, these secular co-movements may be concealed by short-term developments that push either variable away from their long-run shared trend.

The modelling strategy most suited to these features is that of cointegration. A cointegrating model posits that the variables in the model are tied together by a long-run relationship such that any deviations from the long-run relationship are stationary. In turn, the short-run dynamics are constructed such that the changes in the variables depend on each other and also on their distance from the long-run relationship – the so-called error-correction mechanism. More formally, in the first step, we estimate for each country i in our panel the following system of equations:

$$w_{i,t} = \mu_{i,w} + \beta_{i,w} p_{i,t} + \delta_{i,w} l_{i,t} + e_{i,w,t};$$

$$p_{i,t} = \mu_{i,p} + \gamma_{i,p} w_{i,t} + \delta_{i,p} l_{i,t} + e_{i,p,t};$$

$$l_{i,t} = \mu_{i,l} + \beta_{i,l} p_{i,t} + \gamma_{i,l} w_{i,t} + e_{i,l,t},$$

where $w_{i,t}$ is the log of nominal wages, $p_{i,t}$ the log of consumer prices and $l_{i,t}$ is the log of labour productivity The key output from these regressions is the residuals, which capture deviations of these three variables from their long-run equilibrium relationship. To allow for a different response to positive and negative deviations from the equilibrium relationship, we separate the residuals into positive and negative ones, denoted generically by $e^{(+)}$ and $e^{(-)}$, respectively. These are then used as explanatory variables in panel regressions for the short-run dynamics of the changes in the variables:

$$\Delta w_{i,t} = \alpha_w^{(+)} e_{i,w,t}^{(+)} + \alpha_w^{(-)} e_{i,w,t}^{(-)} + \sum_{j=1}^{q} \phi_{w,j} \Delta w_{i,t-j} + \sum_{j=1}^{q} \psi_{w,j} \Delta p_{i,t-j} + \sum_{j=1}^{q} \zeta_{w,j} \Delta l_{i,t-j} + \kappa_w \hat{u}_{i,t} + \eta_{i,w} + \lambda_{t,w} + \epsilon_{i,w,t};$$

$$\Delta p_{i,t} = \alpha_p^{(+)} e_{i,p,t}^{(+)} + \alpha_p^{(-)} e_{i,p,t}^{(-)} + \sum_{j=1}^{q} \phi_{p,j} \Delta w_{i,t-j} + \sum_{j=1}^{q} \psi_{p,j} \Delta p_{i,t-j} + \sum_{j=1}^{q} \zeta_{p,j} \Delta l_{i,t-j} + \kappa_p \hat{u}_{i,t} + \eta_{i,p} + \lambda_{t,p} + \epsilon_{i,p,t};$$

$$\Delta l_{i,t} = \alpha_l^{(+)} e_{i,l,t}^{(+)} + \alpha_l^{(-)} e_{i,l,t}^{(-)} + \sum_{j=1}^{q} \phi_{l,j} \Delta w_{i,t-j} + \sum_{j=1}^{q} \psi_{l,j} \Delta p_{i,t-j} + \sum_{j=1}^{q} \zeta_{l,j} \Delta l_{i,t-j} + \kappa_l \hat{u}_{i,t} + \eta_{i,l} + \lambda_{t,l} + \epsilon_{i,l,t}.$$

In these equations, we also control for the unemployment gap $\hat{u}_t$ and also include country and time fixed effects. The six α coefficients represent the speed of reversion towards to the long-run relationship; as such, their signs are expected to be negative.

Before estimating the system of equations above, we formally test for the presence of cointegration among the series. We conduct this test separately on two different subsamples: 1970 to 1994 and 1995 to 2019. We conduct two different tests for panel cointegration. For both tests, the null hypothesis is that there is no cointegration, but the alternative hypothesis varies. In the first test, by Westerlund (2007), the alternative hypothesis is that some panels are cointegrated, while in the second test, one by Kao (1999), the alternative hypothesis is that all panels are cointegrated. Both tests fail to reject the null hypothesis in the pre-1995 subsample, and they do not reject in the post-1995 subsample. This indicates that the cointegrating relationship has weakened over time, coincident with the moderation of inflation.①

The short-run adjustment to the long-run equilibrium relationship[1]

Table B

	Sample period: pre-1995			Sample period: post-1995		
Coefficient	Wages ($\Delta w_{i,t}$)	Prices ($\Delta p_{i,t}$)	Productivity ($\Delta l_{i,t}$)	Wages ($\Delta w_{i,t}$)	Prices ($\Delta p_{i,t}$)	Productivity ($\Delta l_{i,t}$)
κ	–0.147***	–0.064***	0.119***	–0.089***	–0.031***	0.029
	0.024	*0.018*	*0.025*	*0.017*	*0.006*	*0.024*
$\alpha^{(+)}$	–0.022	–0.008	–0.072*	–0.016	–0.018	–0.029
	0.016	*0.014*	*0.028*	*0.022*	*0.013*	*0.033*
$\alpha^{(-)}$	–0.064**	–0.063***	–0.101***	–0.046	–0.044**	–0.030
	0.020	*0.013*	*0.03*	*0.027*	*0.013*	*0.041*
$\sum\phi_j$	0.379***	0.509***	0.152***	–0.104*	–0.018	–0.084
	0.059	*0.072*	*0.050*	*0.058*	*0.019*	*0.089*
$\sum\psi_j$	0.287***	0.152***	–0.126*	0.142	0.522***	–0.423**
	0.079	*0.056*	*0.066*	*0.174*	*0.048*	*0.199*
$\sum\zeta_j$	0.038	–0.015	0.137*	–0.168***	0.026*	–0.413***
	0.059	*0.049*	*0.079*	*0.061*	*0.015*	*0.133*

[1] Estimates based on an unbalanced panel of 14 countries, for a total of 1,235 observations for the pre-1995 sample and 1,400 observations for the post-1995 sample. Standard errors (in italics) are based on Driscoll and Kraay (1998) with four lags. ***/**/* indicates statistical significance at the 1%/5%/10% level.

Source: Authors' calculations.

Full estimation results of the cointegrating models outlined above are presented in Table B. Overall, estimates of the error-correction coefficients α highlight important asymmetries. First, most of the $\alpha^{(+)}$ coefficients are not statistically significant, hinting at the fact that adjustment takes place mainly following negative deviations from the common trend. This is consistent with the presence of downward rigidities in prices and wages so that, whenever one of wages or prices grows at slower rate than the other, the one that was growing more slowly tends to speed up to restore the long-run relationship. Thus, if prices start to grow more quickly than wages, it is more likely for wage growth to speed up than for price growth to slow down. Second, while the $\alpha^{(-)}$ coefficients are all significant, their magnitude is smaller in the post-1995 subsample, suggesting that the adjustment mechanism is weaker and shallower in the later subsample. Third, the cyclical sensitivity of prices, wages and productivity – as measured by the coefficients on the unemployment gap – also diminished once inflation was tamed; in fact, there is no longer statistically significant evidence of any cyclical sensitivity of labour productivity growth. Fourth, the short-run dynamics of the system – that is, the short-run reaction of both wages and prices to their past fluctuations, as well as their individual persistence – have also dampened between the two samples. In the post-1995 sample, changes in wages do not react significantly to price inflation in the short run, nor does inflation react significantly to wage growth. In contrast, in the pre-1995 subsample, both short-run effects were statistically significant.

① Running Johansen (1995) tests for cointegration at the country-specific level, we find that in the post-1995 subsample evidence of cointegration is found only Spain, France, Italy and the United States.

We estimate the cointegrating model on a panel of advanced economies for two separate subsamples: 1970–1995 and 1996–2019. These periods correspond roughly to the high- and low-inflation periods in the countries examined. The speed of adjustment to the long-run relationship is governed by two separate sets of coefficients: one for deviations of wages, prices and productivity when they are below the common trend, and another for deviations when they are above. By doing so, we allow for potential non-linearities in the relationship, for example due to downward rigidities in wages.

The results reveal three interesting patterns.

First, the statistical evidence of reversion to the common trend of wages, prices and labour productivity was much stronger in the pre-1995 subsample, when inflation was higher.[22] In other words, wages and prices are more tightly linked in the high-inflation regime.

This is shown also in the speed of reversion to the trend, which is considerably slower in the low-inflation regime. Graph 10 illustrates this catch-up process, focusing on the estimated speed of adjustment for shortfalls of prices and wages, respectively. Panel A shows that, in the pre-1995 subsample, it took workers two and a half years on average to recoup half of the purchasing power lost when wages had fallen behind prices. Such a half-life almost increases by about 50 percent in the post-1995 subsample, indicating a much slower adjustment speed. Similarly, when prices had fallen behind wages (panel B), firms took on average slightly less than three years to recoup half of their margins versus almost four years in the post-1995 subsample.[23]

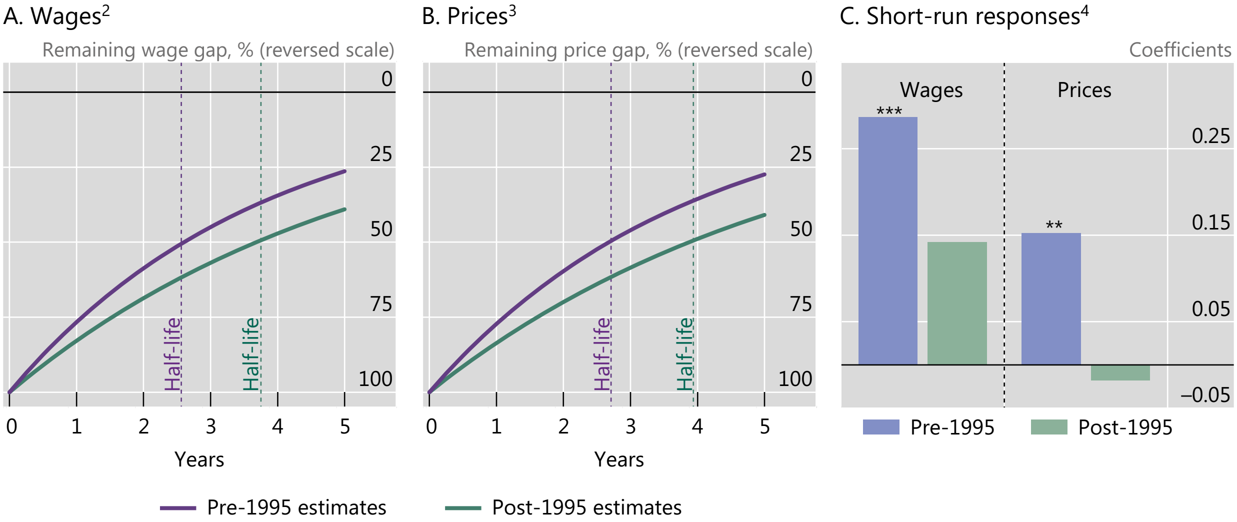
Second, the short-term sensitivity of wages to prices (and vice versa) follows a similar pattern across regimes. Our cointegration framework allows us to separate out

22 In more technical terms, statistical tests for cointegration tend to show stronger results in the pre-1995 subsample – see Box B for full details. Note also that this result is consistent with the notion that both wages and prices are less rigid in a high-inflation regime, as argued previously.

