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POST PANDEMIC PHILLIPS CURVES: CYCLICAL AND STRUCTURAL DRIVERS IN THE GREAT POLICY TRADE OFF

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Abstract

Using panel data techniques, we draw on the Phillips curve framework to address gaps in the cross-country inflation literature. We provide a comprehensive assessment of the relative contributions of cyclical and structural drivers to inflation dynamics, the latter including globalisation, innovation, and demographics. We also assess how parameters vary across advanced and emerging economies, as well as goods and services sectors. Our results highlight the importance of both backward and forward-looking inflation expectations, and in turn monetary policy credibility. While structural factors play a role in inflation dynamics, their influence is modest, felt over many years and able to be offset by central banks. Supply-side drivers should be thought of as headwinds or tailwinds rather than true determinants of inflation in the medium and long term, though, we do find evidence that globalisation and technological innovation helped flatten the Phillips curve in the 20-years before the pandemic. This implies some risk of re-steepening if the trend towards the fragmentation of the global trading system were to continue, though technological progress continues to work in the opposite direction. Finally, we investigate whether the pandemic has served to alter the position or slope of the Phillips curve. We think the evidence is more consistent with the pandemic helping uncover a steeper section of the curve rather than causing a more fundamental shift or steepening over more normal ranges for economic slack. But that benign conclusion is contingent on central banks doing what is necessary to return inflation swiftly to their targets.

JEL Classification: E31, E37, E52, J11, J21

Keywords: Monetary policy, inflation, Innovation, Phillips curve, Demographics, Globalisation

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February 2023

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JEL Classification: E310, E370, E520, J110, J210,

Keywords: Inflation, Phillips Curve, Demographics, Globalisation, Innovation, Monetary Policy,

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1 Introduction

The synchronised global inflation surge in the wake of the pandemic has raised many questions. How might the supply and demand distortions combine with structural drivers such as demographics, technological progress, and globalisation to alter inflation dynamics over different time horizons? What are the risks of entering a new inflation paradigm of permanently higher inflation or returning to a more volatile macro backdrop? And critically, how should central banks navigate the immediate and long-term challenges?

Phillips curve models have long been the standard framework for analysing inflation dynamics. But there are several limitations that imply they should be used cautiously for forecasting and policymaking. These include a disproportionate focus on cyclical dynamics that omits the contribution of structural drivers, the failure to account for how sensitivities can vary across the goods and services sectors, and the difficulty in identifying the Phillips curve following exogenous shocks and periods of transition or inflection.

Prior to the outbreak of the pandemic, there was a clear trend towards secular disinflation across a broad swathe of developed and emerging economies. Across Latin America for example economies that had struggled through periods of persistently high inflation in excess of 30% y/y during the 1980s were averaging closer to 3% by 2019. Meanwhile central banks of many advanced economies faced the challenge of inflation remaining persistently below target between the Great Financial Crisis (GFC) and the onset of the Covid pandemic.

Traditional modelling frameworks have often struggled to fully explain inflation dynamics in real time. Inflation fell less than expected in the wake of the 2008 recession but also failed to accelerate meaningfully as economies recovered. As a result, central banks consistently over-estimated future inflation in their forecasts through most of the post-GFC period, and often kept monetary policy too tight as a result. Numerous studies attempted to explain the change in the relationship between economic slack and inflation which appeared to have flattened so much that even very large changes in slack appeared to have minimal impact on inflation.

Any economic framework needs to be considered within the context of the exogenous shocks that can shift prevailing relationships. For example, the Covid pandemic, the war in Ukraine, and the policy and behavioural responses to those shocks significantly altered aggregate and sectoral patterns of demand and supply. In the face of such shocks, policymakers seeking to control inflation have had to develop expertise in supply chains, logistics and epidemiology. Even as these original shocks are starting to dissipate, policymaking remains complicated by uncertainties about the speed and scale of transmission through prices and the appropriate levels of interest rates required to return economies to equilibrium. The risk of further policy errors is high.

In this environment, disentangling the relative effects of cyclical and structural factors on inflation is key to assessing the future path of inflation and appropriately calibrating policy responses. This paper extends the Phillips curve framework using cross-country panel techniques.

The analysis begins by considering the relative contribution of cyclical and structural drivers including globalisation, technological progress, and demographic forces to inflation dynamics. We also assess how parameters vary across the advanced and emerging economies, as well as when core inflation is decomposed into its goods and services components. We then examine non-linearities in the Phillips Curve through the prism of post-pandemic inflation trends.

The paper is structured as follows. Section 2 reviews the relevant literature, showing how few papers jointly consider a wide range of relevant cyclical and structural drivers of inflation. Forbes (2019) is one of the main exceptions, but we extend her framework to account for a fuller set of structural factors and additional time and sector decompositions. Section 3 outlines the methodology, Section 4 present the results. Section 5 analyses the inflation drivers within the context of the post pandemic world to see how the framework can be used to provide insights for the inflation outlook.

Our key findings across the various specifications, are that inflation expectations and lagged inflation repeatedly appear as the most important drivers of inflation relative to other drivers. Furthermore, expectations measures have become more important over time.

Emerging economies have a slightly steeper Phillips curve and are more sensitive to global value chains than advanced economies and there is evidence prior to the pandemic, Phillips curves had been on a flattening trend across a large swathe of economies. Core goods inflation has a greater sensitivity to inflation expectations and global measures of economic slack, while lagged inflation and local labour market dynamics are more influential for services inflation.

Demographic variables such as aging population have a positive influence on inflation, but they are statistically weak relative to other drivers. The results do, however, highlight how technological innovation and globalisation have combined to contribute to the flattening of Phillips Curves prior to the pandemic.

Though our results imply that structural supply side drivers have important effects on inflation, the influence is generally felt over the course of many years, and act as longer run headwinds or tailwinds that central banks must navigate within their policy frameworks. Ultimately it is central banks, their institutional frameworks, policy decisions and how they anchor expectations around their objectives that determine inflation over the medium and long-term.

Indeed, at the time of writing globally, inflation stands far above the levels implied by traditional measures of economic and labour market slack. We think the evidence is most consistent with the pandemic having revealed a steeper part of the Phillips curve that had not been observed over the previous two decades, rather than an outright shift in the curve.

This is challenging for policymakers as they assess the “sacrifice ratio” or the trade-off between growth and inflation. A steeper Phillips curve implies inflation can be brought back to target levels more quickly with less aggressive pace of tightening and less damage to growth. However, if inflation remains elevated for a prolonged period the risk of second-round effects and an outward shift in the Phillips curve increases. This could open doors to a new paradigm of persistently higher inflation. The evidence suggests that central banks may be wise to prioritise inflation over growth and risk a shorter recession than lose a decade to stagflation.

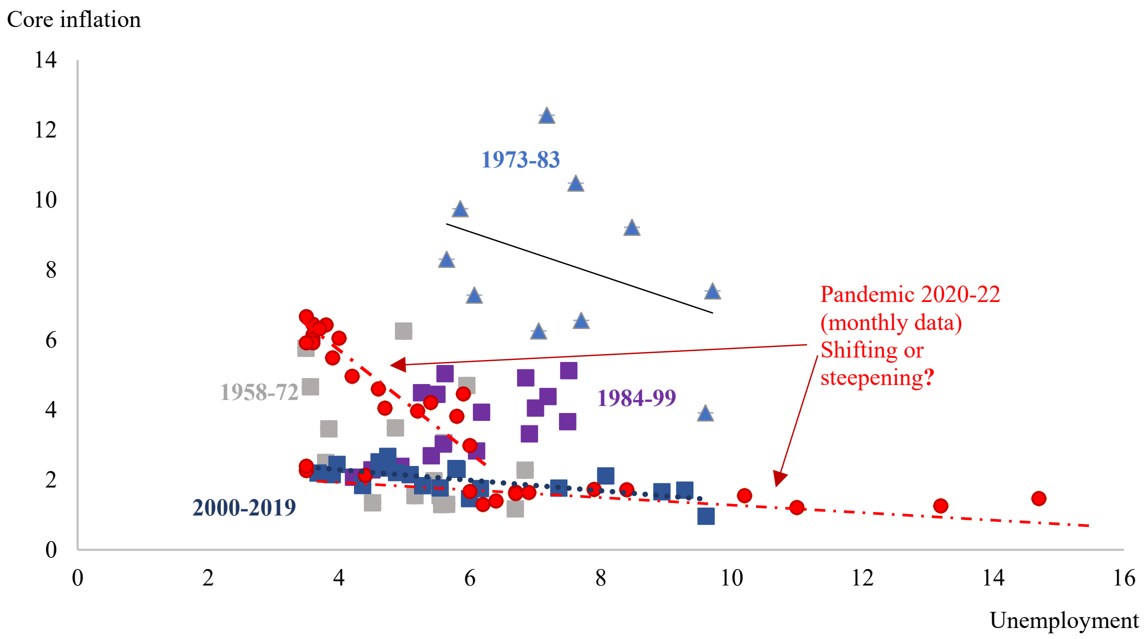
2 Literature Review

Although Fisher (1926) first documented a potential trade-off between unemployment and inflation, it was Phillips (1958) who first robustly identified the curve empirically drawing on British data from 1861 to 1957. Samuelson and Solow (1960) then provided more theoretical heft to the empirical regularities, demonstrating the factors that could cause the curve to shift or change slope over time, and how the curve could potentially be exploited to fine-tune policy.

However, this early work failed to properly account for the role of inflation expectations in determining the position of the Phillips Curve and how supply-side factors could cause the natural rate of unemployment to vary over time. And it wasn't until the seminal work of Freidman (1968, 1977), Phelps (1969), and Lucas (1972), and then the disastrous experiences of the 1970s that the modern expectations-augmented Phillips Curve framework came into being (Taylor, 1980). This involves a downward sloping (potentially kinked or non-linear) Short Run Phillips Curve (SRPC), intersecting with a vertical Long Run Phillips Curve (LRPC) at the natural or non-accelerating inflation rate of unemployment for a given level of inflation expectations.

In this framework, any attempt to lower the unemployment rate (increase output) below the natural rate of unemployment (above the level of potential output) will only yield transitory benefits before inflation expectations reset higher, workers realise their real wages are lower than anticipated, the SRPC shifts up, and equilibrium is restored at the natural rate and a new higher level of realised inflation. Wage-price spirals also become possible if policymakers attempt to keep the economy operating above its capacity.

Figure 1: US Phillips curve – a shift, steepening or mismeasurement of slack?



