The inflation conundrum in advanced economies and a way out

(Based on remarks at the University of Basel, May 5 2019)

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1. Introduction

On 17 February 2005, a puzzle for macroeconomists was dubbed a "conundrum" by the then Federal Reserve Chairman Alan Greenspan, who was testifying before the Senate Committee on Banking, Housing, and Urban Affairs. After a 150-basis point increase in the federal funds rate, US long-term rates were actually trending lower. According to conventional wisdom and experience, hikes in the short-term policy rate had to be followed by similar movements in longer-term rates. What was going on then?

Over the last 15 years, the macroeconomic situation in advanced economies (AEs) has changed substantially. First there was the Global Financial Crisis (GFC), which prompted a revision of the mainstream consensus on monetary policy (Blanchard et al (2010, 2013)). Second, the set of very accommodative monetary policies put in place to mitigate the GFC has resulted for many AEs in low or rapidly decreasing headline unemployment rates. According again to conventional wisdom and past experience, this should have triggered demands for higher wages and eventually more inflation. Instead, we are observing an unusual combination of low unemployment with low price inflation. Are we facing a new conundrum in AEs? What is going on now?

If there is indeed a new conundrum, it might have major implications for the conduct of macroeconomic policies. More recently, AEs have experienced an economic deceleration, due largely to the cumulative effect of trade sanctions coupled with policy uncertainty. Eventually, this has affected confidence worldwide. How should stimulus to these weakening economies now be designed? What is the balance of risks that more stimulus poses in terms of inflation and financial stability? Is there a significant risk of a surprise surge in inflation that could trigger a bond yield snapback with severe consequences for financial stability? Is there a way out that takes into consideration the opportunities as well as risks the posed by this new environment?

Answering those questions requires a closer look at the risks of a sudden pickup in inflation. That means analysing wages and thus current labour market developments, as inflation, to be sustained, requires some wage inflation. We do so below in this piece. To refer to our conclusion in advance, the snapback scenario, while possible, does not look like the most likely outcome. On the contrary, based on a careful analysis of AE labour markets, slack may be larger than usually thought. Indeed, unemployment rates can be misleading in gauging the situation

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of the labour market. In other words, low and falling unemployment rates may well have led to an overstatement of the ongoing tightening of the labour market. In other words, the labour market's tightness may be much more limited than headline unemployment figures suggest.

Several medium-term trends on labour markets point in that direction. Among these, some are well known, such as the growing international contestability of local labour markets brought about by globalisation. But some other factors, which may be equally – if not more – important, also deserve a careful analysis. These are, among others, ageing work forces and the lasting effects of the crisis on the mobility of employees as well as changes in the contractual relationship between employers and employees. These trends imply that the equilibrium rate of unemployment has declined and that the participation of seniors in the labour market has been increasing in AEs. In turn, the inflation response to the decline of unemployment has been blurred by these changes in the labour force.

Finally how should macroeconomic policy be conducted in light of these developments? While further monetary policy easing by central banks – likely by means of unconventional tools – would be predicated if inflation remains below its target, this could bring unintended consequences, not least the risk of overburdening monetary policy. In view of such risks, the focus should rather turn to rebalancing the policy mix. This means that the way out requires an exploration of how other non-monetary policies, especially fiscal where there is space, could take a more active role. Moreover, the downward trend in the cost of servicing public debt, a natural consequence of the current depressed environment, calls for a critical reassessment of fiscal space measures. In other words, in a low interest rate environment, expansionary fiscal policies might be preferable on two grounds. First, the room to activate monetary policy is limited. Second, to the extent that low real rates go *pari passu* with a shortage of safe assets, issuing more public debt would raise the equilibrium real rate and the monetary policy space. Additional fiscal space suggests that calls for rebalancing the policy mix might be not only desirable but also, most importantly, possible.

We will therefore address these issues in turn. First we will analyse the risks for inflation, focusing on changes in labour market characteristics. We will then ask whether there would be merit in deploying other policies to stimulate the economy by analysing whether AEs have fiscal space. We end with some suggestions for fostering structural reforms in AEs to strengthen the sustainability of our economies.

2. The risks of the post-GFC monetary policy framework: inflation or no inflation?

The GFC triggered major changes in the pre-crisis monetary policy framework (Bean et al (2010)). On the monetary policy front, facing a subdued macroeconomic environment, the central banks of major AEs have set very accommodative monetary stances with very low interest rates. Moreover, facing limits on conventional monetary policy tools as policy rates were getting closer to their effective lower bound, AE central banks added "unconventional monetary policy" (UMP) instruments to their toolkit. The policy rate could be set at very low levels (the "zero lower bound") for a prolonged period of time. Forward guidance on future rate decisions, together with large asset purchases, pushed down term premia. Asset purchase

programmes, specific communication strategies and negative interest rates may have become part of central banks' standard toolkit.[2]