23 Also note the relatively faster speed of adjustment of prices (compared with wages). This is consistent with the notion that prices are the more flexible of the two. Lorenzoni and Werning (2023) argue that, as a result, an inflationary shock will tend to result in wages falling behind prices before catching up.

the short-run from the long-run dynamics. Here we find that, when we compare the low-inflation regime against the high, the short-run feedback between prices and wages is more muted and even becomes statistically insignificant (Graph 10.C).[24]

Wage and price reactions to past shortfalls have become slower in AEs[1] Graph 10



[1] AEs: AU, BE, CA, DE, DK, ES, FR, GB, IE, IT, JP, NL, SE and US. The half-life is the time taken for half of the wage or price gap to have closed. [2] Response of nominal wages when real wages fall in year zero. [3] Response of the consumer price index when real wages rise in year zero. [4] Short-run response of changes in wages to changes in consumer prices and vice versa, defined as $\sum_{j=1}^{q}\psi_{p,j}$ and $\sum_{j=1}^{q}\phi_{p,j}$, respectively (see Box B). ***/** indicates statistical significance at the 1%/5% level.

Sources: OECD; national data; authors' calculations.

Finally, there is evidence of an inflationary bias, regardless of regime. Specifically, once a gap opens up between wages and prices due to exogenous shocks, it tends to close because the variable that falls behind starts growing faster and catches up, rather than through a slowdown of the faster-growing variable (see Table B for full estimation details). This highlights the relevance of non-linearities, and points to a degree of "downward stickiness" in wages and prices

3. Understanding the facts and transitions across regimes

So much for the stylised facts, what about their interpretation? And what are the implications for transitions across regimes?

The place to start is, again, the wage-price nexus – the inflation engine. The degree to which self-sustaining spirals can take hold depends critically on the "pricing power" of both firms and workers. All else equal, higher pricing power will go hand in hand with higher inflation. Fundamentally, understanding how inflation dynamics vary across regimes means understanding what determines that pricing power.

[24] This is also consistent with the results reported in Graph 9.

Some of the factors that determine pricing power are independent of the inflation rate – they cause it but, as a first approximation,[25] are not caused by it. These factors can be of two types. One type is cyclical. Most prominently, the degree of slack in labour and product markets falls into this category. This is very much what the Phillips curve focuses on (Box C). The other type is structural. Obvious examples are globalisation, technology, demographics and political priorities (see Box D for an illustration regarding wages).[26] These factors influence the structure of labour and product markets and the behaviour of participants therein.[27] In a standard Phillips curve, these factors are not considered explicitly. They influence the various parameters of the relationship, such as the constant, the response of the inflation rate to economic slack or that of inflation expectations to inflation.

Box C

The Phillips curve and inflation under the hood

The Phillips curve first emerged as an empirical relationship between wages and the level of unemployment (Phillips (1958)). Since this seminal contribution, the empirical regularity has been extended to prices (Samuelson and Solow (1960)) and further explored and broadened. It has now come to play a key role in many macroeconomic models as the main device to explain inflation.

In its simplest, prototypical version, a Phillips curve relates inflation (typically for a broad price index) to a measure of economic slack (typically the output or unemployment gap). When this reduced-form relationship is brought to the data, it turns into a linear regression in which inflation is expressed as a function of a chosen proxy for economic slack. The other elements in the model are a constant, representing the level around which inflation hovers, and residuals, capturing *temporary*, if possibly persistent, inflation deviations from their mean that are not explained by slack ("shocks"). More formally, a prototypical Phillips curve takes the following form:

$$\pi_t = c + \beta(y_t - \hat{y}_t) + \epsilon_t.$$

Such a framework is obviously too stylised to provide a faithful representation of inflation. Thus, the most typical approach is to extend it to capture the role of expectations and relate the residuals to some observable variables representing key sources of shocks. The variables included to capture prominent shocks are salient relative price changes, most often oil prices or exchange rates. Expectations are assumed to influence inflation directly; they can be thought of as replacing the constant, allowing it to move systematically over time. The prototypical Phillips curve thus becomes:

$$\pi_t = (1-\alpha)\pi_{t+h}^E + \alpha\pi_{t-1} + \beta(y_t - \hat{y}) + \delta s_t + \epsilon_t,$$

where π_{t+h}^E is a measure of inflation expectations over a certain horizon h, and s_t is a (vector of) relative price changes.

This approach is a very useful parsimonious way of capturing key relationships behind the inflation process. However, from an under the hood perspective, it misses some important elements: aggregation has obvious consequences.

25 The clause "as a first approximation" refers to the possibility of more indirect linkages that can play out over time. For instance, in any given year, the degree of unionisation or globalisation are exogenous; but over long horizons it could be argued that they are least partially endogenous. The experience of high inflation in the 1970s may have provided fertile ground for a political backlash that led to a market-friendly environment (James (2023)).

26 For the effects of globalisation, see eg Auer et al (2017), Borio and Filardo (2007), Forbes (2019) and Gilchrist and Zakrajšek (2020); technology, see Paciello (2011); and demographics, see Juselius and Takáts (2018) and Goodhart and Pradhan (2020).

27 As an illustration, Box D examines how some of these factors may have affected the bargaining power of labour and hence the response of wages to prices.

For one, a single measure of economic slack cannot capture sectoral developments and differences in the sensitivity of prices to sectoral slack. For example, sectors may differ in their exposure to global conditions – the tradable/non-tradable distinction is an obvious example. And even differences across purely domestic sectors can matter, as highlighted by the post-Covid developments.

In addition, there is a lot that can be learnt about the dynamics of inflation from the behaviour of individual prices. A valuable insight is the much bigger role of (mostly transitory) idiosyncratic or relative price changes when inflation settles at a low level. The importance of secular relative price trends is another, most prominently the long-term increase in the price of non-tradables, including many services, relative to that of tradables, which are mainly goods. Yet relative price changes are assumed to play only a temporary role, as inflation is anyway bound to hover around inflation expectations.

The other implications are more closely related to the wage- and price-setting mechanisms and their interactions. These are at the very heart of the inflation process but are necessarily glossed over in the Phillips curve representation.

First, the framework considers explicitly only the cyclical forces that influence the pricing power of labour and firms, working through economic slack. As a result, it obscures the role of structural factors. Notable examples include globalisation, technology, demographics and other features of labour and product markets.

Second, inflation expectations affect inflation directly. Yet they are often taken off the shelf (eg based on surveys), and hence are determined exogenously to the Phillips curve relationship. Thus, there is no explicit feedback between slack, relative price changes and inflation expectations. One implication is that there is no role for attempts to recoup losses in purchasing power, or to compensate for squeezes in profit margins. In other words, unless inflation expectations adjust, bygones are bygones, so that wage-price spirals cannot occur.

Third, there is no role for shocks to feed into the wage-price process and generate permanent, or even persistent, changes in the inflation rate. For example, a large oil price increase does not directly affect economic slack, and hence the cyclical component of pricing power. Nor does it induce attempts to compensate for losses in purchasing power or squeezes in profit margins.

Finally, there is no room for the level of inflation to systematically influence its dynamics. For instance, the response of wages and prices to slack or to changes in salient prices is modelled the same way, whether or not the economy is operating in a high- or low-inflation regime. These omitted factors tend to show up as changes in equation coefficients. For instance, structural changes that diminish the sensitivity of inflation to slack (eg globalisation, technology, a weakening in workers' bargaining power), will result in a "flattening" of the Phillips curve, a well-documented stylised fact.

One way of bringing agents' pricing decisions to centre stage is to invoke "microfounded" versions of the Phillips curve, that is, ones in which the relationship is derived directly from pricing decisions (see eg Roberts (1995)). In these models, inflation results from the optimising behaviour of individual economic agents in the presence of "nominal rigidities", ie impediments to instantaneous price adjustments. These so-called "New Keynesian Phillips curves" describe a relationship between inflation, inflation expectations and marginal production costs, mc_t ie:

$$\pi_t = E(\pi_{t+1}) + \gamma mc_t.$$

While appealing from a theoretical standpoint, such a version of the Phillips curve suffers from serious practical shortcomings. As neither inflation expectations nor marginal costs can be directly observed, applying a New Keynesian Phillips curve to the data requires additional assumptions. Marginal costs are typically proxied using the output or unemployment gap, or even real unit labour costs. Inflation expectations can then be estimated in a model-consistent way, assuming rationality. But, even starting from the microfounded version of the Phillips curve, a researcher typically ends up estimating a reduced-form relationship between inflation and a measure of slack that looks a lot like the prototypical version described above. Moreover, the standard version features only a bundled consumer good, and hence does not allow a role for relative price changes. And even in versions with multiple sectors, relative price changes reflect only different adjustment speeds in prices, so that longer-run trends play no role.

Box D

Structural forces and pricing power: the case of labour markets

Structural forces play a major role in the wage formation process. Labour markets have seen significant structural changes over time, notably since the Great Inflation of the 1970s. The net effect of these changes has been to reduce labour's pricing power. This decline reflects many factors, including a declining role of the public sector in setting wages, dwindling unionisation, a wave of labour market deregulation, and globalisation.

Measuring workers' pricing power means assessing their ability to raise wages under any given market conditions. This is difficult in practice, in part because the concept itself is vague and can be interpreted in different ways. That said, a number of measures are useful proxies of its evolution over time. We follow Lombardi et al (2023) in selecting four indicators constructed by the OECD, each related to a different facet of the wage bargaining process: two measures related to union density and coverage (respectively, the percentage of workers who are members of a trade union and those in jobs where a trade union is present); the presence of employment protection legislation; and the coverage of collective bargaining agreements. We then construct a summary measure of bargaining power by taking the first principal component of the standardised log-changes in these four indicators.

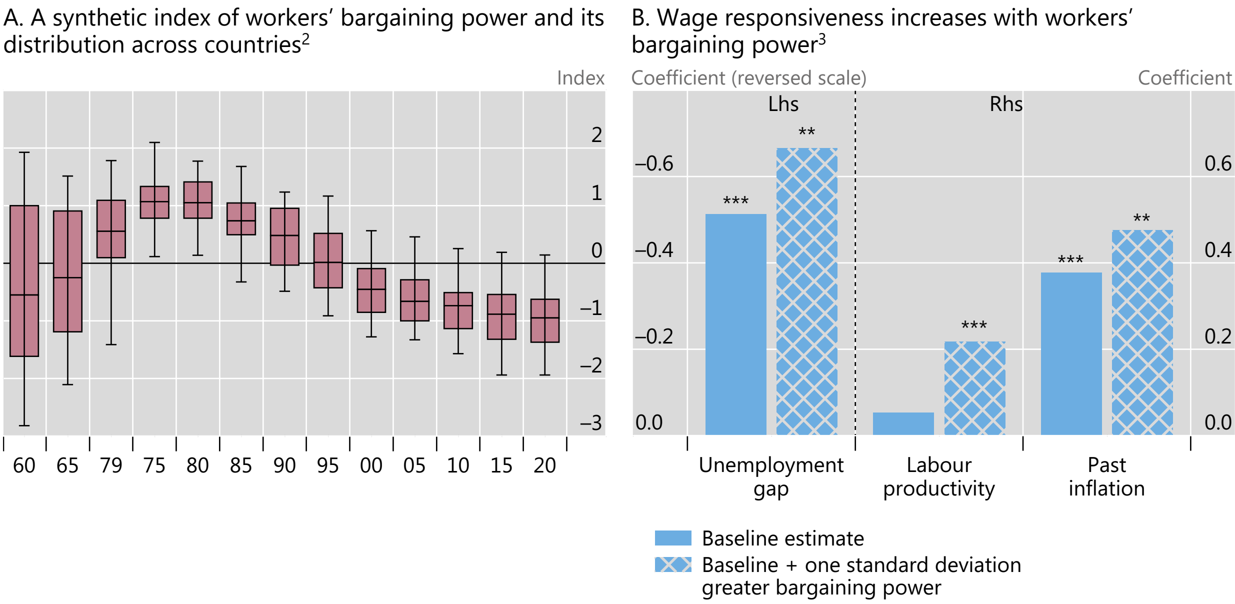
More specifically, let $k_{j,i,t}$ be the log of the j-th indicator in country i at time t. We start by standardising the log-changes in the indicators $\Delta k_{j,i,t}$ and then take their first principal component, which we denote by $c_{i,t}$. We then construct an index of bargaining power $b_{i,t}$ by cumulating $c_{i,t}$ over time:

$$b_{i,t} = 1 + \sum_{\tau=1}^{t} c_{i,\tau}.$$

The historical evolution of the index exhibits a clear pattern. Across all countries with available data, this summary measure of workers' bargaining power has been trending downwards since the early 1980s (Graph D.A).