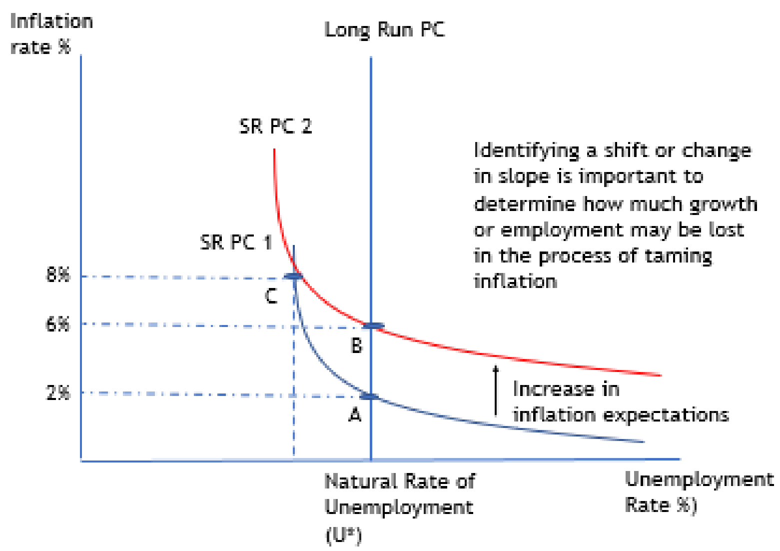
Source: Haver, abrdn Research Institute

Figure 1 shows one representation of how the SRPC in the US has evolved since the 1950s, while leaving open the question (for now) of whether the recent bout of higher inflation has been caused by a shift in the curve or a movement towards its steeper sloping sections, in part because the current measured U3 unemployment rate may be understating the degree of tightness in the labour market. This distinction is critical in current policy debates. If the recent bout of higher inflation has occurred through movement along a highly non-linear part of the curve, the "sacrifice ratio" - or how much growth or employment may be lost in the process of taming inflation – is likely to be lower than if the curve has shifted upwards.

Figure 2 illustrates the point. Assume that the combination of excessively loose monetary and fiscal policy has pushed the unemployment rate below its natural rate (U*). To make things simpler also assume the natural rate of unemployment rate has not been affected by the shock (in practice the natural rate has likely increased because of a deterioration in the labour matching function). The economy is therefore operating at Point C, where inflation is well above the central bank target and unemployment below the natural rate.

If Point C is on the steeper portion of the blue Phillips Curve SRPC1, policy makers only have to tighten policy enough to bring the economy back to point A. The "sacrifice" to return to 2% is an increase in unemployment, but the magnitude of this adjustment is lessened by the steepness of the Phillips curve at this point. However, if the Phillips Curve has shifted up, to the red curve SRPC2, then a central banker's task becomes much harder as the unemployment rate will temporarily have to rise above the natural rate to bring inflation back to 2%. We will return to this question of whether the post-pandemic SRPC has shifted up, become steeper at all points in the curve, or revealed a steeper part of the pre-pandemic curve that had previously been unobserved, in the final section of this paper.

Figure 2 The importance of identifying a shift or change in slope of the short run Phillips Curve



Source: abrdn Research Institute

2.1 The evolution of the Phillips curve literature

The rational expectations revolution in economics (see Muth ,1961; Sargent 1986; and Lucas 1987) led to the conclusion there might be no trade-off between inflation and unemployment, even in the short run. However, the extent to which this was at odds with the empirical evidence saw sticky wage and price setting behaviour under imperfect information underpin the broad consensus for the existence of a SRPC within the mainstream neoclassical synthesis (Humphrey, 1986). This also supported the potential for monetary policies to stabilise the economy at full employment and target consistent inflation. And it highlighted how increased central bank transparency, in conjunction with rules-based inflation targeting frameworks, could help keep expectations anchored at modest levels even in the presence of large shocks to unemployment (Bordo and Siklos, 2014). Indeed, as the faith in central bank credibility increased, theory implied that the observed Phillips Curve would flatten to the extent that it might be difficult to identify empirically.

Following the GFC many advanced economy central banks struggled to return inflation to target even as economies recovered. Reviewing this period, Forbes et al. (2021) found evidence that inflation had become less responsive to unemployment or other slack measures during and immediately after recessions, becoming more responsive only when output was above potential. Prior to the pandemic, some observers had even declared the Phillips Curve dead (see Niskanen 2009; Ireland 2019; and Frankel 2019) with researchers increasingly seeking structural explanations through drivers such as globalisation, demographics, and technological progress.

2.2 Globalisation

By the mid 2000s the role of globalisation and the integration of lower wage countries into the global economy had become a key focus for the research community as it sought explanations for the 'Great Moderation' in global inflation. This was most often done by adding import price or exchange rate controls to standard Phillips Curve models.

However, Borio and Filardo (2005) proposed that a country's inflation rate depended not just on domestic slack but also the output dynamics of its trading partners as local firms interacted in global markets. Not only were foreign output gaps statistically significant additions to domestic gaps in their Phillips Curve specification but they also explained more of the variation in inflation over the period from 1985-2005. Those results were soon contested. Ball (2006) found that by altering the model specification and the country weights used to construct foreign output gaps, the primacy of domestic slack returned. But Borio and Filardo (2007) extended their previous analysis to include a more general weight structure, broadly affirming the original results.

Empirical research since the GFC has tended to support a clear role for global factors, albeit through more nuanced channels than earlier research. Auer, et al. (2016) flagged the importance of supply chain integration, finding that input-output linkages accounted for half of the global component of producer price inflation, while also helping to synchronise inflation rates. Obstfeld (2019) showed that global drivers indirectly impact domestic inflation through exchange rates and the global neutral interest rates, but evidence of direct impacts on inflation was weaker.

Meanwhile, Forbes (2019) extended the literature by seeking to capture how the growth of global manufacturing value chains has influenced inflation dynamics. Her results pointed to global factors explaining most of the flattening of the Phillips curve, as access to cheaper inputs along different parts of the supply chain helped increase price competition and squeeze margins. The upshot was that headline CPI inflation was increasingly determined abroad, though wage and core CPI inflation were still primarily domestically driven.

2.3 Technology

Yet globalisation involves much more than trade integration. Over the past three decades globalisation has occurred through multiple interconnected channels including greater cross-border trade in services, the integration of capital markets, the diffusion of technology, and migration of workers. Technological change in particular is deeply embedded in the globalisation process as it facilitates the diffusion of innovation and the cross-border flows of goods, services information, and people.

Indeed, the debate around "deglobalisation" and inflation sometimes ignores the opposing forces of technological change and innovation, which can influence inflation through a variety of channels (see Figure 3). Innovation can directly lower the absolute and relative prices of ICT-related goods and services. The Monetary Authority Singapore (2018), Riksbank (2015) and Bank of Canada (2017) have all highlighted the secular declines in ICT related goods and services prices over the past decades. The ability to ship quickly and cheaply across continents also intensifies competition across online retailers and reduce costs

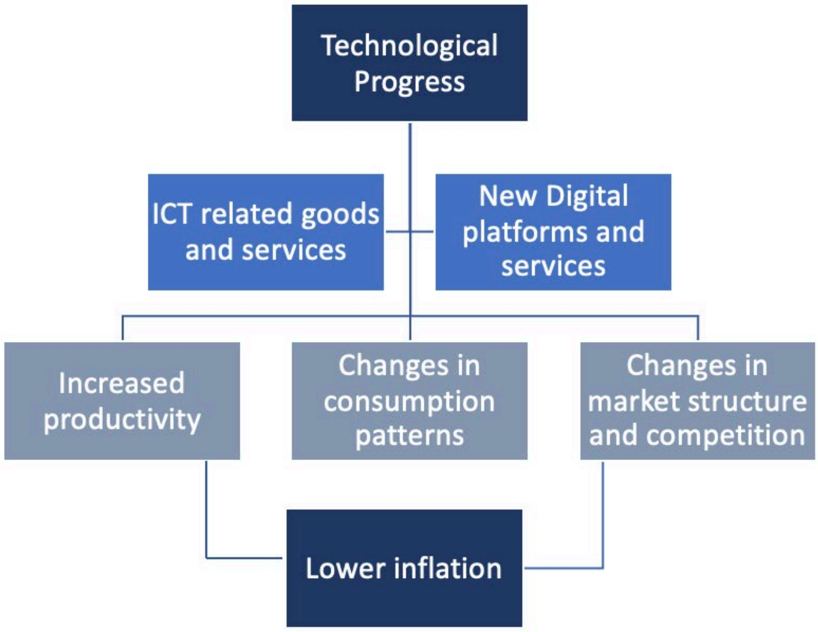
Innovation influences consumption patterns over time. It reduces demand for 'transition' or older goods. Smart phones and tablets have replaced multiple devices and changed the way we shop and consume entertainment. This in turn has triggered a chain of industry changes to adapt to consumer demand (Varian, 2016). As information spreads more quickly and easily, so does knowhow and different consumption and investment options. Additionally, technological change breaks down barriers to trading services as well as the cross-border provision of labour without the need for formal migration. And network capacity expansion and innovation has also reduced costs for some services.

There can also be indirect effects on inflation. Development of new platforms providing "near instant" products and services can change worker productivity and consumption patterns as well as industry competition and market structure. Ride hailing, online food and grocery deliveries and entertainment streaming services have fundamentally changed consumer preferences and for several years lowered the pricing power of incumbents in some sectors.

The growth of ecommerce can also increase transparency of product quality and pricing and consequently change consumer behaviour and increase competition. However, the ability to change prices almost instantaneously can reduce "menu cost" to adjusting prices. The ECB's Mersch (2017) flagged the potential for ecommerce to change market structure, disrupting monopolistic or monopsonist power of suppliers. Changes in mark-ups can also contribute to flattening of the Phillips curve.

Technology can also affect inflation dynamics over shorter horizons – by altering the equilibrium levels of the instruments of policy. For example, fluctuations in the pace of technological change influence the return on capital, potential growth and thus the equilibrium real interest rate. Since policy is partly transmitted through the difference between the term structure of real interest rates and corresponding equilibria, changes in the pace of technological change can impact the stance of policy, particularly if their effects are mis-calibrated.

Figure 3 Technology can influence inflation through multiple channels



2.4 The demographic conundrum

In the academic literature, the manner and extent to which demographics influence inflation is highly contested, reflecting the difficulty of disentangling the multitude of forces at play. A thorough literature review is covered in Roy (2022) and Table 1 summarises the key channels and their opposing signs of effect.

The first view emerges from the life-cycle hypothesis, where aging populations imply a greater number of households that are not directly producing and contributing to the economy but are running down savings and wealth to fund consumption. This could lead to excess demand and higher inflation if authorities misjudge the impact on supply capacity. This risk is also greater in countries (itself more common in EMs) with weaker central bank credibility.

Goodhart and Pradhan (2020) opine that increased dependency ratios will lead to lower savings rates and higher real wages as the labour force shrinks and worker bargaining power increases. They also expect long-term yields to rise as desired savings decline relative to desired investment. However, this analysis does not fully account for the potentially offsetting effect of flexibility in retirement ages, migration, and the role of technological advancements.

Bielecki et al. (2022) propose that low fertility rates and aging populations may lower the natural interest rate leaving central banks struggling with policy settings at the lower bound on nominal rates. Gilhooly and Glossop (2022) found evidence that r* had declined over the past decade and that demographics had contributed to this decline across several EM economies.

Pointing in the opposite direction, Bullard et al. (2012) analysed the intergenerational redistribution of resources in the economy, and the optimal inflation rate. They found that populations dominated by young cohorts, with no assets and wages as their primary income source, prefer low real interest rates and willing to endure higher rates of inflation. Older cohorts in contrast preferred higher rates of return from savings, lower wages and lower inflation which could erode asset values. This highlights the importance of the political economy. As older people become a larger share of the population (older people are also more likely to vote), they may seek to influence policy choices in a disinflationary direction.

However, another channel could be through the rising debt burden and increased risks of fiscal dominance, see Kotlikoff, L.J. and Burns, S.F. (2005) and Banerjee , R. N., et al (2022). Falling birth rates and expectations for an older society could push up debt and lead to a preference for inflationary policy choices to erode the debt burden. This could in turn lead to more politicised central banks and loss of independence so that monetary policy acts primarily to support fiscal decisions (so-called fiscal dominance), a risk that may be greater among EM economies.

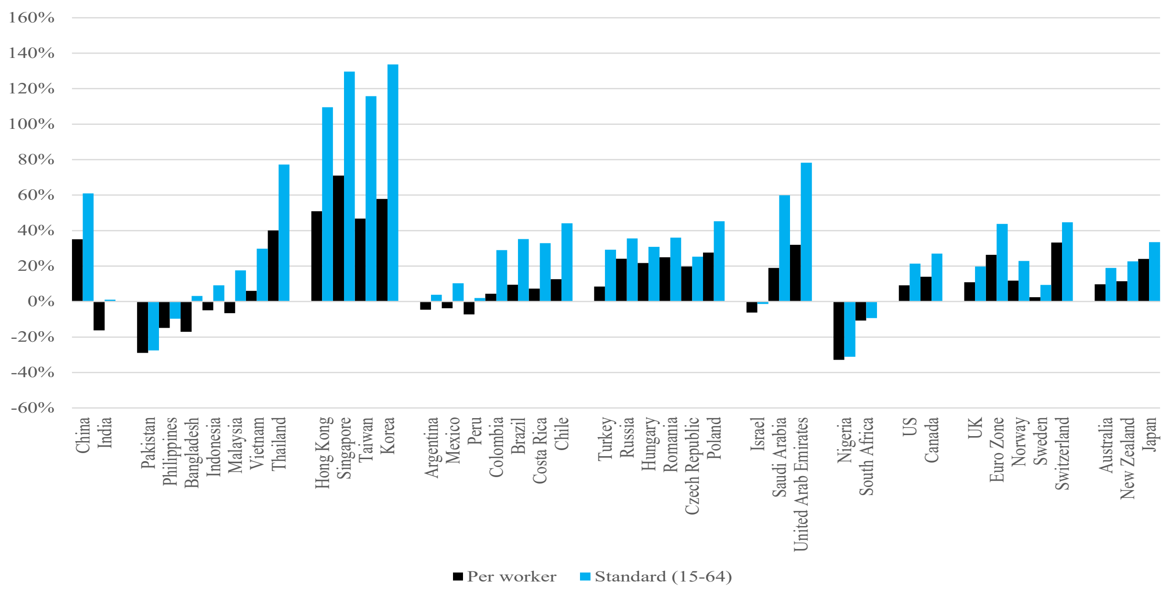
Table 1 – The ambiguous sign of demographic changes on inflation

	Impact on inflation	Demographic Channels
Wage Channel	↑	Assuming migration from countries with younger populations does not occur, a lower proportion of working age population increases wage pressure and labour bargaining power.
Migration flows	↔	Potentially ambiguous. Workers from countries with younger populations could migrate to those with aging populations and help increase the size of the workforce, counteracting aging population and exerting downward pressure on wages. Alternatively, migration can increase capacity constraints if infrastructure does not rise to meet additional demand, placing upward pressure on inflation.
Political economy	↓	Older population have a greater dependency on fixed incomes which are eroded by higher inflation and may reinforce disinflationary policy choices.

That said, the experience of Japan (and to a lesser extent Germany) would suggest that the high debt burden has done little to switch preferences in a rapidly aging society. Indeed, Japan illustrates the overriding importance of policy decisions regardless of the impulse from structural drivers. The Bank of Japan kept monetary policy far too tight during the decade after the crisis. Japan's over-levered banks were not recapitalised quickly enough, further reinforcing the demand shortfall. And despite steadily rising public debt, fiscal policy was not sufficiently focused on supporting growth once policy rates were at their effective lower bound.

Given these opposing forces, the effect of demographics on inflation is ultimately an empirical question. The traditional definition of dependency ratio frequently seen in the demographic literature may no longer be the most useful metric. The standard definition is that individuals aged 15-64 are of working age, while everyone else is defined as "dependent" or non-working. As discussed in Gilhooly and Glossop (2022), this does not account for participation rates of those aged 15-19, nor later retirement and changes in participation of the older population.

Figure 4: Change in dependency ratios 2020-2050



Source: abrdn, UN, OECD

Instead of assuming dependency by age bracket, an alternative measure, we will use the ratio of non-workers relative to working population in our empirical analysis. Changes in "Worker" dependency ratios are far less dramatic than the traditional age-based dependency ratios across most EM regions (Figure 4). In addition to this, the impact of changes in "youth" and "older" cohorts are analysed separately to analyse the different demographic theories outlined earlier. To test the different theories of cyclical and structural drivers of inflation, this paper adapts the approach taken by Forbes (2019) which focuses purely on the trade related side of globalisation. Instead, we integrate the effect of globalisation, technology and demographics - with cyclical drivers like spare capacity, within a cross-country panel model.

In summary, there is an extensive literature seeking to identify the slope of the Short Run Phillips Curve and the role that structural factors play in the inflation process. However, a key weakness of most studies is the way they usually consider cyclical and structural drivers in isolation rather than jointly. This weakens confidence in the conclusions to the extent that the effects may be correlated with one another. There are also important gaps in our understanding of why post-pandemic inflation dynamics have been so different from those of the previous 40 years. The rest of the paper seeks to address these gaps.

3 Methodology

Our basic method is to extend Forbes (2019) to include a broader range of structural variables including globalisation, technology, and demographics within a Phillips curve framework. We estimate a single global panel, and also split the sample by region, time and sector, to investigate whether there are differences in inflation sensitivity to cyclical and structural drivers. We draw on data for 43 economies, 19 EM and 24 DM, beginning in 1995. The domestic equation is outlined as follows:

$$\pi^{h}{}_{it} = \beta_1 \pi_{it}^{e} + \beta_2 \pi_{it}^{L} + \beta_3 \mathrm{SLACK}_{it}^{D} + + \alpha_i + \varepsilon_{it}$$

$$\pi^{c}{}_{it} = \beta_1 \pi_{it}^{e} + \beta_2 \pi_{it}^{L} + \beta_3 \mathrm{SLACK}_{it}^{D} + + \alpha_i + \varepsilon_{it}$$

Definitions of variables

- $\pi^{h}{}_{it}$ Headline CPI q/q saar
- $\pi^{C}{}_{it}$ Core CPI qq saar
- π_{it}^{e} inflation expectations, 5 year ahead inflation forecast from IMF WEO
- π_{it}^{L} lagged inflation over the previous four quarters
- SLACK_{it}^{D} domestic slack measured by OECD estimation of output gap as % of potential GDP

This baseline model is estimated using fixed effects such that identification comes from within-country variation over time. Several different measures of domestic slack were considered for this analysis. Forbes (2019), Albuquerque and Baumann (2017) highlight the importance of using a broad measure of domestic slack, as the simple deviation of unemployment from an estimation of NAIRU fails to capture changes in the labour force participation, discouraged workers or underemployment. The pandemic has highlighted the inadequacies of a simple unemployment rate to measure the degree of labour market slack or tightness as other labour market indicators signalled significant supply and demand imbalances.

Forbes computes the principal component of seven domestic variables including the participation gap, the share of self-employed workers, the share of involuntary part-time workers, and the share of temporary employment. However, these detailed slack measures are not available for many EM economies. Furthermore, comparing across a number of specifications using both detailed and standard simple slack measures show only minor differences in coefficients and overall fit.

To compare results across a larger number of EM and DM economies, the simple metric of OECD estimate of output gap as % of potential GDP is used for all countries. However, when considering just individual countries, regression output may be significantly improved by using broader measures to capture slack and labour market tightness where data permits.

The specification with global variables is outlined as follows:

$$\pi_{it} = \beta_1 \pi_{it}^{e} + \beta_2 \pi_{it}^{L} + \beta_3 \mathrm{SLACK}_{it}^{D} + \gamma_1 \mathrm{SLACK}_{t}^{G} + \gamma_2 \mathrm{Oil}_{it}^{LC} + \gamma_3 \mathrm{Comm}_{it}^{LC} + \gamma_4 GVC_{t}^{G} + \alpha_i + \varepsilon_{it}$$

- Oil_{it}^{LC} Oil price in local currency

- Comm_{it}^{LC} Commodity prices ex-energy in local currency lagged 1 quarter
- SLACK_t^G World slack measured by weighted average of DM and China output gaps
- GVC_t^G Global value chains, measured as a principal component of i) growth in merchandise trade relative to global GDP growth ii) volume of intermediate trade, iii) average change in dispersion in PPI prices

Traditionally, global factors are incorporated into a Phillips curve model by including variables such as real effective exchange rates, as well as dollar denominated oil and global commodity prices to capture global supply shocks. While these measures may work well when considering DM economies, estimating for a broader set of EM economies showed that dollar denominated commodity price variables were either insignificant or incorrectly signed. This was true even when regrouping the sample according to commodity export or importer status. Instead, we find that including commodity prices in local currency terms produced more intuitive coefficients for both DM and EM subgroups.

Globalisation measures that capture the impact of global slack and the increased integration of global value chains were found to be very important drivers of inflation (Forbes 2019) and these are also incorporated here. Alternative specifications including real effective exchange rates and import prices were estimated but the above global specification provided stronger results.

4 Results

In table 2, regressions were estimated using fixed effects for headline inflation for the full sample from 1996 to end 2019. Columns 1-5 show results across all countries in the sample, 6-10 across just the DM economies and 11—15 for only the EM economies. Table 3 repeats the analysis for core inflation, while Table 4 examines how the drivers of inflation have changed over time with separate results for pre-crisis (1996-2008) and the decade between the crisis and pandemic (2009-2019).

Following Forbes (2019) at this stage, the tables start with a simple domestic specification and build up to a fuller set with global variables and potential supply shocks from commodity prices (columns 3, 8, 13) and finally includes an interaction term between domestic slack and import share of GDP (columns 5, 10, 15).

4.1 Domestic vs Global Slack Results

The broad conclusions across the regressions are as follows:

- Higher inflation is associated with higher commodity prices, lower levels of domestic and global slack and weaker global trade integration.
- In each specification, the output gap variable has the expected sign, higher inflation is associated with less domestic slack, the coefficient is significant with a negative sign and a similar magnitude across each specification in the full sample.
- Global variables also have the expected negative sign and are generally significant at the 1% level.
- Real exchange rate movements were significant in most specifications, but the magnitude is exceptionally small signalling that the impact of currency depreciation were not as important as other global measures.
- In contrast, inflation expectations and lagged inflation are consistently the most important drivers, whether backward or forward looking, are critical in determining the path for inflation.
- Intuitively, commodity price rises are associated with higher inflation. Oil has a small positive coefficient, while non-fuel commodities have a stronger relationship, particularly for emerging economies which have a larger coefficient than advanced economies. Interestingly the influence of commodities declines over time, even for emerging economies. As discussed in the section 5, this coincides with the rising importance of inflation expectations over time.
- Comparing across regions shows that EM economies have a slightly steeper Phillips Curves than DM economies, showing headline inflation in EMs have a marginally stronger sensitivity to domestic slack.
- However, global measures such as value chains prove to be more important for emerging markets. The coefficient on global value chain is more than three times the magnitude of domestic slack in each of the EM specifications. For DM, global measures are not consistently significant, and the coefficient is relatively small in magnitude.
- Core inflation results unsurprisingly show lower sensitivity to global trade integration compared to headline, but these coefficients are no longer significant nor is the sign consistently negative.
- While domestic slack and inflation expectations remain important, lagged inflation becomes more important for both DM and EM for core compared to headline. This may reflect the fact that core inflation has been relatively stable across many countries over the past two decades prior to the pandemic.