Institutional features play a key role in the wage-setting process in AEs[1]

Graph D



[1] AEs: AU, BE, CA, DE, DK, FR, GB, IE, IT, JP, NL, SE and US. [2] For each year, the box-plot shows the distribution of the index of workers' bargaining power $b_{i,t}$ (Lombardi et al (2023)); vertical lines represent the range of the observations each year, while the shaded boxes are the interquartile ranges and the horizontal dash within the boxes are the medians. [3] ***/** indicates statistical significance at the 1%/5% level. For the cross-hatched bars, statistical significance refers to the incremental effect of a change in bargaining power.

Sources: OECD; OECD/AIAS ICTWSS database; authors' calculations.

We next assess how the dwindling bargaining power of workers affects the wage formation process. To do this, we estimate a wage equation in which three key determinants of wage developments – past inflation, the unemployment gap and labour productivity growth – are interacted with our proposed measure of workers' bargaining power. More formally, we estimate the following panel regression:

$$\Delta^4 w_{i,t+4} = \alpha\Delta^4 w_{i,t} + \beta_1\Delta^4 p_{i,t} + \gamma_1\hat{u}_{i,t} + \delta_1\Delta l_{i,t} + [\beta_2\Delta^4 p_{i,t} + \gamma_2\hat{u}_{i,t} + \delta_2\Delta l_{i,t}] \times b_{i,t} + \eta_i + \epsilon_{i,t},$$

where $w_{i,t}$ is the log of wages, $\hat{u}_{i,t}$ is the unemployment gap, $\Delta l_{i,t}$ is labour productivity growth, $b_{i,t}$ is our measure of workers' bargaining power and Δ^4 indicates the four-quarter change in a variable.

The role of workers' bargaining power in a simple wage equation[1] Table D

	α	β_1	γ_1	δ_1	β_2	γ_2	δ_2
Estimate	0.336***	0.378***	-0.514***	0.053	0.098**	-0.152**	0.165***
Std. err.	*0.093*	*0.099*	*0.058*	*0.061*	*0.043*	*0.068*	*0.057*

[1] Estimates based on an unbalanced panel of 13 countries for a total of 2,529 observations. Standard errors (in italics) are based on Driscoll and Kraay (1998) with one lag. ***/** indicates statistical significance at the 1%/5% level.

Source: Authors' calculations.

The results highlight the importance of bargaining power for the inflation process (Graph D.B; and Table D). The interaction coefficients are all statistically significant, indicating that, when workers' bargaining power is higher, wages become more responsive to economic conditions. In particular, they increase by more in response to a given decline in the unemployment gap, as well as in response to past inflation and productivity gains.

But a key factor determining pricing power is inflation itself. All else equal, the higher the inflation rate, the higher the pricing power. This is because higher inflation increases agents' incentives and ability to raise wages and prices, which in turn helps to sustain inflation.

It is precisely the influence of inflation on pricing power that helps to explain why transitions from low- to high-inflation regimes can be self-reinforcing. In general, when inflation increases, behavioural changes raise the probability that higher inflation will become entrenched, not least by amplifying the impact of relative price increases. Several mechanisms are at work.

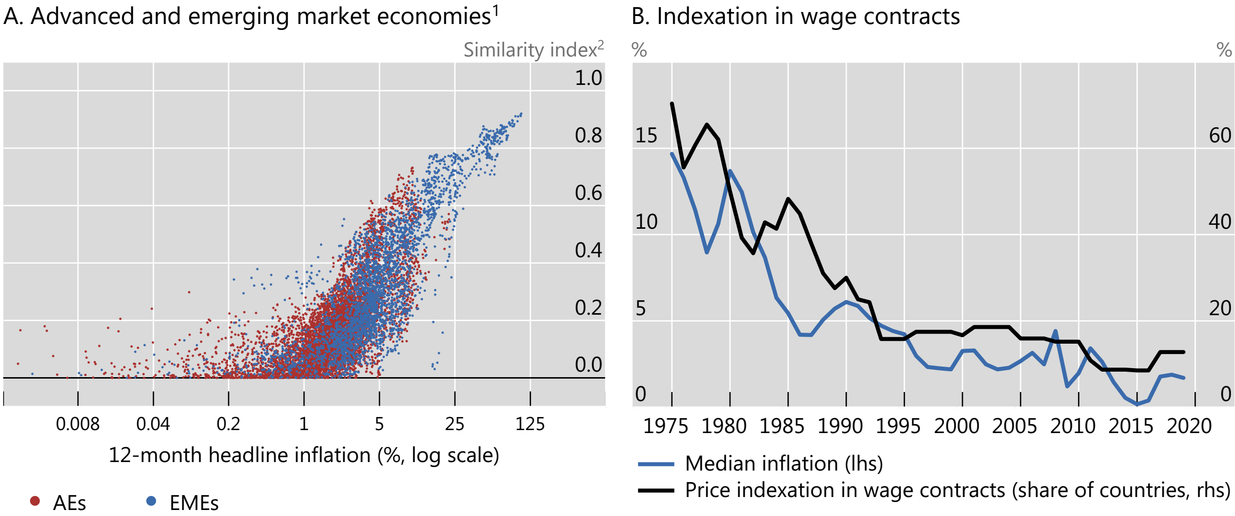
First and foremost, when inflation is very low, it may cease to be a significant factor influencing economic decisions. After all, agents' bandwidth is limited and acquiring information is costly – leading to so-called "rational inattention".[28] But once the general price level becomes a focus of attention, workers and firms will initially try to make up for the erosion of purchasing power or profit margins that *they have already incurred*. And once inflation becomes sufficiently high and is expected to persist, they will also try to *anticipate future changes* in the general price level, as these

[28] See the discussions in Sims (2010) and Maćkowiak et al (2023), for example. Akerlof et al (2000) described price- and wage-setting at low inflation rates as "near-rational", since the costly monitoring of inflation may not be worthwhile once the inflation rate drops below some threshold. They develop a simple model and illustrate that near-rationality implies a long-run Phillips curve in which small amounts of inflation lead to higher average output levels that disappear once inflation rises to the point that "fully rational" price- and wage-setting becomes optimal.

will erode purchasing power and profit margins before contracts can be renegotiated.[29]

Several papers provide evidence consistent with the rational inattention hypothesis.[30] For example, Goodspeed (2023) finds that the average consumer's forecasts of inflation in the United States perform poorly when inflation is low. But when inflation is high, such forecasts become unbiased, rational and efficient, and inflation moves one-for-one with them.[31] Similarly, Cavallo et al (2017) use survey experiments on households in the United States and Argentina to show that households are better informed about inflation when it is high than when it is low: in the former case, they have stronger priors about inflation, and so update by less in response to new information. In addition, Niu and Harvey (2023) find that consumers' inflation expectations were much more responsive to actual price changes during recent episodes of higher inflation than during low inflation. Finally, Coibion et al (2020) find that the inflation expectations of both households and firms are unresponsive to monetary policy in low-inflation environments – precisely when the rational inattention hypothesis suggests that they would be less likely to be paying attention.

Higher inflation means more similar sectoral price changes and more indexation — Graph 11



[1] AEs: AT, BE, CA, CH, DE, DK, ES, FI, FR, GB, IE, IT, JP, NL, NO, PT, SE and US. EMEs: BR, CL, CO, CZ, HU, KR, MX, PE, PL, RO, SG and TR. [2] See Mink et al (2007).

Sources: OECD/AIAS ICTWSS database; CEIC; national data; authors' calculations.

Second, and closely related, it stands to reason that the degree to which the *general* price level becomes relevant for *individual* decisions increases with the level of inflation. Wage earners do not care about the general price level per se, but

[29] If costs become more persistent at higher inflation, this would have a similar effect, as Taylor (2000) outlined.

[30] A prerequisite for rational inattention is that inflation expectations of households and firms do not follow rational expectations. For a survey article on this, see Coibion et al (2018).

[31] Goodspeed (2023) finds that the opposite is true for the average professional forecaster: when inflation is low, their expectations are unbiased, and inflation moves one-for-one with them, while they perform relatively poorly when inflation is high.

only about their own cost of living. Similarly, firms care about the general price level only insofar as it carries information about how competitors might react or about their own costs, not least indirectly, through wages. But when inflation is high, price changes become more similar (Graph 11.A) and more closely linked to wages.[32] As a result, differences in consumption patterns across consumers, and input costs across firms, matter relatively less.

Third, if sufficiently high and persistent, inflation will influence the *structural* features of wage- and price-setting. As inflation increases, prices and wages are likely to become less "sticky" – that is, to be changed more frequently, since the cost of keeping them constant increases.[33] Strikes may be a symptom of such behavioural changes. Over time, the incentives for workers to unionise, and for wage negotiations to be centralised, will also increase, as the inflation rate acts as a stronger focal point.

There is considerable evidence supporting the impact of the inflation regime on contractual arrangements. For instance, indexation practices tend to be more prevalent in countries with a higher inflation history (eg in EMEs in Latin America relative to those in Asia). And reliance on indexation has declined along with the inflation rate (Graph 11.B).

The bottom line is that transitions are self-reinforcing and regimes self-entrenching. When inflation settles at a low level, it loses traction on agents' behaviour. When it increases from those levels, it tends to feed on itself. And when it becomes persistently higher, it can more easily spin out of control.

4. Monetary policy in a two-inflation-regime world

Monetary policy is a key determinant of whether a low- or a high-inflation regime prevails.[34] The features of the monetary policy framework ultimately determine the central bank's credibility and its ability to deliver on its mandated objectives. Within a given framework, the appropriate management of the monetary policy stance ensures that the policy response is adequate and brings inflation back to target once it moves away.

So much is clear. What may be less appreciated is that the different behaviour of inflation in high- and low-inflation regimes has first-order implications for the conduct of monetary policy. Those implications have relatively limited consequences for the conduct of policy in a high-inflation regime: in those circumstances, there is little choice but to tighten policy in order to bring inflation down. This will be

32 The similarity index is based on Mink et al (2007), modified by adding 1 so that it lies in the range between 0 and 1. Higher numbers indicate greater similarity of price changes at each point in time. The index reference is the unweighted cross-sectional median of 12-month log-price changes. Twelve-month headline inflation is shown on a logarithmic scale.

33 For empirical evidence of shorter average contract lengths when the level of inflation is higher, see Alvarez et al (2019) and Riggi and Tagliabracci (2022) on Argentinian and Italian data, respectively. Relatedly, Kumar and Wesselbaum (2022) find that New Zealand firms with relatively high inflation expectations sign shorter purchase and sales contracts. For a theoretical analysis, see Devereux and Yetman (2002). For a more general model of how inflation affects pricing behaviour, see Alvarez et al (2011).

34 See eg Bianchi (2013) and Clarida et al (2000).

increasingly difficult as inflation rises and becomes more entrenched. Rather, the more interesting implications relate to the conduct of policy in a low-inflation regime and when the risk of a transition to the high-inflation one increases. Consider each in turn.