4.2 How have cyclical influences changed over time?

The role of different inflation drivers can change over time. Comparing across pre-and post-GFC crisis samples shows this more clearly (Table 4). Our measures of inflation expectations become increasingly more important over time across both EM and DM economies while most other variables have become less important. For headline inflation, the coefficient on inflation expectations more than doubled. Meanwhile the influence of lagged inflation almost halved in some specifications for EM and remained stable for the DM economies.

These results are consistent with the important role of central banks and policy credibility in driving inflation expectations. For emerging economies, the change in coefficient coincides with the rising number of EM central banks adopting inflation targeting frameworks since the late 90s. Increased policy credibility has been accompanied by a stabilisation of inflation expectations as well as lower and less volatile inflation rates for most countries.

Turkey clearly stands out as an exception where loss of central bank credibility and independence has led to a swift de-anchoring of inflation expectations and sharply higher inflation volatility. But for many other countries it is interesting that the backward-looking component became less important over the past 20 years, and expectations became predominantly forward looking.

The results also show how much the relationship between slack and inflation has flattened over time, consistent with the broad easing of inflation and the intensification of globalisation during the 2000s. The coefficient on domestic slack declines sharply post-GFC for both headline and core inflation, while the estimated impact of global variables also surprisingly weakened.

As an alternative test for the impact of globalisation on inflation, Forbes (2019) includes an interaction term between domestic slack and trade shares. Repeating this analysis across regions and the global sample show that globalisation has contributed to some of the flattening in the Phillips curve (Tables 2 and 3, columns 5, 10, 15).

The coefficient on domestic slack in the full global sample is almost double that of the equivalent specification without the interaction term. The impact is much stronger for emerging compared to advanced economies, suggesting that EM economies are more trade dependent as some economies became more deeply integrated into the global value chain. This implies that should more lacklustre globalisation trends come to pass – as we expect – globalisation as measured via the trade channels, may no longer help drive inflation lower, and could even generate higher inflation in the event of any broader shift toward reshoring over time, and without a corrective response from central banks.

4.3 Demographics: a slow-moving tailwind

As discussed in Section 2.4, demographics can work through multiple channels, and the impact on inflation has been highly contested in the literature. Working age population growth has already passed the peak in China, much of EU, Eastern Europe and Latin America. UN population projections suggest that the proportion of workers will steadily decline over the next 3 decades. Africa alone is set to benefit from a “Demographic dividend”.

The specification adding demographic variables is outlined as follows:

$$\pi_{it} = \beta_1 \pi^{e}_{it} + \beta_2 \pi^{L}_{it} + \beta_3 \text{SLACK}^{D}_{it} + \gamma_1 \text{SLACK}^{G}_{t} + \gamma_2 \text{Oil}^{LC}_{it} + \gamma_3 \text{Comm}^{LC}_{it} + \gamma_4 GVC^{G}_{t} + \text{65plus5y5y}^{D}_{it} + \text{Youth5y5y}^{D}_{it} + \text{LFdepency}^{D}_{t} + \alpha_i + \varepsilon_{it}$$

- $\text{65plus5y5y}^{D}_{it}$ 5 year growth in proportion of domestic population age 65 plus (UN)
- $\text{Youth5y5y}^{D}_{it}$ 5 year growth in proportion of domestic population age 0 to 15 (UN)
- LFdepency^{D}_{t} Domestic Labour dependency ratio = population not in Labour force / Total labour force (OECD)

Changes in demographic ratios are used in this analysis to capture the speed of aging across countries as these have a stronger impact on inflationary pressures than using the simple slow-trending ratio of youth and elderly population. However, even then, over the past decade the impact of demographics has generally been dwarfed by other drivers, in particular inflation expectations and domestic slack are far more powerful drivers of inflation trends.

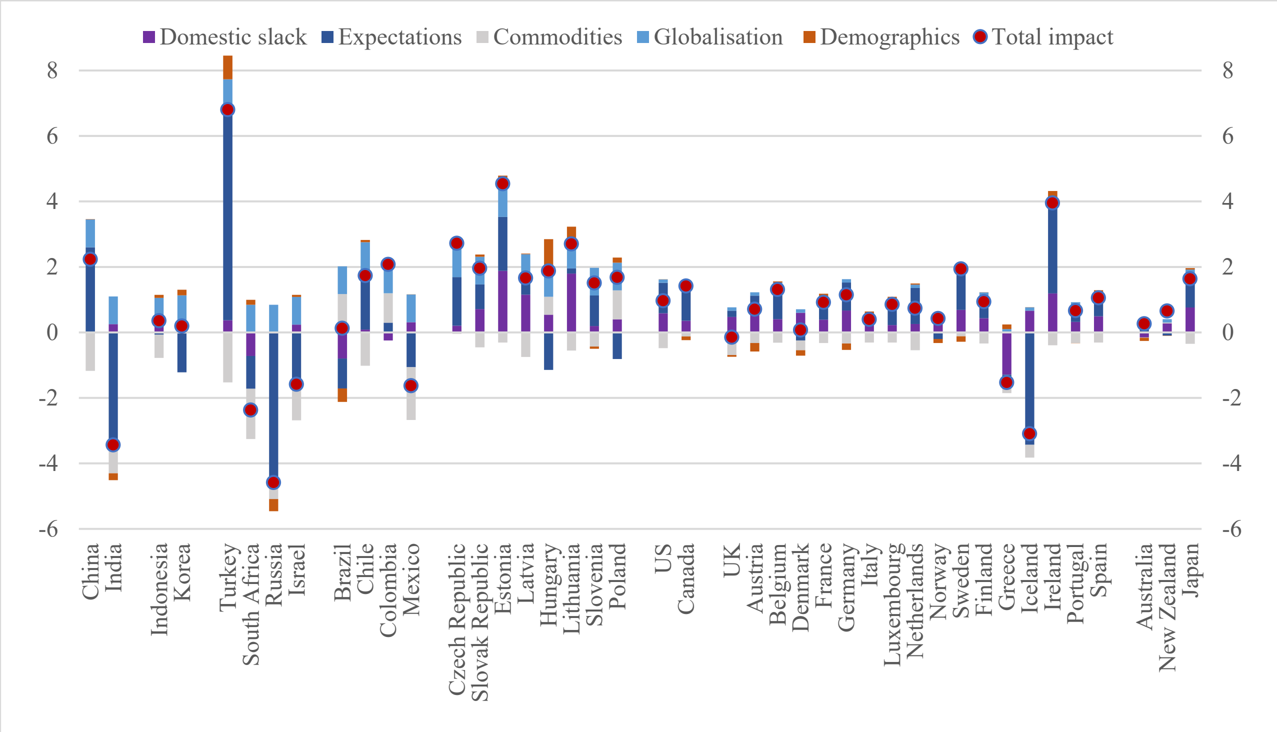
The results show that population aging has a positive but statistically effect on inflation, while an increase in the proportion of "youth" is disinflationary. The impact of "65 plus" grouping might be too broad, reflecting diverse consumption patterns and political preferences and in turn differ in how they influence inflation. In order to statistically test this the older group is split into two buckets, aged 65 to 80 and 80 plus. The results shows that an increase in the proportion aged 80 plus is positively related to inflation and is also statistically significant for developed markets. This would be in line with the life cycle hypothesis of inflation and demographics; however, the relationship is very weak relative to other drivers.

The coefficient on the alternative dependency ratio, (non-workers/total labour force) is significantly negative - suggesting that a shrinking workforce would lower inflation. This seems counterintuitive but the channel of effect may be through cyclical dynamics, responding to labour demand changes during recessions. Thus highlights the importance of the business cycle and policy decisions over structural variables.

Furthermore, as supply chains became integrated across borders, multinationals were able to pick and choose across the global workforce leading to greater convergence in global wages. The results show that EM inflation has become increasingly sensitive to global value chains over time as many of these economies are specialised in goods production.

Increases in elderly populations could become a drain on the state and encourage prime age workers to migrate. All of which underlines the fact that demographics cannot be viewed in isolation, as these trends interact with the forces of globalisation, politics and trade policy.

Figure 5 Average contribution of structural drivers are dwarfed by expectations (2009-2019)



Source: Haver, abrdn

In China and some Eastern European economies, populations are aging, but at a slower pace compared with their recent history; hence, we find that demographic change in the near-term imparts slightly less inflationary pressure going forward than it did in the recent past. However, in the case of Europe and UK, there may also be some Brexit related migration distortions at work, which may only become clearer in a few years. More generally, central bank independence and credibility appears to be well entrenched, however structural changes will likely provide a more challenging backdrop for policy makers going forward.

Overall, the results show that changes in demographic compositions have made a marginal contribution to inflation over the past decade. The most important drivers of inflation remain cyclical, such as the output gap and inflation expectations. This reinforces the key point: over the coming decades, demographics may provide a long run tail wind and challenging policy backdrop by slowly altering the supply-demand balance within economies. Some inflationary bias could be introduced if these changes are not fully internalised in policy making, but ultimately the results suggest policy setting will determine the inflationary regime which countries operate in.

4.4 Technological diffusion and migration results

As outlined earlier, technological progress has been a key facilitator of globalisation over the past 30 years, while the migration of people across borders represents another dimension of globalisation. In the next specification we test the effects of both, alongside global value chains, excluding the demographic variables to avoid the double counting arising from UN population data incorporating migration assumptions, using the following regression:

$$\pi_{it} = \beta_1 \pi_{it}^e + \beta_2 \pi_{it}^L + \beta_3 \text{SLACK}_{it}^D + \gamma_1 \text{SLACK}_t^G + \gamma_2 \text{Oil}_{it}^{LC} + \gamma_3 \text{Comm}_{it}^{LC} + \gamma_4 GVC_t^G + \theta_1 \text{Tech}_{it}^G + \theta_2 \text{Migration}_{it}^D + \theta_1 \text{Interaction terms}_{it} + \alpha_i + \varepsilon_{it}$$

$Migration_t^D$ annual growth of UN international migrant stock.

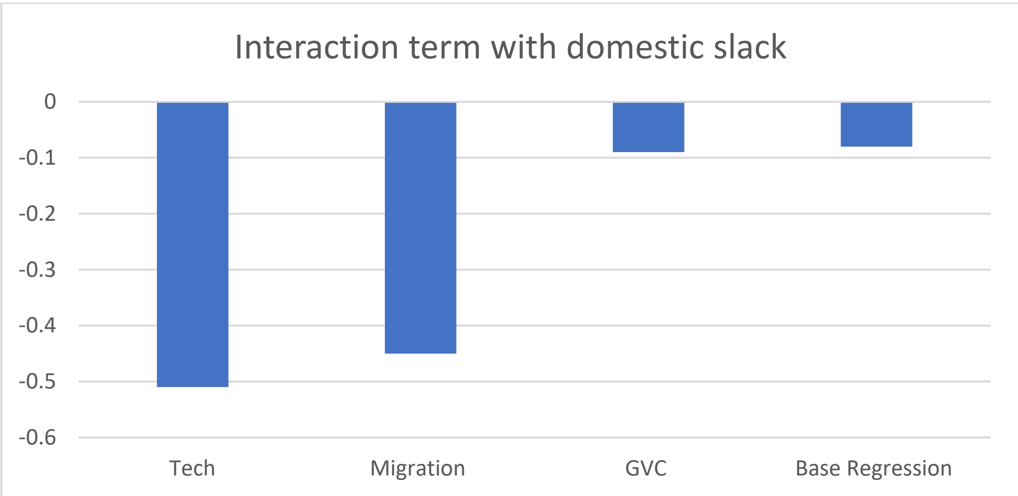
$Tech_t^G$ Annual growth of an aggregate tech index which combines standardised measures of:

- Non-resident patent application (US, EU, Japan)
- Individuals using the internet (% pop)
- Non-resident trademark applications
- GFCF Intellectual property products investments
- Mobile phone subscribers

Simply including these measures int the panel regression analysis provided mixed results with no clear signal of independent inflationary impacts. However, more interesting, is to test the influence of these drivers on the slope of the Phillips curve itself. Did innovation and migration trends alter the sensitivity of inflation to the business cycle? To test this we include 'interaction terms' with domestic slack.

Figure 6 compares the results of interacting technology, migration, and global value chains (GVC) with domestic slack to differentiate between the relative influences. The results highlight that both technology and migration were highly influential in flattening the Phillips curve over the past decade contributing to low inflation before the pandemic, even as economies recovered from recessions.

Figure 6 – Innovation and a more globalised labour market have been key to flattening the Phillips curve



Source: abrdn Research Institute

This sheds an interesting insight into the growing debate over the impact of structural drivers on inflation. Much of the discussion has focused on the inflationary tailwinds from demographics and "deglobalisation". As corporate and government policy shifts toward reshoring production and supply chain security there is a fear that this will lead to a persistently higher inflation regime. Our results highlight an important offsetting role of technology within a wider definition of the globalisation process.

4.5 Decomposing core inflation into goods and services components

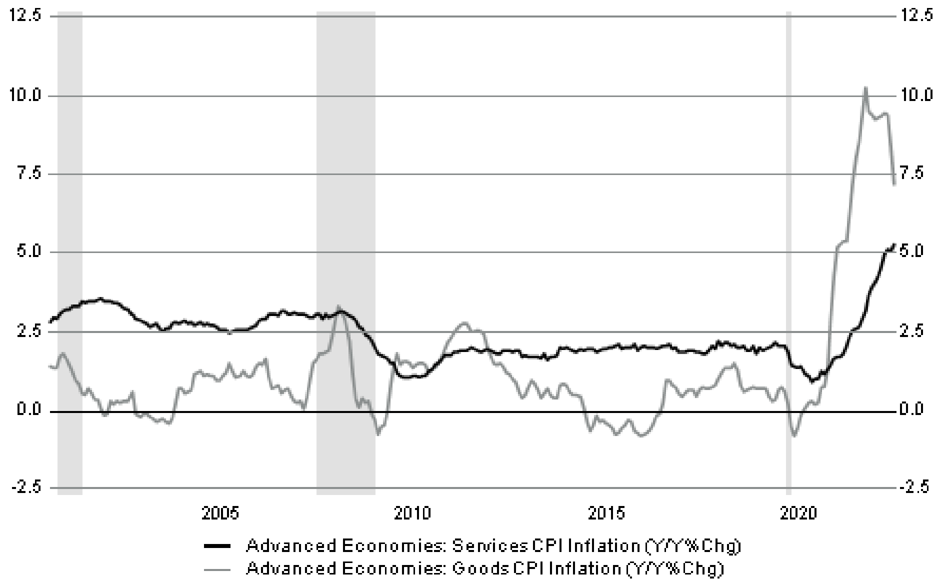
In this section core inflation is decomposed into its goods and services components to analyse their potentially different sensitivities to cyclical and structural drivers.

Table 6 presents the Phillips curve results for the two sectors. Equivalent data were not consistently available, so the regressions include only data for the advanced economies. Starting with the cyclical drivers, there are some interesting differences between the sectors.

The coefficient on lagged inflation, or inflation persistence, is significantly positive and stable across all samples, and for both goods and services. Consistent with previous results, inflation expectations became more important and significant over time for both sectors. In the decade following the GFC, the coefficient on expectations outpaced that of lagged inflation.

Interestingly core goods inflation is more sensitive to both backward- and forward-looking inflation expectations than the service sector. This may signal a more agile approach to price changes that may not be displayed in services where wage setting is conducted on a more discrete, annual basis and faces more rigidity. Labour market dynamics set the backdrop for stickier core services inflation. Meanwhile goods prices have experienced greater volatility over the past 20 years and experienced more frequent periods of deflation across many countries.

Figure 7 - Price setting behaviour more volatile for goods relative to service sector



Source: abrdn Research Institute

Unsurprisingly, commodity prices are not as relevant for core inflation as headline inflation, although in the pre-GFC sample, non-fuel commodities were more important for core goods inflation.

The Phillips Curve for both core goods and service inflation flattened over time, as the sensitivity to domestic slack declined or became insignificant over time. Interestingly, global slack become more important in the latter period for core goods, driving the disinflation trend. The estimated effect of global value chains is insignificant over the past decade. As seen in earlier results global variables are less important for core inflation than for headline inflation. Nonetheless, we see here the importance of the global business cycle for core goods inflation.

Moving on to the other structural drivers, technological progress stands out as consistently disinflationary for both core goods and services although the impact is much greater for goods. The impact of technology also becomes more significant over time. Migration plays a more important role for the service sector, although the results are not very significant over the past decade. Increased financial integration via capital flows have a stronger disinflationary impact on goods sector, becoming more significant overtime. The positive sign on the coefficient for services is less intuitive.

5 A framework for analysing post-pandemic inflation dynamics

The results in the previous sections sit comfortably within the mainstream pre-pandemic empirical inflation literature. Domestic and global slack influence inflation dynamics, but the combination of increased central bank credibility via the widespread adoption of inflation targeting, and the disinflationary forces emanating from globalisation and technological change, had flattened SRPCs considerably, such that underlying inflation in particular was relatively insensitive to even large economic shocks.

The pandemic has upended this comfortable consensus. Headline and core inflation rates have surged across most countries, often to levels not seen since the early 1980s, particularly in the advanced economies. This surge has also been broadly based across the goods and services sectors, as well as within them. And though inflation rates now appear to have peaked in most countries, at the time of writing they and the best measures of labour cost growth remain well above rates consistent with reasonable definitions of price stability.

At the same time, measures of long-term inflation expectations have remained relatively well anchored close to central bank targets. And though unemployment rates have fallen to multi-decade lows across a wide range of economies, the magnitude of the increases in underlying inflation are hard to reconcile with the size of the reductions in unemployment and both ours and previous estimates of the slope of the SRPC.

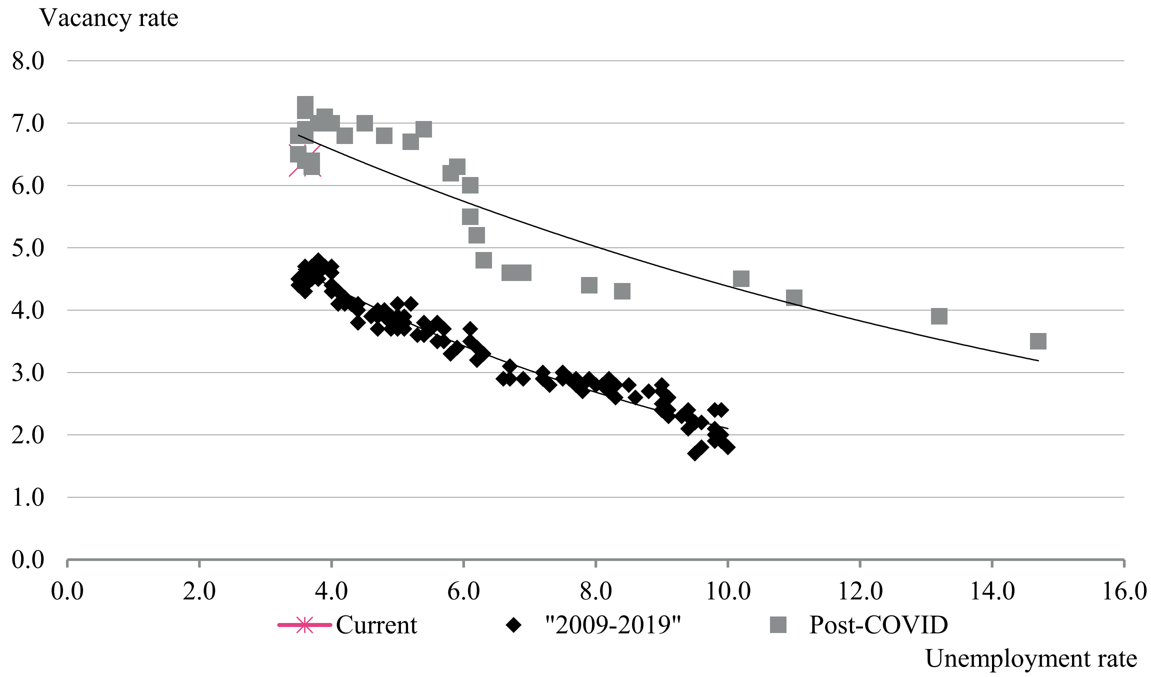
The key question then is whether the pandemic has fundamentally altered the position and slope of the SRPC as well as the effect of structural parameters on inflation. The following subsections discuss each of the key drivers within the context of the post-pandemic world to see how the framework can be adapted to provide insights for the inflation outlook.

5.1 The importance of correctly measuring labour market slack

Labour market slack is usually measured by taking the difference between the unemployment rate and relatively stable estimates of the natural rate of unemployment. In the US for example, today this gap is around 1ppt – implying a tight labour market but one not much tighter than observed on the eve of the pandemic, when the unemployment rate was 3.6% yet core inflation was broadly in line with the Fed's target.

But in the post-pandemic labour market, the traditional way of estimating slack is likely to be wrong for three key reasons. First, it doesn't account for the way that vacancy and quit rates have surged relative to hiring and unemployment rates, pointing to considerable excess labour demand. Second, it ignores the way that the natural rate of unemployment may itself have increased, as the efficiency of the labour market matching function has deteriorated due to rapidly changing patterns of relative geographic and sectoral labour demand and supply. This is illustrated in the outward shift of the post-pandemic Beveridge curve (see Figure 8).