Monetary policy in a low-inflation regime

The dynamics of prices in a low-inflation regime allow the central bank considerable flexibility. This is because inflation has valuable self-stabilising properties: its evolution largely reflects changes in sector-specific relative prices that, for the most part, leave only a transitory imprint on the inflation rate itself. Partly as a result, wages and prices do not tend to chase each other higher. Flexibility in this context means that the central bank can afford to have greater tolerance for moderate, even if persistent, deviations of inflation from narrowly defined targets. It is as if, having succeeded in bringing inflation under control, the central bank can enjoy the fruits of its hard-earned credibility.[35]

This flexibility applies also to shortfalls from targets and hence, arguably, to gradually declining prices – ie deflation. A fundamental reason is that, with the general price level changing at a low rate, supply side forces become relatively more important. These forces reflect natural adjustments in the economy that monetary policy should accommodate unless they threaten the inflation regime itself. This applies, with equal force, to the so-called "quality bias" adjustment, often used as an argument for an upward adjustment in the inflation target (Boskin (1998)) or other sources of negative price trends over a product's life (Adam et al (2022)).[36] It is also consistent with the empirical evidence suggesting that there is no systematic link between mild, if persistent, deflations and output weakness.[37] Indeed, episodes of sharp price declines are exceedingly rare – the Great Depression being the notable exception.

In addition, the evidence suggests that in a low-inflation regime it becomes difficult for monetary policy to steer inflation precisely. This, in turn, increases the possible costs of trying.

One reason for the difficulties in steering inflation is the very nature of the price changes. One would expect monetary policy to operate through the common component of inflation, which tends to reflect the driver that all price changes share.

Empirical evidence supports this conjecture. We carry out a standard local projections exercise (Jordà (2005)) to assess the impact of monetary policy shocks

[35] See related arguments in Rajan (2023).

[36] Indeed, once real forces-driven price trends are taken into account, the macroeconomic literature on allocative inefficiencies induced by nominal rigidities suggests that deflation may be optimal. This would be the case if the more rigid prices are those of items rising in relative value: to stabilise those prices, the others need to fall in absolute terms. Arguably, this is precisely the pattern describing the most important long-term trend in relative prices, as those of manufactured goods have tended to fall relative to the more rigid ones of services. For a further discussion, see Borio (2021).

[37] For example, if economic agents' behaviour is not affected by the level of inflation when it is low, concerns about the zero lower bound can be overstated: the moderate increase in real interest rates driven by a falling price level will not generate a deflationary spiral. Similarly, if price declines reflect productivity gains, there is no need for nominal wage cuts, in which case the presence of nominal rigidities does not impose real costs (eg Selgin (1997)). See also Borio et al (2015) and references therein. Feldstein (2015) and Rajan (2015) go as far as talking about a "deflation bogeyman".

identified at high frequency on sectoral price inflation. The exercise uses US data covering a sample going from July 1992 to December 2019 for the United Sates. Specifically, we run the following regression for each sector i and for horizons $h = 1, \ldots, 60$ months:

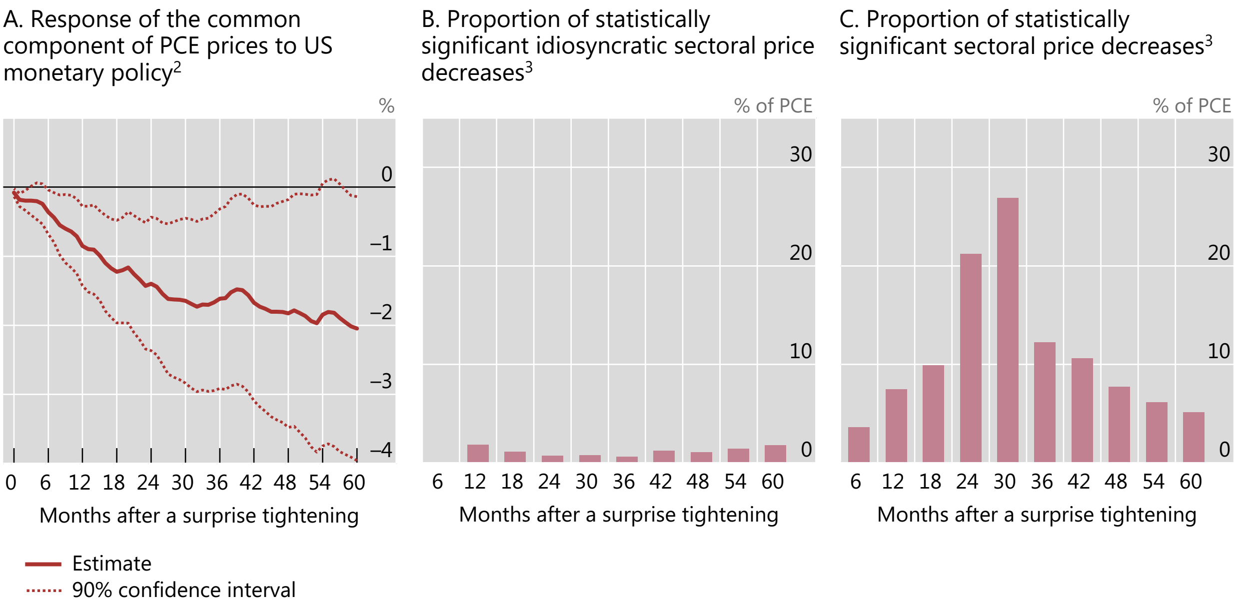
$$p_{i,t+h} - p_{i,t-1} = \alpha_i^h + \beta_i^h MP_t + \sum_{l=1}^{11} \rho_l^h \Delta p_{i,t-l} + \theta_i^h X_t + \epsilon_{i,t+h},$$

where MP_t is the monetary policy shock[38] and X_t is a vector of macroeconomic control variables, including a survey-based measure of long-term inflation expectations from the FRB/US macroeconomic model, the unemployment gap, the 12-month log-difference in average hourly earnings, the one-month log-difference in the WTI spot price, and the excess bond premium of Gilchrist and Zakrajšek (2012).[39] We also repeat the exercise on the common component of inflation PC_t:

$$PC_{t+h} - PC_{t-1} = \alpha^h + \beta^h MP_t + \sum_{l=1}^{11} \rho_l^h \Delta PC_{t-l} + \theta^h X_t + \epsilon_{t+h}.$$

Monetary policy and sectoral price changes in the US[1]

Graph 12



[1] Responses to a surprise policy tightening of 25 basis points. [2] Common component of prices of 131 personal consumption expenditure (PCE) categories. [3] Significant at 5% level.

Sources: Board of Governors of the Federal Reserve System; national data; authors' calculations.

The exercise reveals that monetary policy has a persistent impact on the common component of price changes (Graph 12.A). At the same time, monetary policy surprises have little impact on idiosyncratic elements (Graph 12.B). Thus, as the common component declines relative to the sector-specific one when inflation settles at a low level, the traction of changes in the policy stance declines with it.

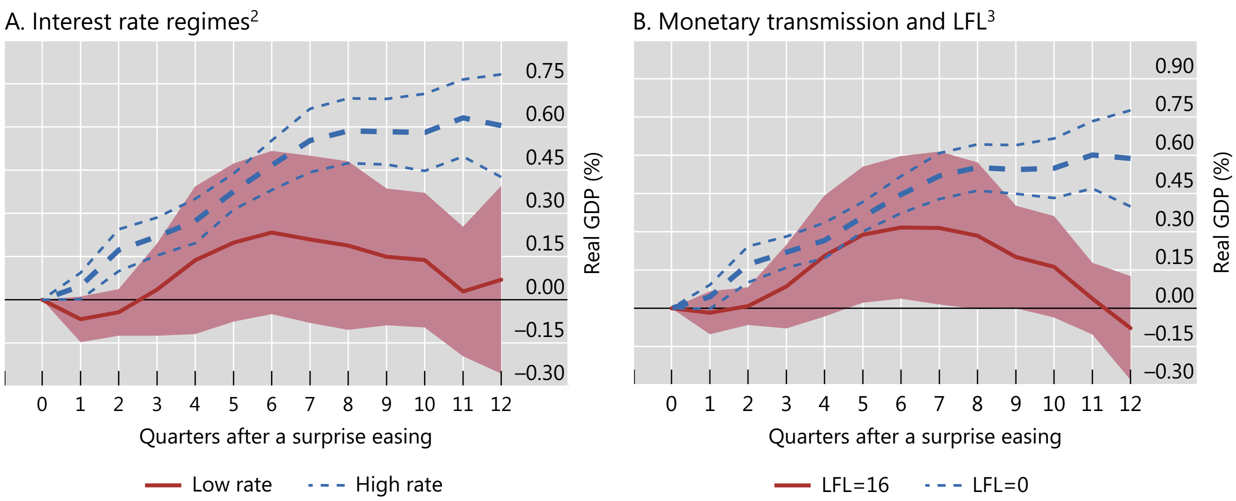
[38] We use the high-frequency shocks constructed by Miranda-Agrippino and Ricco (2021).

[39] The excess bond premium, ie a corporate bond credit spread net of default risk, captures the tightness of credit conditions. The degree of tightness can significantly affect firms' markups and thus inflation dynamics, especially in periods of acute financial market distress; see eg Gilchrist and Zakrajšek (2016) and Gilchrist et al (2017, 2018).

In addition, at least when inflation is low, monetary policy operates through a rather narrow set of prices. When we look at the overall effect of monetary policy surprises on sectoral prices, the impact is statistically different from zero for only around one fourth of sectors, even after three years (Graph 12.C). Not surprisingly perhaps, the prices that exhibit a response are mainly in the cyclically sensitive services subsectors, which are more affected by domestic than foreign demand.[40] In fact, the evidence suggests that this weak effect is asymmetrical: it appears to be even weaker when easing than when tightening (Borio et al (2021)).

Another piece of corroborating evidence is that monetary policy loses traction when nominal interest rates are very low (eg Ahmed et al (2021)). Because nominal interest rates and inflation rates tend to move together, this implies more limited monetary policy traction in low-inflation regimes (Graph 13). For one, the cumulative impact of a policy loosening is shallower and peaks faster in a low-rate environment (panel A). This loss of traction holds even after filtering out the influence of other factors – the state of the economy, the level of debt and the apparent trend decline in "equilibrium" real interest rates. Moreover, once interest rates are low, the effect tends to intensify the longer they remain low (panel B). It is not just the level, but the duration that matters, ie the regime itself.

Monetary policy loses traction when interest rates are low[1] Graph 13



[1] Impulse response of real GDP to a 100 bp expansionary monetary policy shock, with 90% confidence intervals [2] The threshold for the low-rate regime is 2.25%, chosen to maximise empirical fit using a grid-search procedure. [3] LFL ("low-for-long") is defined as the number of consecutive quarters for which the economy has been in the low-rate regime.

Source: Ahmed et. al (2021).

The more limited traction of monetary policy at low levels of inflation means that bigger moves in the policy instrument are needed to produce the same impact on inflation, generating larger side effects for the real economy. This has been in evidence in the post-GFC period, during which central banks have faced difficulties in lifting inflation back to target, partly owing to the structural disinflationary forces at play. Hence the need to keep an exceptionally easy policy stance for exceptionally

[40] This is especially the case for large AEs. In smaller and more open EMEs, a stronger transmission of monetary policy through the exchange rate, and hence its direct effect on the prices of imported goods, should arguably lead to a broader inflationary response.

long – the so-called low-for-long phenomenon. This has been one factor behind the build-up in risk-taking and financial vulnerabilities (eg Borio (2022)).