Figure 8 Post pandemic Beveridge curve signals frictions in the matching process



Source: BLS, Haver

Third, it does not adequately account for how badly the pandemic has damaged the willingness and ability to supply labour. Domash and Summers (2022) show that structural demographic changes, permanent shifts in work-life preferences, as well as the long-term negative health effects of the pandemic have led to a large decline in labour force participation rates. Furthermore, (Faberman et al, 2022) demonstrates that even when working, workers are supplying less labour at the intensive margin, and that real reservation wages have also increased.

The upshot is that the pandemic has led to a much larger increase in excess labour demand, or a much tighter labour market, than implied by traditional measures of slack. And that in turn means that the economies are likely operating on a much lower section of the SRPC than during previous cycles.

5.2 Non-linearities, expectations and the sacrifice ratio

Phillips curves are usually estimated in a linear form because it has often proved difficult to pin down any statistically robust non-linear effects through the inclusion of squared slack terms in regressions. That was also the case in the empirical work in Section 4 of the paper. Yet there is alternative evidence for non-linearities when economies or labour markets are operating away from their equilibrium levels or rates of growth using alternative econometric methods. Forbes (2021) for example shows that there is evidence for a non-linear SRPC that is steep when output is above potential and slack is negative, but flat when slack is positive, with the degree of steepness increasing with the extent of excess demand.

Indeed, the combination of - (1) the greater degree of excess labour demand than originally acknowledged, inputted into SRPC models, and observed over recent decades; (2) the non-linearities in wage-price inflation dynamics that are to be expected when excess labour demand is very high; and (3) the nature of the transitory shocks to energy, food and durable goods markets that have occurred because of or since the pandemic - is likely sufficient to explain post-pandemic surge in inflation, particularly with inflation expectations remaining well anchored in most economies. It is not that the SRPC has steepened or shifted since the pandemic. It is that the shocks associated with the pandemic have revealed parts of the curve that were previously unobserved.

The good news is that if this hypothesis is right, the sacrifice ratio associated with restoring inflation to rates consistent with central bank targets need not be as high as if the SRPC had shifted upwards, particularly as some of the shocks associated with the pandemic – especially related to supply-chain bottlenecks in the goods sector – are now unwinding. However, there is no room for complacency as the window within which the SRPC can remain stable before it shifts and the sacrifice ratio increases, may be short.

For example, De Fiore et al (2022) show how wage-price spirals become more probable the more broadly based inflation dynamics become. And there is growing evidence that the longer inflation is allowed to remain above target consistent levels, the more weight agents put on prior (or backward looking) inflation when setting their expectations for the future and negotiating wages and prices. BoE MPC member Mann (2022) has also recently highlighted the potential importance of increased backward looking expectations formation. Even if long term expectations remain stable and central bank target credible, persistently elevated inflation can generate a higher degree of backward-looking behaviour and lead to greater persistence in high inflation outcomes

A simple expectations-augmented or hybrid Phillips Curve allows us to illustrate the key points.

$$\pi_{it} = \beta_1\pi_{it}^{e} + (1-\beta_1)\pi_{it}^{L} + \beta_3 SLACK_{it}^{D} + +\alpha_i + \varepsilon_{it}$$

Definitions of variables:

- π_{it} CPI q/q saar
- π_{it}^{e} inflation expectations, 5 year ahead inflation forecast from IMF WEO
- π_{it}^{L} lagged inflation over the previous four quarters
- $SLACK_{it}^{D}$ domestic slack measured by OECD estimation of output gap as % of potential GDP

In this model the non-slack measures are a weighted averages of past and expected future inflation. When β_1 tends to zero the model represents the accelerationist Phillips curve where inflation is primarily driven by backward looking behaviour with inflation persistence dominating price setting behaviour. If β_1 increases and tends to 1, the Phillips curve becomes more forward looking, with inflation primarily determined by policymakers' credibility, future expectations of slack, and the impact on future inflation. Higher β_1 indicates greater faith in central banks' ability to tame inflation.

This model helps connect macroeconomics to the micro foundations of firm and household level optimisation decisions. Some firms still face adjustment costs to raising prices such as "menu costs" or administrative costs of offering fixed-length contracts. As a result, prices can be sticky as firms will only consider bearing the costs of changing prices if the adjustment is sufficiently large, so in the early stages of an inflation surge, firms may face a degree of margin squeeze and absorb some wage and input costs.

If the firm anticipates continued price rises, then the optimal decision will be to overshoot current price level. The greater the uncertainty around how fast prices are rising, the greater the incentive to overshoot when hiking prices to cushion against future increase in input costs. There may also be a degree of coordination between firms as they keep up with competitors even if marginal costs have stabilised. This process can drive inflation higher even if demand conditions and input costs remain stable.

A second feature highlighted in the expectations augmented Phillips curve is that the nature of inflation expectations formation can change over time, with agents moving from backward looking accelerationist behaviour to forward-looking with agents switching between them as one rule starts to outperform the other (Cornea-Madeira et al. 2019). When shocks drive inflation away from target for extended periods of time, firms and households can become more backward-looking in their formation of expectations. Monetary policy acting to reinforce the credibility of inflation targets is critical here, as the expected impact on domestic slack can feed back into aggregate inflation expectations.

In short, central banks may be wise to prioritise returning inflation swiftly to target over growth and absorb a swifter, shallower recession, than risk allowing expectations to shift more durably higher and require a deeper and more persistent recession later on.

Central banks should also be mindful of how changing structural dynamics in the global economy might influence the slope of the Phillip curve, even for more normal ranges of economic and labour market slack. In Section 4 we showed how globalisation and technological change had combined with reduced labour bargaining power to help flatten Phillips curves in the two decades before the pandemic. Might the curve re-steepen in a world where governments are focused more on supply chain security, more nativist trade, industrial and migration policies, and incentivising reshoring, nearshoring and friendshoring?

Domestic labour could gain some bargaining power, and firms greater pricing power in a world of reduced foreign competition, weaker cross-border migration and aging populations. And the process of increasing barriers to trade and associated changes in investment and production location decisions could increase the relative prices of trade goods. In this environment, the relative contribution of domestic slack variables to inflation could increase as could the magnitude of the relationship. However, these forces could also spur faster automation and innovation, particularly in emergent general purpose technologies like artificial intelligence. The upshot is that forecasters and central banks should avoid falling for simplistic and incomplete narratives as they continue to adapt their framework for modelling inflation and calibrating policy.

6 Conclusion

The pandemic and its aftershocks has created a challenging backdrop for policy makers, as supply and demand distortions across commodities, supply chains, logistic networks and labour markets have led to a synchronised surge in global inflation. Though some of these shocks are starting to dissipate, some will persist and continue to make it challenging to accurately forecast inflation. In this environment, a comprehensive framework that combines cyclical and structural drivers, and models the interaction between them is critical for understanding inflation dynamics and the path back to target consistent inflation.

Our panel results highlight the importance of inflation expectations, and domestic and foreign economic slack in driving inflation, and how structural factors like globalisation, technological change and demographics act as conditioning factors shaping optimal central bank responses to shocks and the slope of Phillips curves rather than determining inflation outcomes.

This is important as one of the factors that has helped to flatten Phillips curves over time – the integration of global trade and goods markets – begins to reverse. This need not lead to higher inflation over the long-term unless misdiagnosed and accommodated by central banks. More important will the pace of technological change, which our research suggests has played a greater role in reducing the sensitivity of inflation to the business cycle.

We find that emerging economies have slightly steeper Phillips Curves than developed economies, though the relative gap has declined over time. Comparing dynamics across sectors, core goods inflation has a greater sensitivity to inflation expectations and global measures of economic slack, while lagged inflation and local labour market dynamics are more influential for determining core services inflation.

A natural question is whether the pandemic and its aftershocks have fundamentally altered the position and slope of the Phillips curve or altered the coefficients of structural drivers. We think the best evidence points to economies moving along the Phillips Curve into a previously unobserved, steeper section in which consumer price and wage inflation becomes much more sensitive to domestic and international slack.

This is good news in the sense that it reduces the sacrifice ratio required to bring inflation back down to levels consistent with central bank inflation targets. But there is no room for complacency, particularly when expectations are more likely to re-adjust higher and cause the Phillips curve to shift up, the longer economies are allowed to remain in a state of excess demand and inflation above targets. That in turn would increase the welfare costs of lowering inflation in the future.

This brings us back to some lessons gleaned from history and the importance of central bank credibility in helping to stabilise expectations and in turn inflation itself. There are three necessary and sufficient conditions that must be met to move to a permanently higher inflation regime: 1) a sustained period of excess demand; 2) inflation expectations becoming unanchored; and 3) monetary policy response accommodating the demand and expectations shock.

While criterion (1) has been met, (2) has not, and will not unless central banks lose their nerve or lose their independence, violating criterion (3). And while structural drivers provide the backdrop for the long run, the near-term macro policy mix will play a much stronger role in determining the path for inflation over the coming decade.