Monetary policy when transitions threaten

The self-reinforcing nature of transitions from low- to high-inflation regimes puts a premium on a timely and forceful response when the risk of a transition increases. All else equal, the costs of doing too little, too late outweigh those of doing too much, too early. Bringing inflation under control has generally proven costly. And the higher and more entrenched the initial inflation rate, and hence the larger the required disinflation, the greater the cost is likely to be. Once inflation becomes entrenched, monetary policy's task becomes much harder. This is true not only from a technical standpoint, but also from a political one. A broad political consensus that inflation must be brought back under control would greatly help the central bank's task.[41] But this consensus may take time to emerge and may waver once the effects of central banks' necessary actions to bring inflation under control take their toll on the economy.

Thus, a key challenge for the central bank is how to identify the risks of a transition to a high-inflation regime sufficiently promptly and reliably. Ultimately, of course, signs of wage-price spirals are the most reliable signal of a regime shift. These can be especially worrying if they go hand in hand with incipient changes in inflation psychology. For labour, examples include demands for greater centralisation of wage negotiations or for indexation clauses or greater militancy (eg strikes). For firms, they include surveys indicating that they have regained pricing power as a result of broader changes in the competitive environment. But by the time reliable signs of wage-price spirals emerge, the transition may have already taken place: it could be too late to limit the costs substantially.

The challenge of identifying transitions in real time is particularly tough because it is precisely around those periods that standard models perform more poorly in predicting inflation (De Fiore et al (2022)). For one, many of these models take for granted that inflation is mean-reverting. In addition, as noted above, standard models tend to assume that the parameters governing the inflation process are independent of the level of inflation itself, and hence cannot change to generate self-reinforcing dynamics. And, exacerbating the problem, those parameters may well have been estimated on a sample when inflation was mostly low and stable, as is the case for many estimates available today. Put differently, the models are least valuable when needed most. The Phillips curve is no exception (Box C). No doubt this helps to explain the persistent forecasting misses as inflation surged recently, especially given the specificities of the post-pandemic recovery (Carstens (2022), BIS (2022)).

In the end, the central bank has no option but to rely on all the information available, both hard and soft, to form a view. At the same time, is it possible to be more specific about the pros and cons of some of the indicators? What follows considers, in turn, the signals provided by disaggregated price dynamics, by measures of inflation expectations and by relatively model-free indicators, such as monetary aggregates.

[41] For example, it could be instrumental in inducing trade unions to accept the abandonment of indexation clauses, as occurred in the 1980s.

Disaggregated price dynamics

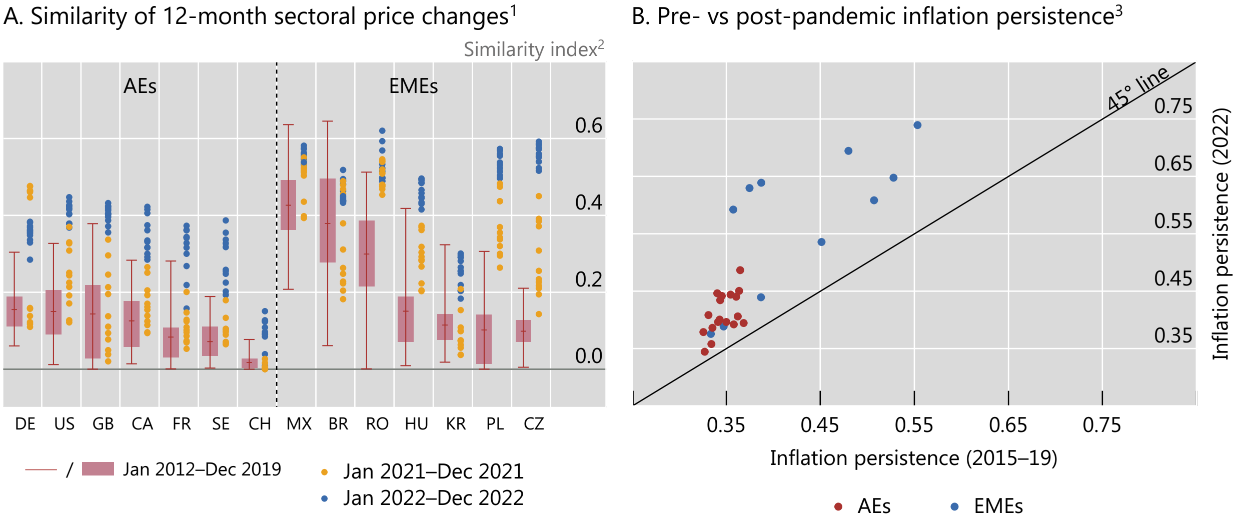
A common practice to capture the likely evolution of inflation is to exclude the more volatile prices from the aggregate price index and calculate "core" measures of inflation. The idea is to capture only the more long-lasting influences on inflation trajectory.

Arguably, however, this practice could backfire when the risk of transition to the high-inflation regime is greatest. Salient prices play a key role around transitions, and these prices tend to be precisely the volatile ones excluded from measures of underlying inflation. Large and persistent changes in salient prices test the self-stabilising properties of the system. Around transitions, it is more likely that, in contrast to the usual pattern, headline leads core. This has clearly been the case recently. In particular, the war in Ukraine has triggered large increases in the prices of energy and food, adding to previous upward pressures in part related to the broader rebound in global demand (BIS (2022)). More generally, the exchange rate could play a similar role, as large depreciations can both reflect serious concerns about higher inflation and cause inflation to rise, triggering second-round effects.

In fact, rather than narrowing the set of prices on which to focus, looking at the more granular disaggregated behaviour of all prices may provide useful information.

Signs of low-inflation regime being tested

Graph 14



[1] Box plots show mean, minimum, maximum and interquartile range. [2] See Mink et al (2007). [3] AEs: AT, BE, CA, CH, DE, DK, ES, FI, FR, GB, IE, IT, JP, NL, NO, PT, SE and US. EMEs: BR, CL, CO, CZ, HU, KR, MX, PE, PL, RO, SG and TR.

Sources: CEIC; national data; authors' calculations.

Key indicators include the size of spillovers between sectors and the degree of commonality of price changes. For example, adding just a few post-Covid observations to the measure of spillovers discussed previously indicates that spillovers increased in the majority of countries (BIS (2022)). A more timely indicator, which does not require long estimation windows and relies only on cross-sectional information at each point in time, is an index of similarity of price changes across sectors (Graph 14.A). This measure reinforces the same message: the similarity index was relatively high in 2021 (yellow dots) by recent historical standards (red bars) and moved even higher in 2022 (blue dots).

Another sign of a possible transition towards a high-inflation regime is an increase in the persistence of inflation. Complementing the persistence measured on aggregate data with the more granular information used to generate the similarity index elucidates this point.

Specifically, we estimate a country-level panel regression in which monthly inflation rates are regressed on their own lags, as well as the (lags of) the index of similarity and its interaction with the lags of inflation. More formally, the regression specification is:

$$\Delta p_{i,t} = \sum_{j=1}^{11} \alpha_j \Delta p_{i,t-j} + \sum_{j=1}^{11} \beta_j m_{i,t-j} + \sum_{j=1}^{11} \gamma_j (\Delta p_{i,t-j} \times m_{i,t-j}) + \eta_i + \lambda_t^A + \lambda_t^E + \epsilon_{i,t},$$

where m_{it} is the similarity index of sectoral price changes between month $t-1$ and month t in country i, and λ_t^A and λ_t^E are time fixed effects for, respectively, advanced and emerging economies; estimation results are reported in Table 1. For a given value of the similarity index $\overline{m}_i$, the inflation persistence in country i can then be computed as:

$$\sum_{j=1}^{11} \alpha_j + \sum_{j=1}^{11} \gamma_j \overline{m}_i.$$

The key result is that persistence varies substantially with the degree of price change similarity in the cross-section. For example, when $\overline{m}_i$ = 0.1 (the approximate value in many countries before 2020), estimated inflation persistence is 0.42. By contrast, when $\overline{m}_i$ = 0.4 (as in 2022 in some countries), inflation persistence jumps to 0.72.

Drivers of inflation persistence[1] Table 1

			Sum of coefficients	Standard error	p-value
Baseline model[2]	Autoregressive terms	$\sum_{j=1}^{11} \alpha_j$	0.812	0.037	0.000
Full model	Autoregressive terms	$\sum_{j=1}^{11} \alpha_j$	0.323	0.089	0.000
	Similarity index terms	$\sum_{j=1}^{11} \beta_j$	4.655	2.310	0.053
	Interaction terms	$\sum_{j=1}^{11} \gamma_j$	0.989	0.166	0.000

[1] Estimates are based on an unbalanced panel of 30 countries featuring a total of 8,400 observations; standard errors are clustered across countries and time. [2] A panel AR(11) specification with country fixed effects and separate time fixed for advanced and emerging market economies.

Source: Authors' calculations.

We also show this graphically, at the country level. For each country, we calculate pre-pandemic inflation persistence using the country-specific average of the similarity index between 2015 and 2019, and the post-pandemic inflation persistence using the average of the similarity index in 2022. Graph 14.B highlights how the increase in similarity has contributed to inflation persistence. In advanced economies the increases lie in the range of 15–30%, while for some EMEs inflation persistence has more than doubled.

Inflation expectations

A complementary signal of regime transitions is the behaviour of inflation expectations. This is an indicator to which central banks pay particular attention.[42]

Inflation expectations have several merits. They can provide a clear signal of changes in inflation psychology. They can be measured in a timely way. They can yield a better sense of how inflation is seen to evolve at different horizons – in contrast to the measures based on price indices alone, which tend to work best over shorter horizons. And, as long as firms and workers have sufficient pricing power, they are likely to be reflected in actual inflation, as prices (and wages) are reset.

At the same time, expectations need to be interpreted with caution.[43]

First, conceptually, wage-price spirals can take place even if inflation expectations do not adjust.[44] All that is required is for workers to catch up with losses in purchasing power or firms to compensate for profit margin squeezes *that have already occurred*. These can, in turn, feed into each other, creating a spiral. The behaviour of inflation expectations during such a process is an empirical question.

Second, inflation expectations are only imperfectly measured. Those inferred from market prices are contaminated by risk premia.[45] Those of households and firms are based on surveys, which may not be very reliable.[46]

Finally, the information content of expectations varies. Those of professional forecasters provide little insight beyond central bank forecasts: after all, they are based on very similar models.[47] Those of financial market participants, in principle, aggregate all the information available and reflect money put at risk, but, just like those of professional forecasters, do not portray the view of the agents who negotiate wages and set prices. They may also be excessively influenced by the central bank's own assessments and credibility – in these cases, they could even lull the central bank into a false sense of security. Meanwhile those of households and firms tend to be backward-looking, and the distribution of participants is unlikely to reflect their weight in price- and wage-setting decisions.[48]

In the end, the proof of the pudding is in the eating. In general, inflation expectations are only noisy indicators of future inflation (eg Stock and Watson (2020); Binder and Kamdar (2022)). But what is their signalling value around *transitions*? This

42 Inflation expectations is also the *only* variable that allows for permanent changes in the inflation rate in a standard Phillips curve; see Box C.

43 For a thought-provoking review of the pitfalls of inflation expectations, as well as the background to their prominence in modern macroeconomics, see Rudd (2021).

44 See eg Lorenzoni and Werning (2023) for a recent formalisation of this point.

45 For example, Faust and Wright (2013) argue that break-even inflation rates calculated from comparing real and nominal bonds are too volatile to represent either long-run inflation expectations or the implicit inflation target of the central bank.

46 See Weber et al (2022) for a discussion of the challenges with such surveys.

47 For discussions of the differences between inflation expectations from different types of agents, see eg Thomas (1999); Mankiw et al (2003); Coibion and Gorodnichenko (2015); Palardy and Ovaska (2015); and Reis (2023).

48 Ultimately, of course, all these various types of expectations interact in general equilibrium.

is likely to be difficult to identify, both because such transitions have not been common and because of the short length of the available series for most countries.[49]

That said, while limited, the available evidence points to some interesting patterns. For example, a look at the behaviour of long-run inflation expectations in the United States suggests that the reduction that took place as the Fed brought down inflation through the 1980s can help explain changes in the relationship between headline and core inflation (see Box E).

Box E

Inflation expectations and the self-stabilising properties of inflation

Starting in the mid-1980s, as the Fed tamed inflation, headline inflation gradually stopped being an "attractor" for core inflation. In fact, the opposite started to hold: headline inflation began displaying reversion towards core (Graph 6). A firmer anchoring of long-run inflation expectations probably played a key role in this process, which ultimately helped prevent individual price changes from percolating through into underlying inflation.

One way to see this formally is to relate the time variation in the feedback between headline and core inflation (Graph 6) to the evolution of long-term inflation expectations. To do so, we augment the specifications by adding a term that interacts the responses of headline to core inflation, and core to headline, with a survey-based measure of long-term inflation expectation. Specifically, we estimate:

$$\Delta^{12}p^H_{t+12} - \Delta^{12}p^H_t = \alpha_0 + \alpha_1(\Delta^{12}p^H_t - \Delta^{12}p^C_t) + \alpha_2\hat{u}_t + \alpha_3\pi^E_t + \alpha_4(\Delta^{12}p^H_t - \Delta^{12}p^C_t) \times \pi^E_t + \epsilon_{t+12};$$

$$\Delta^{12}p^C_{t+12} - \Delta^{12}p^C_t = \beta_0 + \beta_1(\Delta^{12}p^C_t - \Delta^{12}p^H_t) + \beta_2\hat{u}_t + \beta_3\pi^E_t + \beta_4(\Delta^{12}p^C_t - \Delta^{12}p^H_t) \times \pi^E_t + \epsilon_{t+12},$$

where π^E_t denotes the survey-based expectations of average headline PCE inflation over the following 10 years from the FRB/US model.

Table E summarises the results of this exercise. It indicates that an increase in long-run inflation expectations significantly dampens the reversion of headline inflation to core, following periods in which the headline exceeds core. Specifically, the estimate of α_4, the coefficient on the interaction term $(\Delta^{12}p^H_t - \Delta^{12}p^C_t) \times \pi^E_t$, is positive and statistically significant while α_1 is negative. By the same token, a fall in long-run inflation expectations is associated with a reduced propensity for core inflation to converge to headline inflation. In other words, the statistically significant negative estimate of β_4, the coefficient on the interaction term $(\Delta^{12}p^C_t - \Delta^{12}p^H_t) \times \pi^E_t$, is negative.

In addition, there is evidence that the anchoring of agents' long-run inflation expectations significantly affects the respective speeds of adjustment of the two measures of inflation, which reflect the magnitude and duration of second-round effects. Graph E shows the implied time-varying estimates of the speed of reversion of headline inflation to core, $\alpha_1 + \alpha_4\pi^E_t$ (panel A), and those of core inflation to headline, $\beta_1 + \beta_4\pi^E_t$ (panel B). For comparison purposes, the two panels also show the corresponding estimates based on rolling 10-year windows from Graphs 6.A and 6.B. Note that, in both panels, the estimates of the reversion parameters based on long-term inflation expectations (black lines) broadly follow the same pattern of those based on the rolling windows approach (orange lines): the tendency for headline to converge to core strengthens and becomes statistically significant in the early 1990s, while that for core to converge to headline becomes insignificant as of the late 1980s.

49 The oldest continuous measure of inflation expectations of which we are aware is the Livingston Survey, for the US economy, which started in 1946 (Croushore (1997)). Survey-based inflation expectations for some other economies are only available from the late 1980s or 1990s. Market-based measures generally also have short histories. For example, calculating break-even inflation rates requires the coexistence of comparable nominal and real bonds; two countries with relatively long series of these are the United Kingdom (since 1981) and the United States (since 1997) (Campbell et al (2009)).

Inflation expectations and the stability of underlying inflation[1]

Table E

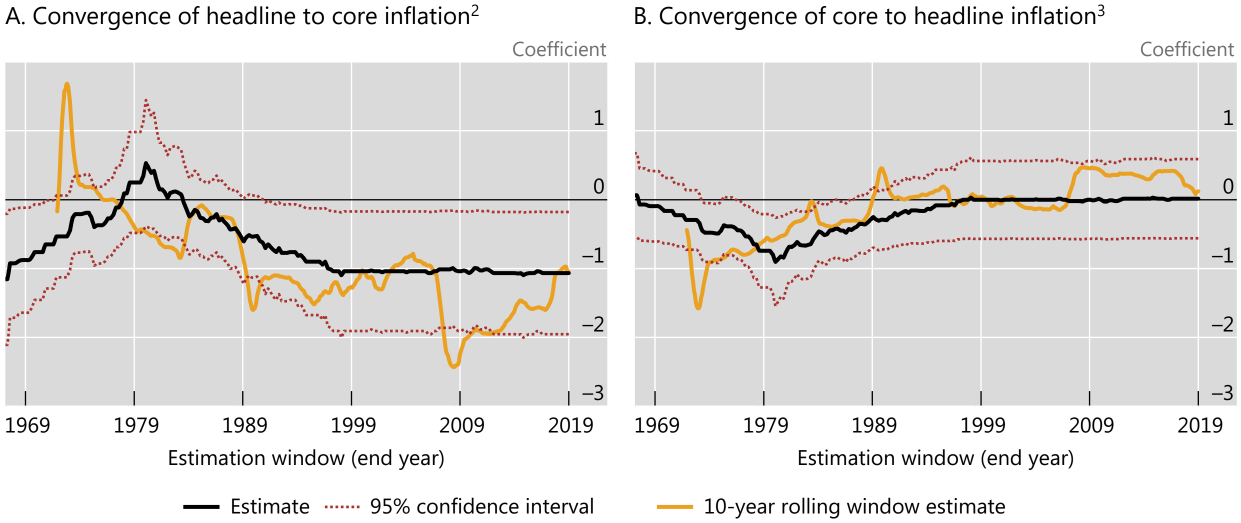
Reversion of headline to core			Reversion of core to headline		
Coefficient	Baseline[2]	Interaction	Coefficient	Baseline[2]	Interaction
α_1	–0.496	–1.627**	β_1	–0.315	0.333
	0.327	*0.671*		*0.236*	*0.416*
α_2	–0.373**	–0.343*	β_2	–0.276**	–0.257**
	0.166	*0.182*		*0.112*	*0.117*
α_3		–0.076	β_3		–0.046
		0.136			*0.083*
α_4		0.279**	β_4		–0.160**
		0.127			*0.078*
Adjusted R^2	0.114	0.166		0.194	0.232

[1] Estimates based on the sample period January 1968 to December 2019 for a total of 624 observations; standard errors (in italics) are based on Newey and West (1987) with 12 lags. **/* indicates statistical significance at the 5%/10% level. [2] Specification excluding all terms involving long-term expected inflation.

Source: Authors' calculations.

Inflation expectations and the reversion of headline to core inflation [1]

Graph E



[1] Core inflation excludes food and energy prices. [2] Time-varying reversion parameter: $\alpha_1 + \alpha_4\pi_t^E$. [3] Time-varying reversion parameter: $\beta_1 + \beta_4\pi_t^E$.

Sources: National data; authors' calculations.

Other authors have provided supportive evidence. Goodspeed (2023) seeks to identify regime changes in the United States (from both high-to-low and low-to-high inflation). He finds that, during these, consumers revise their expectations by more than professional forecasters and start to expect recent inflation rate changes to persist rather than revert.[50] Another example is Reis (2022a), who reports that a creeping de-anchoring of US households' expectations went hand in hand with the transition towards a high-inflation regime in the 1970s. This was at first visible as an increase in the disagreement among households, with an increasing share expecting higher inflation rates – in more technical terms, with a fattening of the right tail of the distribution of inflation expectations.

Monetary aggregates

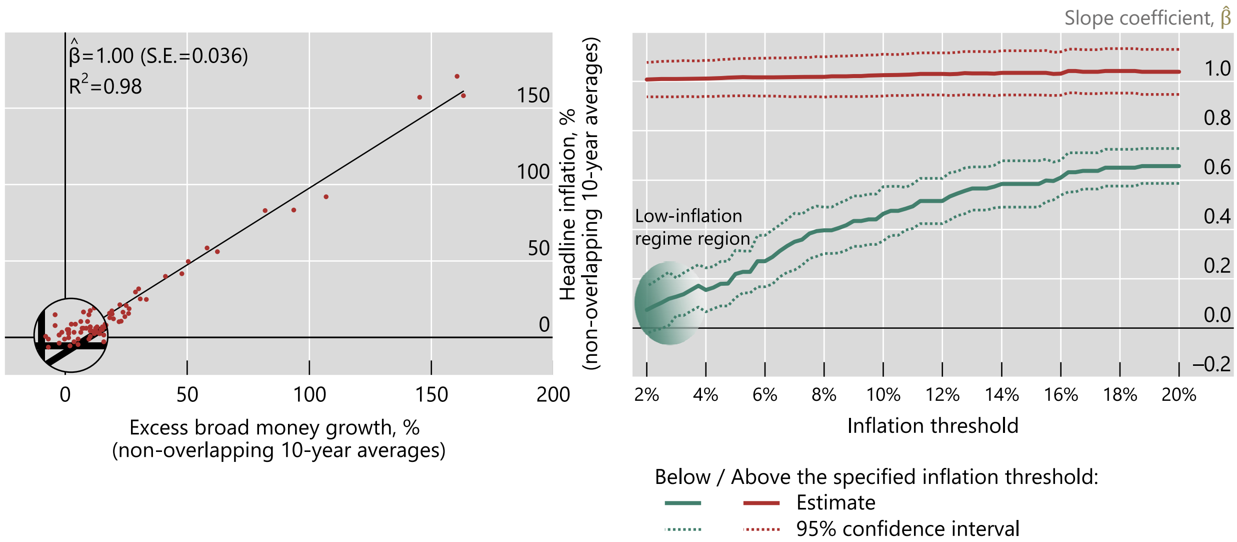
A once-familiar, but long-forgotten, possible leading indicator of inflation is monetary aggregates. This has received particular attention in the current episode after falling out of favour during the low-inflation regime period. A key reason is that money growth accelerated in many countries before the recent inflation flare-up.[51]

Inflation and money growth go hand in hand[1]

Graph 15

A. Long-run relationship[2]

B. Long-run relationship conditional on the inflation regime[3]



[1] Country-specific non-overlapping 10-year averages from 1951 to 2021 (subject to data availability). The sample covers: AR, AU, BR, CA, CH, CL, CN, CO, DK, EA, GB, HU, ID, IL, IN, JP, KR, MX, MY, NO, NZ, PE, PH, RU, SA, SE, SG, TH, TR, TW, US and ZA. Broad money is defined following the national broad money definitions (M2 or M3) and money plus quasi-money for PE, backdated with money and quasi-money data to get long series. Excess broad money growth is defined as the difference between the growth in broad money and the growth in real GDP. [2] The circled area shows a zoomed-in section where excess money growth and inflation are below 5%. [3] Slope coefficients from the regression of non-overlapping 10-year average inflation on non-overlapping 10-year average excess money growth, where the coefficient on excess money growth (as well as the intercept) is allowed to switch across the specified inflation threshold; the shaded area highlights the range of (10-year average) inflation rates that are generally acknowledged as constituting a "low-inflation regime".