Table 2 Headline Inflation – Full sample 1996Q1 to 2019Q4

	World 1996Q1 to 2019Q4					DM 1996Q1 to 2019Q4					EM 1996Q1 to 2019Q4				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Domestic only	Domestic + oil prices	Global	Global + Real exchange rate	Global + Domestic slack * Import share	Domestic only	Domestic + oil prices	Global	Global + Real exchange rate	Global + Domestic slack * Import share	Domestic only	Domestic + oil prices	Global	Global + Real exchange rate	Global + Domestic slack * Import share
Inflation	0.28	0.28	0.27	0.27	0.14	0.21	0.21	0.19	0.21	0.31	0.27	0.27	0.26	0.26	0.14
Expectations	(0.01)**	(0.01)**	(0.01)**	(0.01)**	(0.02)**	-0.11	(0.11)*	-0.11	(0.11)*	(0.10)**	(0.02)**	(0.02)**	(0.02)**	(0.02)**	(0.04)**
	[18.75]**	[19.24]**	[19.38]**	[19.38]**	[5.87]**	[1.85]	[1.99]*	[1.79]	[1.99]*	[2.94]**	[12.76]**	[13.08]**	[13.18]**	[13.19]**	[3.88]**
Inflation lagged	0.56	0.56	0.56	0.57	0.55	0.39	0.42	0.42	0.41	0.44	0.56	0.56	0.57	0.57	0.56
1 year	(0.01)**	(0.01)**	(0.01)**	(0.01)**	(0.01)**	(0.03)**	(0.03)**	(0.03)**	(0.03)**	(0.03)**	(0.02)**	(0.02)**	(0.02)**	(0.02)**	(0.02)**
	[45.95]**	[46.81]**	[47.56]**	[47.66]**	[45.33]**	[13.52]**	[15.65]**	[16.05]**	[15.49]**	[16.61]**	[31.80]**	[32.25]**	[32.01]**	[32.06]**	[30.17]**
Domestic	-0.15	-0.14	-0.12	-0.12	-0.23	-0.15	-0.13	-0.12	-0.13	-0.21	-0.18	-0.19	-0.19	-0.19	-0.31
Slack	(0.02)**	(0.02)**	(0.02)**	(0.02)**	(0.05)**	(0.01)**	(0.01)**	(0.01)**	(0.01)**	(0.03)**	(0.04)**	(0.04)**	(0.04)**	(0.04)**	(0.08)**
	[-6.76]**	[-6.75]**	[-5.27]**	[-5.24]**	[-4.97]**	[-10.98]**	[-10.59]**	[-8.24]**	[-8.62]**	[-7.40]**	[-4.17]**	[-4.42]**	[-4.33]**	[-4.31]**	[-3.61]**
Real Oil price															
(lag 1q)		0.04	0.02	0.02	0.02		0.03	0.03	0.03	0.03		0.06	0	0	0
		(0.00)**	(0.00)**	(0.00)**	(0.00)**		(0.00)**	(0.00)**	(0.00)**	(0.00)**		(0.01)**	(0.01)	(0.01)	(0.01)
		[11.85]**	[4.28]**	[4.28]**	[4.19]**		[18.94]**	[14.92]**	[15.10]**	[14.99]**		[7.12]**	[0.28]	[0.28]	[0.04]
			-0.12	-0.12	-0.13			-0.03	-0.03	-0.07			-0.22	-0.23	-0.21
Glopbal slack			-0.07	-0.07	-0.07			-0.04	-0.04	(0.03)*			-0.13	-0.13	-0.14
			[-1.79]	[-1.82]	[-1.92]			[-0.89]	[-0.72]	[-2.15]*			[-1.68]	[-1.70]	[-1.48]
Real non fuel			0.16	0.16	0.16			0.04	0.03	0.04			0.27	0.27	0.27
commodities			(0.01)**	(0.01)**	(0.01)**			(0.01)**	(0.01)**	(0.01)**			(0.02)**	(0.02)**	(0.02)**
(lag 1q)			[15.75]**	[15.72]**	[15.88]**			[6.86]**	[6.40]**	[6.86]**			[13.66]**	[13.63]**	[13.73]**
Global value			-0.27	-0.27	-0.28			-0.04	-0.04	-0.01			-0.65	-0.66	-0.68
chain (lag 1q)			(0.09)**	(0.09)**	(0.09)**			-0.04	-0.04	-0.04			(0.21)**	(0.21)**	(0.21)**
			[-3.01]**	[-3.04]**	[-3.17]**			[-0.90]	[-0.99]	[-0.17]			[-3.09]**	[-3.12]**	[-3.24]**
Real exchange				0					-0.01					0	
rate %8q/8q				(0.00)**					(0.00)**					(0.00)*	
				[-3.21]**					[-3.17]**					[-2.21]*	
Constant	0.81	0.69	0.9	0.9	1.24	0.8	0.64	0.7	0.68	0.43	1.38	1.23	1.85	1.85	2.29
	(0.08)**	(0.08)**	(0.10)**	(0.10)**	(0.11)**	(0.23)**	(0.21)**	(0.21)**	(0.21)**	(0.21)*	(0.18)**	(0.18)**	(0.23)**	(0.23)**	(0.25)**
	[9.76]**	[8.33]**	[9.33]**	[9.34]**	[11.36]**	[3.49]**	[3.03]**	[3.29]**	[3.21]**	[2.08]*	[7.59]**	[6.86]**	[7.98]**	[8.00]**	[9.08]**
Observations:	3990	3990	3990	3990	3919	2208	2208	2208	2208	2208	1782	1782	1782	1782	1711
R-squared:	0.68	0.69	0.71	0.71	0.59	0.33	0.43	0.44	0.44	0.44	0.67	0.68	0.71	0.72	0.59
F-statistic:	188.81	194.28	200.15	196.82	115.89	43.3	62.25	58.71	57.32	57.92	162.83	162.36	168.73	163.02	91.39
Prob(F-stat):	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3 Core Inflation – Full sample 1996Q1 to 2019Q4

	World 1996Q1 to 2019Q4				DM 1996Q1 to 2019Q4				EM 1996Q1 to 2019Q4			
	1	2	3	4	5	6	7	8	9	10	11	12
	Domestic only	Domestic + oil prices	Global	Global + Domestic slack * Import share	Domestic only	Domestic + oil prices	Global	Global + Domestic slack * Import share	Domestic only	Domestic + oil prices	Global	Global + Domestic slack * Import share
Inflation Expectations	0.17	0.17	0.17	0.05	0.14	0.13	0.11	0.22	0.16	0.16	0.16	0.04
	(0.01)**	(0.01)**	(0.01)**	(0.01)**	-0.09	-0.09	-0.09	(0.09)*	(0.01)**	(0.01)**	(0.01)**	(0.02)*
	[19.00]**	[19.19]**	[19.13]**	[3.42]**	[1.53]	[1.53]	[1.30]	[2.49]*	[12.72]**	[12.95]**	[12.83]**	[2.04]*
Inflation lagged 1 year	0.76	0.76	0.77	0.77	0.54	0.54	0.55	0.56	0.77	0.77	0.79	0.79
	(0.01)**	(0.01)**	(0.01)**	(0.01)**	(0.02)**	(0.02)**	(0.02)**	(0.02)**	(0.01)**	(0.01)**	(0.01)**	(0.02)**
	[83.51]**	[84.05]**	[82.73]**	[79.13]**	[21.98]**	[22.25]**	[22.07]**	[22.94]**	[58.45]**	[58.99]**	[54.98]**	[52.38]**
Domestic Slack	-0.09	-0.09	-0.07	-0.13	-0.11	-0.11	-0.11	-0.18	-0.12	-0.12	-0.09	-0.14
	(0.01)**	(0.01)**	(0.01)**	(0.03)**	(0.01)**	(0.01)**	(0.01)**	(0.02)**	(0.02)**	(0.02)**	(0.03)**	(0.05)**
	[-7.66]**	[-7.62]**	[-5.23]**	[-4.97]**	[-10.98]**	[-10.74]**	[-8.54]**	[-7.29]**	[-4.78]**	[-4.98]**	[-3.38]**	[-2.98]**
Real Oil price (lag 1q)		0.01	0.00	0		0.01	0	0		0.02	0.01	0.01
		(0.00)**	(0.00)*	(0.00)*		(0.00)**	(0.00)*	(0.00)*		(0.00)**	0	0
		[6.76]**	[2.23]*	[2.11]*		[4.32]**	[2.08]*	[2.19]*		[5.38]**	[1.38]	[1.18]
Global slack			-0.11	-0.11			0	-0.04			-0.21	-0.19
			(0.04)**	(0.04)**			-0.03	-0.03			(0.08)**	(0.08)*
			[-2.83]**	[-3.05]**			[0.02]	[-1.52]			[-2.62]**	[-2.39]*
Real non fuel commodities (lag 1q)			0.06	0.06			0.02	0.02			0.1	0.1
			(0.01)**	(0.01)**			(0.00)**	(0.00)**			(0.01)**	(0.01)**
			[9.92]**	[10.36]**			[4.84]**	[4.87]**			[8.12]**	[8.49]**
Global value chain (lag 1q)			0.07	0.06			-0.04	0			0.2	0.16
			-0.05	-0.05			-0.03	-0.03			-0.14	-0.13
			[1.36]	[1.10]			[-1.03]	[-0.10]			[1.46]	[1.22]
Real exchange rate %8q/8q												
Constant	0.2	0.16	0.17	0.44	0.57	0.54	0.59	0.34	0.3	0.24	0.21	0.57
	(0.05)**	(0.05)**	(0.06)**	(0.06)**	(0.17)**	(0.17)**	(0.18)**	(0.17)*	(0.10)**	(0.10)*	-0.15	(0.15)**
	[4.34]**	[3.46]**	[3.03]**	[7.36]**	[3.28]**	[3.14]**	[3.34]**	[1.98]*	[2.96]**	[2.39]*	[1.38]	[3.70]**
Observations:	3770	3770	3770	3708	2208	2208	2208	2208	1562	1562	1562	1500
R-squared:	0.88	0.88	0.88	0.81	0.48	0.49	0.49	0.49	0.89	0.89	0.9	0.82
F-statistic:	618.82	613.35	593.49	323.87	80.89	79.13	72.47	71.18	585.41	570.25	527.59	273.97
Prob(F-stat):	0	0	0	0	0	0	0	0	0	0	0	0

Table 4 Headline and core Inflation for different periods

	Headline Inflation				Core Inflation			
	1996Q1 to 2008Q4		2009Q1 to 2019Q4		1996Q1 to 2008Q4		2009Q1 to 2019Q4	
	DM	EM	DM	EM	DM	EM	DM	EM
Inflation Expectations	0.27	0.24	0.72	0.64	0.03	0.15	0.42	0.57
	[0.16]	[0.03]**	[0.21]**	[0.13]**	[0.13]	[0.02]**	[0.18]*	[0.11]**
	[1.75]	[9.18]**	[3.48]**	[4.92]**	[0.26]	[9.20]**	[2.39]*	[5.22]**
Inflation lagged 1 year	0.41	0.54	0.45	0.35	0.64	0.8	0.35	0.36
	[0.04]**	[0.03]**	[0.03]**	[0.05]**	[0.04]**	[0.02]**	[0.04]**	[0.04]**
	[9.20]**	[21.14]**	[13.23]**	[7.82]**	[17.60]**	[36.94]**	[9.25]**	[7.99]**
Domestic Slack	-0.17	-0.25	-0.04	-0.1	-0.15	-0.13	-0.07	-0.15
	[0.03]**	[0.08]**	[0.02]*	[0.04]**	[0.02]**	[0.06]*	[0.02]**	[0.03]**
	[-5.68]**	[-3.25]**	[-2.14]*	[-2.72]**	[-6.21]**	[-2.33]*	[-4.01]**	[-4.99]**
Real Oil price (lag 1q)	0.03	-0.01	0.03	0.02	0.01	0.02	0	-0.01
	[0.00]**	[0.01]	[0.00]**	[0.01]**	[0.00]*	[0.01]*	[0.00]	[0.00]
	[10.42]**	[-0.40]	[10.55]**	[4.02]**	[2.49]*	[2.19]*	[0.08]	[-1.14]
Global slack	-0.44	-1	0.2	-0.04	-0.08	-0.48	0.04	-0.29
	[0.08]**	[0.40]*	[0.05]**	[0.10]	[0.07]	[0.24]	[0.04]	[0.08]**
	[-5.44]**	[-2.50]*	[3.99]**	[-0.44]	[-1.23]	[-1.96]	[1.02]	[-3.57]**
Real non fuel commodities (lag 1q)	0.03	0.41	0.02	0.09	0.02	0.14	0.02	0.07
	[0.01]**	[0.03]**	[0.01]**	[0.01]**	[0.01]**	[0.02]**	[0.01]**	[0.01]**
	[4.34]**	[12.02]**	[2.88]**	[6.08]**	[3.26]**	[6.53]**	[3.42]**	[5.84]**
Global value chain (lag 1q)	-0.17	-1.54	-0.61	0.07	-0.13	-0.21	0.09	0.67
	[0.07]*	[0.36]**	[0.14]**	[0.29]	[0.05]*	[0.26]	[0.12]	[0.23]**
	[-2.53]*	[-4.31]**	[-4.27]**	[0.26]	[-2.38]*	[-0.84]	[0.75]	[2.91]**
Constant	0.48	2.06	-0.24	0.2	0.53	0.01	-0.01	-0.01
	[0.32]	[0.35]**	[0.44]	[0.49]	[0.26]*	[0.23]	[0.38]	[0.39]
	[1.48]	[5.93]**	[-0.56]	[0.41]	[2.02]*	[0.04]	[-0.02]	[-0.02]
Observations:	1196	902	1012	880	1196	727	1012	835
R-squared:	0.43	0.73	0.45	0.53	0.53	0.91	0.41	0.62
F-statistic:	30.17	91.03	27.63	36.92	45.99	305.1	23.07	52.86
Prob(F-stat):	0	0	0	0		0	0	0