Source: Borio et al (2023).

[50] Goodspeed's identification of regime changes is based on how far both the current level of inflation and the future five-year moving average of inflation differ from the past five-year moving average of inflation, adjusted for past inflation volatility. Any sufficiently large sustained change in the inflation rate will be identified as a regime change using this approach, regardless of the level of inflation.

[51] See eg Congdon (2022), Issing (2021a), Laidler (2021), Goodhart (2021) and King (2021).

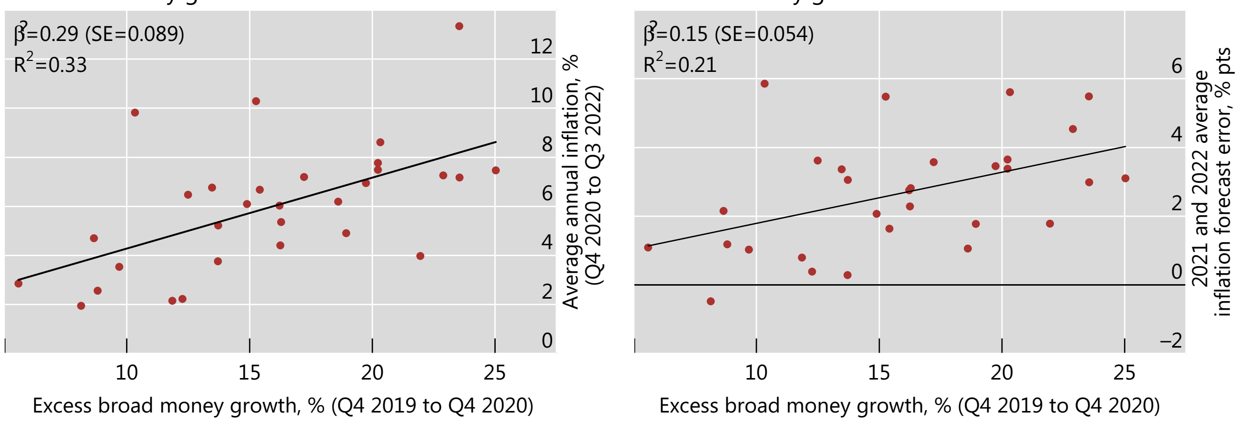
Indeed, there is clear evidence that the link between money growth and inflation is regime-dependent (Graph 15.A).[52] To illustrate the point, consider the relationship between inflation and excess money growth – the difference between the growth rates of money and real income – in a sample of countries for the period 1960–2022. Here we split the observations into high- and low-inflation ones using different 10-year average inflation rate thresholds. We see that this relationship exists only when the inflation threshold moves out of the "low-inflation regime region" – indeed, it is one-to-one above that threshold. Moreover, as expected, the difference between "low" and "high" narrows noticeably as the inflation threshold increases (Graph 15.B).

More to the point, the link appears to survive also around possible transitions, at least based on the current episode. For one, across countries, there is a statistically and economically significant positive correlation between excess money growth in 2020 and average inflation in 2021 and 2022 (Graph 16.A). In addition, and more tellingly, there is a statistically and economically significant positive relationship between excess money growth in 2020 and professional forecasters' misses of inflation in 2021 and 2022 (Graph 16.B). That is, the underprediction of inflation was greater for those countries that saw higher excess money growth during the pandemic.[53]

Money growth and the global post-pandemic inflation surge[1] Graph 16

A. Excess money growth and inflation

B. Excess money growth andinflation forecast errors[2]



[1] The sample covers: AU, BR, CA, CH, CL, CN, CO, DK, EA, GB, HU, IL, IN, ID, JP, KR, MX, MY, NO, NZ, PE, PH, RU, SA, SE, SG, TH, TW, US and ZA. Broad money is defined following the national broad money definitions (M2 or M3) and money plus quasi-money for PE. [2] Inflation forecast errors for 2021 are calculated as the difference between actual CPI inflation in 2021 and the 2021 inflation forecasts from Consensus Economics of December of 2020; inflation forecast errors for 2022 are calculated as the difference between actual CPI inflation in 2022 (where available) or the annualised year-to-date inflation and the 2022 inflation forecasts from Consensus Economics of December 2021.

Source: Borio et al (2023).

While promising, it is hard to assess how reliable this indicator is likely to be in future. The results reported here are based on a single episode. During the low-inflation regime that preceded the recent flare-up, it was not uncommon for money growth to provide misleading signals, for the reasons noted above. Moreover, the

[52] See eg Amisano and Fagan (2013), Amisano and Colavecchio (2013), Amisano, Colavecchio and Fagan (2014) and Cadamuro and Papadia (2021).

[53] Taken at face value, the results indicate that the effect is material: each 1 percentage point difference in the rate of excess money growth in 2020 across countries reduces the average 2021–22 inflation forecast error by .15 percentage points.

current episode is not yet over. Only time will tell. Still, the evidence opens the possibility that this information could be used to cross-check – and hence reinforce or weaken – the signals provided by other indicators (eg Issing (2021b)).

Conclusion

This study has sketched the two-regime view of inflation. This view characterises the inflation process as two regimes – a low- and a high-inflation regime – with self-reinforcing transitions from the low- to the high-inflation one. The two regimes tend to become entrenched unless severely tested. But while inflation tends to be self-stabilising in the low-inflation regime, it is especially sensitive to relative price increases in the high-inflation one.

This view of inflation has significant implications for monetary policy. First, it suggests that it would be desirable to conduct monetary policy flexibly in low-inflation regimes, tolerating moderate, even if persistent, deviations from narrowly defined targets. Second, it highlights the importance of being pre-emptive when the risk of a transition to the high-inflation regime increases, although assessing this risk in real time remains challenging. Central banks' response to the recent inflation flare-up can be seen partly in this light. Although slow to realise the strength of the underlying inflation surge, in part as a result of limitations of prevailing models and forecasting tools, central banks were then forceful in quickening the pace of policy tightening (eg Cavallino et al (2022)).

This study should be seen just as a first step in the development of this perspective on the inflation process. There is no attempt to construct a formal model. And the statistical analysis should be deepened and broadened further. The goal of the study is simply to act as a catalyst for further investigation.

References

Adam, K, E Gautier, S Santoro and H Weber (2022): "The case for a positive euro area inflation target: evidence from France, Germany and Italy", *Journal of Monetary Economics*, vol 132, pp 140–53.

Ahmed, R, C Borio, P Disyatat and B Hofmann (2021): "Losing traction? The real effects of monetary policy when interest rates are low", *BIS Working Papers*, no 983.

Akerlof, G, W Dickens and G Perry (2000): "Near-rational wage and price setting and the long-run Phillips curve", *Brookings Papers on Economic Activity*, 2000(1), pp 1–60.

Altissimo, F, B Mojon and P Zaffaroni (2009): "Can aggregation explain the persistence of inflation?", *Journal of Monetary Economics*, vol 56, no 2, pp 231–41.

Alvarez, F, M Beraja, M Gonzalez-Rozada and P Neumeyer (2019): "From hyperinflation to stable prices: Argentina's evidence on menu cost models", *Quarterly Journal of Economics*, vol 134, no 1, pp 451–505.

Alvarez, F, F Lippi and L Paciello (2011): "Optimal price setting with observation and menu costs", *Quarterly Journal of Economics*, vol 126, no 4, pp 1909–60.

Amisano G and R Colavecchio (2013): "Money growth and inflation: evidence from a Markov switching Bayesian VAR", Hamburg University, Department Wirtschaft und Politik Macroeconomics and Finance Series Discussion Paper 4/2013.

Amisano G, R Colavecchio and G Fagan (2014): "A money-based indicator for deflation risk", Hamburg University, Department Wirtschaft und Politik Macroeconomics and Finance Series Discussion Paper 3/2014.

Amisano, G and G Fagan (2013): "Money growth and inflation: a regime-switching approach", *Journal of International Money and Finance*, vol 33, pp 118–145.

Auer, R, C Borio and A Filardo (2017): "The globalisation of inflation: the growing importance of global value chains", *BIS Working Papers,* no 602, January.

Bank for International Settlements (BIS) (2022): "Inflation: a look under the hood", *Annual Economic Report*, Chapter II, Basel.

Baumeister, C and J Hamilton (2019): "Structural interpretation of vector autoregressions with incomplete identification: revisiting the role of oil supply and demand shocks", *American Economic Review*, vol 109, no 5, pp 873–910.

Bianchi, F (2013): "Regime switches, agents' beliefs, and post-World War II U.S. macroeconomic dynamics", *Review of Economic Studies*, vol 80, no 2, pp 463–90.

Binder, C and R Kamdar (2022): "Expected and realized inflation in historical perspective", *Journal of Economic Perspectives*, vol 36, no 3, pp 131–56.

Borio, C (2021): "Back to the future: intellectual challenges for monetary policy", Finch Lecture, University of Melbourne, 2 September.

——— (2022): "Monetary policy: past, present and future", remarks at the Cato Institute's 40th Annual Monetary Conference, 8 September.

Borio, C, M Erdem, A Filardo and B Hofmann (2015): "The costs of deflations: a historical perspective", *BIS Quarterly Review*, March, pp 31–54.

Borio, C, P Disyatat, D Xia and E Zakrajšek (2021): "Monetary policy, relative prices and inflation control: flexibility born out of success", *BIS Quarterly Review*, September, pp 15–29.

Borio, C and A Filardo (2007): "Globalisation and inflation: new cross-country evidence on the global determinants of domestic inflation", *BIS Working Papers*, no 227, May.

Borio, C, B Hofmann and E Zakrajšek (2023): "Does money growth help explain the recent inflation surge?", *BIS Bulletin*, no 67.

Boskin, M (1998): "Consumer prices, the consumer price index, and the cost of living", *Journal of Economic Perspectives*, vol 12, no 1, pp 3–26.

Cadamuro, L and F Papadia (2021): "Does money growth tell us anything about inflation?", *Working paper* 11/2021, Bruegel.

Cavallino P, G Corneli, P Hördahl and and E Zakrajšek (2022): "Front-loading monetary tightening: pros and cons", *BIS Bulletin*, no 63.

Campbell, J, R Shiller and L Viceira (2009): "Understanding inflation-indexed bond markets", *Brookings Papers on Economic Activity*, Spring, pp 79–120.

Carstens, A (2022): "The return of inflation", speech at the International Center for Monetary and Banking Studies, Geneva, 5 April.

Cavallo, A, G Cruces and R Perez-Truglia (2017): "Inflation expectations, learning, and supermarket prices: evidence from survey experiments", *American Economic Journal: Macroeconomics*, vol 9, no 3, pp 1–35.

Chang, K and C He (2010): "Does the magnitude of the effect of inflation uncertainty on output growth depend on the level of inflation?", *The Manchester School*, vol 78, no 2, pp 126–48.

Cecchetti, S and R Moessner (2008): "Commodity prices and inflation dynamics", *BIS Quarterly Review*, December, pp 55–66.

Choudhri, E and D Hakura (2006): "Exchange rate pass-through to domestic prices: does the inflationary environment matter?", *Journal of international Money and Finance*, vol 25, no 4, pp 614–39.

Clarida, R, J Gali and M Gertler (2000): "Monetary policy rules and macroeconomic stability: evidence and some theory", *Quarterly Journal of Economics*, vol 115, no 1, pp 147–80.

Coibion, O and Y Gorodnichenko (2015): "Information rigidity and the expectations formation process: a simple framework and new facts", *American Economic Review*, vol 105, no 8, pp 2644–78.

Coibion, O, Y Gorodnichenko and R Kamdar (2018): "The formation of expectations, inflation, and the Phillips Curve", *Journal of Economic Literature*, vol 56, no 4, pp 1447–91.

Coibion, O, Y Gorodnichenko, S Kumar and M Pedemonte (2020): "Inflation expectations as a policy tool?", *Journal of International Economics*, vol 124, pp 1–27.

Congdon, T (2022): "The case for restoring the role of monetary aggregates", *Central Banking*, 8 August.

Croushore, D (1997): "The Livingston survey: still useful after all these years", *Business Review-Federal Reserve Bank of Philadelphia*, vol 2, no 1, pp 1–12.

De Fiore, F, M Lombardi and D Rees (2022): "Inflation indicators amid high uncertainty"; *BIS Bulletin*, no 60.

Devereux, M and J Yetman (2010): "Price adjustment and exchange rate pass-through", *Journal of International Money and Finance*, vol 29, no 1, pp 181–200.

——— (2002): "Menu costs and the long-run output–inflation trade-off", *Economics Letters*, vol 76, no 1, pp 95–100.

Días, D and C Marques (2010): "Using mean reversion as a measure of persistence", *Economic Modelling*, vol 27, no 1, pp 262–73.

Diebold, F and K Yilmaz (2009): "Measuring financial asset return and volatility spillovers, with application to global equity markets", *Economic Journal*, vol 119, no 534, pp 158–71.

Driscoll, J. and A Kraay (1998): "Consistent covariance matrix estimation with spatially dependent data", *Review of Economics and Statistics*, vol 80, no 4, pp 549–60.

Faust, J and J Wright (2013): "Forecasting inflation", *Handbook of economic forecasting*, vol 2(A), Elsevier, pp 2–56.

Feldstein, M (2015): "The deflation bogeyman", *Project Syndicate*, 25 February.

Forbes, K (2019): "Has globalisation changed the inflation process?", *BIS Working Papers*, no 791.

Gilchrist, S and E Zakrajšek (2012): "Credit spreads and business cycle fluctuations", *American Economic Review*, vol 102, no 4, pp 1692-1720.

Gilchrist, S and E Zakrajšek (2016): "Customer markets and financial frictions: implications for inflation dynamics", In *Inflation Dynamics and Monetary Policy*, 2015 Jackson Hole Economic Policy Symposium Proceedings, pp 1-52, Federal Reserve Bank of Kansas.

Gilchrist, S and E Zakrajšek (2020): "Trade exposure and the evolution of inflation dynamics", In *Changing Inflation Dynamics, Evolving Monetary Policy*, ed. By G Castex, J Galí and D Saravia, Central Banking, Analysis and Economic Policies Book Series no 27, pp 173-226, Central Bank of Chile.

Gilchrist, S, R Schoenle, J Sim and E Zakrajšek (2017): "Inflation dynamics during the financial crisis", *American Economic Review*, vol 107, no 3, pp 785-823.

Gilchrist, S, R Schoenle, J Sim and E Zakrajšek (2018): "Financial heterogeneity and monetary union", Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series no 2018-043.

Goodhart, C (2021): Interview with Central Banking, vol XXXII, September.

Goodhart, C and M Pradhan (2020): *The great demographic reversal: ageing societies, waning inequality, and an inflation revival*, Palgrave MacMillan.

Goodspeed, T (2023): "Trust the experts? The performance of inflation expectations, 1960–2022", mimeo.

Greenspan, A (1996), Meeting of the Federal Open Market Committee, 2–3 July.

Hamilton, J. (2003) "What is an oil shock?" *Journal of Econometrics*, vol 113, no 2, pp 363-398.

Hamilton, J (2018): "Why you should never use the Hodrick-Prescott filter", *Review of Economics and Statistics*, vol 100, no 5, pp 831-843.

Hartmann, M and H Herwartz (2012): "Causal relations between inflation and inflation uncertainty: cross-sectional evidence in favour of the Friedman-Ball hypothesis", *Economics Letters*, vol 115, no 2, pp 144–47.

Humpage, O (2008): "Rising relative prices or inflation: why knowing the difference matters", *Economic Commentary*, Federal Reserve Bank of Cleveland, June.

Issing, O (2021a): "The return of inflation?", *Project Syndicate*, 16 July.

——— (2021b): "An assessment of the ECB's strategy review", *Central Banking*, 10 August.

James, H (2023): "Inflation and globalisation: the Tawney Lecture 2022", *The Economic History Review*, forthcoming.

Johansen, S (1995): *Likelihood-based inference in cointegrated vector autoregressive models*, Oxford University Press.

Jordà, Ò (2005): "Estimation and inference of impulse responses by local projections", *American Economic Review*, vol 95, no 1, pp 161–82.

Juselius, M and E Takáts (2018): "The enduring link between demography and inflation", *BIS Working Papers*, no 722.

Kao, C (1999): "Spurious regression and residual-based tests for cointegration in panel data", *Journal of Econometrics*, vol 90, pp 1–44.

Kim, D and S Lin (2012): "Inflation and inflation volatility revisited", *International Finance*, vol 15, no 3, pp 327–45.

King, M (2021): "Monetary policy in a world of radical uncertainty", *IIMR Conference Papers Series*, November.

Koop, G, M Pesaran and S Potter (1996): "Impulse response analysis in nonlinear multivariate models", *Journal of Econometrics*, vol 74, no 1, pp 119–48.

Kumar, S and D Wesselbaum (2023): "Contracts and firms' inflation expectations", *Review of Economics and Statistics*, forthcoming.

Laidler, D (2021): "Lucas (1972), a personal view from the wrong side of the subsequent fifty years", *Western Department of Economics Research Report*, no 2021-5.

Lombardi, M, R Calvi and F Di Mauro (2013): "Measuring international spillovers during economic expansions and slowdowns", in Y-W Cheung and F Westermann (eds), *Global interdependence, decoupling and recoupling*, MIT Press, pp 19–36.

Lombardi, M, M Riggi and E Viniano (2023): "Workers' bargaining power and the Phillips curve: a micro-macro analysis", *Journal of the European Economic Association*, forthcoming.

Lorenzoni, G and I Werning (2023): "Wage price spirals", *MIT Working Papers*.

Maćkowiak, B, F Matějka and M Wiederholt (2023): "Rational inattention: a review", *Journal of Economic Literature*, vol 61, no 1, pp 226–73.

Mankiw, N, R Reis and J Wolfers (2003): "Disagreement about inflation expectations", *NBER Macroeconomics Annual*, vol 18, pp 209–48.

Mink, M, J Jacobs and J de Haan (2007): "Measuring synchronicity and comovement of business cycles with an application to the euro area", *CESifo Working Papers*, no 2112.

Miranda-Agrippino, S and G Ricco (2021): "The transmission of monetary policy shocks", *American Economic Journal: Macroeconomics*, vol 13, no 3, pp 74–107.

Newey, W and K West (1987): "A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix", *Econometrica*, vol 55, no 3, pp 703–8.

Niu, X and N Harvey (2023): "Are lay expectations of inflation based on recall of specific prices? If so, how and under what conditions?", mimeo.

Paciello, L (2011): "Does inflation adjust faster to aggregate technology shocks than to monetary policy shocks?", *Journal of Money, Credit and Banking*, vol 43, no 8, pp 1663–84.

Palardy, J and T Ovaska (2015): "Decomposing household, professional and market forecasts on inflation: a dynamic factor model analysis", *Applied Economics*, vol 47, no 20, pp 2092–101.

Pesaran, H and Y Shin (1998): "Generalized impulse response analysis in linear multivariate models", *Economics letters*, vol 58, no 1, pp 17–29.

Phillips, A (1958): "The relationship between unemployment and the rate of change of money wages in the United Kingdom, 1861–1957", *Economica*, vol 25, no 100, pp 283–99.

Quast, J and M Wolters (2022): "Reliable real-time output gap estimates based on a modified Hamilton filter", *Journal of Business & Economic Statistics*, vol 40, no 1, pp 152-168.

Rajan, R (2015): Panel remarks at the IMF conference on "Rethinking Macro Policy III", Washington DC, 15–16 April.

——— (2023): "Central banks can't win when it comes to credibility on inflation", *Financial Times*, 9 January.

Reinhart, C and K Rogoff (2004): "The modern history of exchange rate arrangements: A reinterpretation", *Quarterly Journal of Economics*, vol 119, no 1, pp 1–48.

Reis, R (2022a): "Losing the inflation anchor", *Brookings Papers on Economic Activity*, no 2021(2), pp 307–79.

——— (2022b): "The burst of high inflation in 2021–22: how and why did we get here?", *BIS Working Papers*, no 1060.

——— (2023): "Four mistakes in the use of measures of expected inflation", *CEPR Discussion Papers*, no 17850.

Reis, R and M Watson (2010): "Relative goods' prices, pure inflation, and the Phillips correlation", *American Economic Journal: Macroeconomics*, vol 2, no 3, pp 128–57.

Riggi, M and A Tagliabracci (2022): "Price rigidities, input costs, and inflation expectations: understanding firms' pricing decisions from micro data", *Bank of Italy Occasional Papers*, no 733.

Roberts, J (1995): "New Keynesian economics and the Phillips curve", *Journal of Money, Credit and Banking*, vol 27, no 4, pp 975–84.

Rowthorn, R (1977): "Conflict, inflation and money", *Cambridge Journal of Economics*, vol 1, no 3, pp 215–39.

Rudd, J (2021): "Why do we think that inflation expectations matter for inflation? (And should we?)", Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series, no 2021-06.

Samuelson, P and R Solow (1960): "Analytical aspects of anti-inflation policy", *American Economic Review – Papers and Proceedings*, vol 50, no 2, pp 177–94.

Selgin, G (1997): "Less than zero: the case for a falling price level in a growing economy", *IEA Hobart Papers*, no 132, The Institute of Economic Affairs, April.

Sims, C (2010): "Rational inattention and monetary economics", *Handbook of Monetary Economics*, vol 3, pp 155–81.

Stock, J and M Watson (2020): "Trend, seasonal, and sectorial inflation in the Euro Area" in G Castex, J Galí and D Saravia (eds), *Changing Inflation Dynamics, Evolving Monetary Policy,* Series on Central Banking, Analysis and Economic Policies, no 27, Central Bank of Chile, pp 317–44.

Taylor, J (2000): "Low inflation, pass-through, and the pricing power of firms", *European Economic Review*, vol 44, no 7, pp 1389–408.

Thomas, L (1999): "Survey measures of expected US inflation", *Journal of Economic Perspectives*, vol 13, no 4, pp 125–44.

Volcker, P (1983): "We can survive prosperity", speech to the Joint Meeting of the American Economic Association and American Finance Association, San Francisco, 28 December.

Weber, M, F D'Acunto, Y Gorodnichenko and O Coibion (2022): "The subjective inflation expectations of households and firms: measurement, determinants, and implications", *Journal of Economic Perspectives*, vol 36, no 3, pp 157–84.

Westerlund, J (2007): "Testing for error correction in panel data", *Oxford Bulletin of Economics and Statistics*, vol 69, no 6, pp 709–48.

Yilmaz, K (2015): "Measuring the dynamics of global business cycle connectedness", in S Koopman and N Shephard (eds), *Unobserved Components and Time Series Econometrics: Festschrift in Honor of Andrew Harvey's 65th Year*, Oxford University Press, pp 45–70.

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