Table 5 – Demographics – Headline and Core by region 1996 – 2019

	Headline Global	Headline DM	Headline EM	Core Global	Core DM	Core EM
Inflation Expectations	0.27	0.20	0.26	0.16	0.13	0.15
	(0.01)**	(0.11)	(0.02)**	(0.01)**	(0.09)	(0.01)**
	[21.61]**	[1.86]	[14.78]**	[18.34]**	[1.44]	[12.32]**
Inflation lagged 1 year	0.57	0.42	0.56	0.78	0.54	0.79
	(0.01)**	(0.03)**	(0.02)**	(0.01)**	(0.03)**	(0.01)**
	[50.78]**	[15.43]**	[33.75]**	[81.61]**	[20.96]**	[54.15]**
Domestic Slack	-0.08	-0.12	-0.13	-0.08	-0.11	-0.11
	(0.02)**	(0.02)**	(0.04)**	(0.01)**	(0.01)**	(0.03)**
	[-3.90]**	[-8.23]**	[-3.07]**	[-5.63]**	[-8.59]**	[-3.85]**
Real Oil price (lag 1q)	0.03	0.03	0.02	0.01	0.00	0.01
	(0.00)**	(0.00)**	(0.01)*	(0.00)*	(0.00)*	(0.01)
	[7.13]**	[14.68]**	[2.31]*	[2.49]*	[2.50]*	[1.38]
Global slack	-0.17	-0.03	-0.27	-0.10	0.01	-0.18
	(0.06)**	(0.04)	(0.12)*	(0.04)**	(0.03)	(0.08)*
	[-2.90]**	[-0.70]	[-2.27]*	[-2.62]**	[0.24]	[-2.25]*
Real non fuel commodities (lag 1q)	0.09	0.04	0.15	0.06	0.02	0.10
	(0.01)**	(0.01)**	(0.02)**	(0.01)**	(0.00)**	(0.01)**
	[10.08]**	[6.83]**	[7.95]**	[9.81]**	[4.81]**	[7.92]**
Global value chain (lag 1q)	-0.19	-0.03	-0.60	0.01	-0.04	0.03
	(0.09)*	(0.04)	(0.22)**	(0.06)	(0.04)	(0.16)
	[-2.14]*	[-0.62]	[-2.68]**	[0.11]	[-1.01]	[0.16]
5 year growth in 65 plus cohort	53.74	21.56	19.11	56.10	22.21	48.76
	(32.35)	(18.85)	(68.90)	(20.97)**	(15.56)	(45.01)
	[1.66]	[1.14]	[0.28]	[2.68]**	[1.43]	[1.08]
5 year growth in youth cohort	-69.10	-67.41	-26.18	-5.44	-53.10	14.51
	(24.52)**	(20.22)**	(42.73)	(17.19)	(16.85)**	(30.91)
	[-2.82]**	[-3.33]**	[-0.61]	[-0.32]	[-3.15]**	[0.47]
Labour ratio	-2.07	-0.81	-3.46	-1.10	-0.56	-2.62
	(0.95)*	(0.55)	(1.97)	(0.63)	(0.46)	(1.35)
	[-2.19]*	[-1.48]	[-1.75]	[-1.75]	[-1.23]	[-1.94]
Constant	1.91	1.06	4.01	0.76	0.81	2.02
	(0.61)**	(0.41)*	(1.35)**	(0.41)	(0.34)*	(0.95)*
	[3.13]**	[2.58]*	[2.96]**	[1.88]	[2.37]*	[2.13]*
Observations:	3823	2112	1711	3640	2112	1528
R-squared:	0.76	0.43	0.76	0.89	0.48	0.90
F-statistic:	238.62	50.96	186.56	565.11	62.73	478.11

Table 6 Technology, migration and capital flows 1996 to 2019

	Global		DM		EM	
	Core	**Headline**	**Core**	**Headline**	**Core**	**Headline**
Inflation expectations	0.08	0.15	0.02	0.1	0.07	0.15
	(0.01)**	(0.02)**	-0.1	-0.12	(0.02)**	(0.03)**
	[7.07]**	[8.05]**	[0.20]	[0.82]	[4.59]**	[5.45]**
Inflation lagged 1 year	0.77	0.54	0.51	0.39	0.79	0.54
	(0.01)**	(0.01)**	(0.03)**	(0.03)**	(0.01)**	(0.02)**
	[77.78]**	[43.06]**	[18.88]**	[13.69]**	[53.33]**	[29.18]**
Domestic slack	-0.08	-0.13	-0.12	-0.14	-0.1	-0.22
	(0.01)**	(0.02)**	(0.01)**	(0.02)**	(0.03)**	(0.05)**
	[-5.78]**	[-5.32]**	[-8.94]**	[-8.52]**	[-3.70]**	[-4.47]**
Real oil price lagged 1 quarter	0	0.01	0	0.02	0	-0.01
	0	(0.00)*	0	(0.00)**	0	-0.01
	[0.95]	[2.47]*	[0.68]	[12.07]**	[0.84]	[-0.67]
Global slack	-0.05	-0.11	0.05	0.05	-0.13	-0.26
	-0.05	-0.08	-0.04	-0.04	-0.09	-0.16
	[-1.01]	[-1.33]	[1.33]	[1.14]	[-1.36]	[-1.56]
Real non-fuel commodities lag 1 q	0.06	0.17	0.03	0.04	0.1	0.28
	(0.01)**	(0.01)**	(0.00)**	(0.01)**	(0.01)**	(0.02)**
	[10.43]**	[15.72]**	[5.58]**	[7.08]**	[8.29]**	[13.50]**
Global value chain lag 1 q	-0.02	-0.52	-0.1	-0.25	0.13	-1.08
	-0.08	(0.14)**	(0.05)*	(0.06)**	-0.18	(0.31)**
	[-0.22]	[-3.85]**	[-2.00]*	[-3.89]**	[0.73]	[-3.51]**
Capital flows 1y change	0.31	-0.96	0.11	-0.29	0.63	-2.12
	-0.29	-0.53	-0.21	-0.26	-0.63	-1.12
	[1.06]	[-1.81]	[0.50]	[-1.12]	[0.99]	[-1.90]
Technology 1y change	2.75	4.17	2.6	7.08	2.28	4.75
	-1.73	-3.14	(1.24)*	(1.56)**	-3.66	-6.47
	[1.59]	[1.33]	[2.09]*	[4.54]**	[0.62]	[0.73]
Migration flow 1y change	0.5	1.03	0.29	0.95	0.65	1.25
	-0.39	-0.73	-0.29	(0.36)**	-0.81	-1.49
	[1.26]	[1.42]	[1.01]	[2.64]**	[0.80]	[0.84]
Constant	0.06	1.01	0.56	0.26	0.12	2.22
	-0.17	(0.31)**	(0.23)*	-0.28	-0.36	(0.63)**
	[0.35]	[3.30]**	[2.45]*	[0.92]	[0.35]	[3.53]**
Observations:	3514	3711	2024	2024	1490	1687
R-squared:	0.84	0.62	0.5	0.45	0.85	0.62
F-statistic:	344.77	114.67	63.27	50.36	293.91	92.19

Table7 Core Goods and Services – developed markets - for different periods

	1998Q1 2019Q4		1998Q1 2008Q4		2009Q1 2019Q4	
	Core Goods	**Core services**	**Core Goods**	**Core services**	**Core Goods**	**Core services**
Inflation expectations	-0.23	0.39	-0.88	0.06	1.53	0.83
	-0.2	(0.13)**	(0.29)**	-0.17	(0.37)**	(0.26)**
	[-1.14]	[3.03]**	[-3.00]**	[0.36]	[4.18]**	[3.24]**
Inflation lagged 1 year	0.77	0.47	0.88	0.54	0.84	0.36
	(0.05)**	(0.03)**	(0.09)**	(0.05)**	(0.06)**	(0.04)**
	[16.66]**	[16.35]**	[10.13]**	[10.98]**	[13.45]**	[8.33]**
Domestic slack	-0.09	-0.09	-0.25	-0.1	0.06	-0.05
	(0.03)**	(0.02)**	(0.06)**	(0.03)**	-0.04	-0.03
	[-3.28]**	[-5.28]**	[-4.47]**	[-3.18]**	[1.67]	[-1.85]
Real oil price lagged 1 quarter	0	0	0	0	0	0.01
	0	0	0	0	-0.01	0
	[-0.98]	[1.66]	[-0.84]	[1.09]	[0.98]	[1.49]
Global slack	0.22	0.01	-0.16	-0.3	-0.41	0.29
	(0.07)**	-0.05	-0.23	(0.13)*	(0.17)*	(0.12)*
	[2.99]**	[0.24]	[-0.67]	[-2.27]*	[-2.42]*	[2.45]*
Real non-fuel commodities lag 1 q	0.03	0.01	0.06	0.02	0.02	0.01
	(0.01)**	(0.01)*	(0.01)**	(0.01)*	-0.01	-0.01
	[3.57]**	[2.41]*	[4.25]**	[2.43]*	[1.65]	[0.64]
Global value chain lag 1 q	-0.15	-0.2	-0.83	-0.06	0.34	0.14
	-0.11	(0.07)**	(0.20)**	-0.11	-0.28	-0.2
	[-1.35]	[-2.89]**	[-4.20]**	[-0.51]	[1.19]	[0.68]
Capital flows 1y change	-0.44	0.19	-0.25	0.49	-2.07	1.62
	-0.44	-0.28	-0.64	-0.36	(0.93)*	(0.66)*
	[-0.99]	[0.67]	[-0.39]	[1.35]	[-2.23]*	[2.46]*
Technology 1y change	-2.34	-4.91	-16.02	-3.43	-15.05	-5.68
	-2.64	(1.66)**	-9.33	-5.26	(3.60)**	(2.56)*
	[-0.89]	[-2.95]**	[-1.72]	[-0.65]	[-4.18]**	[-2.22]*
Migration flow 1y change	-0.96	0.28	5.89	-4.52	-1.19	-0.5
	-0.61	-0.38	-3.58	(2.02)*	-0.69	-0.49
	[-1.59]	[0.73]	[1.64]	[-2.24]*	[-1.73]	[-1.04]
Constant	-0.37	1.33	0.72	2.19	-2.23	-0.12
	-0.48	(0.30)**	-0.89	(0.50)**	(0.84)**	-0.58
	[-0.77]	[4.41]**	[0.81]	[4.35]**	[-2.67]**	[-0.21]
Observations:	1751	1672	871	836	880	836
R-squared:	0.34	0.44	0.43	0.56	0.37	0.29
F-statistic:	30.93	46.42	21.46	36.11	16.98	11.83

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