The UMP framework did succeed in avoiding a new 1930s-style depression but its prolonged period of implementation raised discussions about its effectiveness. In particular inflation has remained subdued in spite of extremely low interest rates and low unemployment. The framework prompted debates – some dating back to the pre-crisis era – about the effect of loose monetary policy on financial stability. Indeed, maintaining low interest rates for long periods of time might encourage excessive risk-taking, posing risks to financial stability, for instance, by giving rise to asset price misalignments. With very low interest rates and very low unemployment, any small surge in inflation, which conventional wisdom would assume likely under "tight" labour market conditions, could trigger a reassessment of market expectations about future inflation and about the appropriateness of the accommodative policy stance, eventually triggering a snapback in long-term interest rates (Shin (2017)). This could prompt an abrupt and temporary tightening in financial conditions, leading to a disorderly unwinding especially if central banks are perceived to have fallen behind the curve. Such a snapback would have consequences for financial stability, since the post-GFC period of low long-term interest rates changed the portfolio composition of large financial sector firms (insurers, pension funds, banks etc), increasing their sensitivity to a yield snapback. An abrupt change in term premiums and higher long-term bond yields could inflict valuation losses, asset sell-offs, a risk-off sentiment and accelerated deleveraging. This sequence of events could affect EMEs in particular, and trigger currency crises.

It is therefore necessary to assess the likelihood of a return of inflation. The risk of an inflation surprise can be assessed, for example, from wage increase pressures. These in turn can be measured by various metrics for slack in the labour market (ie the actual level of unemployment vis-à-vis a measure of a natural rate of unemployment (U*) that does not trigger inflationary pressure. The standard approach is to use estimates of the Phillips curve to estimate how changes in unemployment or changes in the output gap translate into inflation. However, the GFC and changes in policy frameworks have made it increasingly difficult to locate the cyclical position of the economy using traditional gap analysis. Indeed, it has become difficult to compare actual readings with their "neutral" levels for well established macroeconomic parameters such as the "neutral" rate of interest, unemployment (the "NAIRU"[3]) and potential output, as noted by the usual "stars" (r*, U*, Y*).[4] Where are the new post-GFC "neutral" positions? In particular, recent analysis of labour market conditions suggests a higher degree of slack than is reflected in conventional measures of unemployment. Where does the post-

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[2]   EME inflation targeting frameworks have also evolved. In order to smooth FX volatility and manage the large capital flows associated with UMP, many EME central banks have started conducting various types of FX intervention. They are also using macroprudential instruments (MaPs) more intensively and explicitly for financial stability purposes (for EMEs and their IT frameworks, see Agénor and Pereira da Silva (2019)). All in all, the post-GFC era has coincided with the recognition of spillovers and spillbacks of monetary policy given the globalised financial system and the interdependence of AEs and large systemic EMEs.

[3]   NAIRU refers to the non-accelerating inflation rate of unemployment and is the theoretical level of unemployment below which wage demands in a tighter labour market would begin igniting inflationary pressure in the economy. Monetary policy would therefore aim at unemployment not falling below the NAIRU to ensure that inflation stays around a given target.

[4]   See Powell (2018).

GFC policy framework stand after a decade of extraordinary monetary stimulus? Why is inflation subdued while unemployment and interest rates are so low? In the next section, we focus in particular on the labour market.

3. The post-GFC conundrum and changing labour markets

If the post-GFC recovery did not feature the same economic growth rates in AEs as in the exuberant pre-crisis years, the continued reduction in unemployment rates is, at least at first sight, impressive. In the United States, the unemployment rate has fallen from 10% of the labour force to less than 4% today. In the euro area, the rate fell from 12% to 8%. At the same time, in the absence of significant inflation pressures, 10-year bond yields fell to new lows (Graph 1). In Japan, where the unemployment rate fell below 2.5%, the government even went as far as introducing tax breaks for firms that increased workers' salaries beyond a given threshold. Even so, wage inflation has been at best moderate, although the number of vacancies exceeds the number of job applicants.

If the higher credibility of central bank inflation-fighting has led to firmer anchoring of inflation expectations, structural changes in labour markets have also put a lid on the traditional bottleneck whereby lower unemployment rates push wages up. One important change has to do with the ageing of the work force. Graph 2 shows that the share of the work force aged 55+ has been on a steady rise, doubling since the turn of the millennium, in both the United States and the euro area. In Japan, no less than 4 million people aged above 65 have returned to work between 2003 and 2018. This is an important development for two reasons. First, because older workers tend to quit their work less than younger workers do. This in and of itself may reduce the equilibrium rate of unemployment (Crump et al (2018)). Such workers may also put a higher premium on non-wage benefits, such as those related to corporate pension packages and therefore reduce their pressure for higher wages. The Bank of Japan has showed, for instance, that the labour supply of older workers is more elastic to wages. As a result, for a given increase in labour demand from employers, we would observe a larger shift of the labour force and a lower change in wages. In other words, the Phillips curve would appear flatter. Taking a cross-country perspective, Mojon and Ragot (2019) show that, over the last two decades, the higher participation of workers aged 55 to 64 has pushed down wage inflation in OECD countries.

Unemployment and interest rates in the United States and the euro area

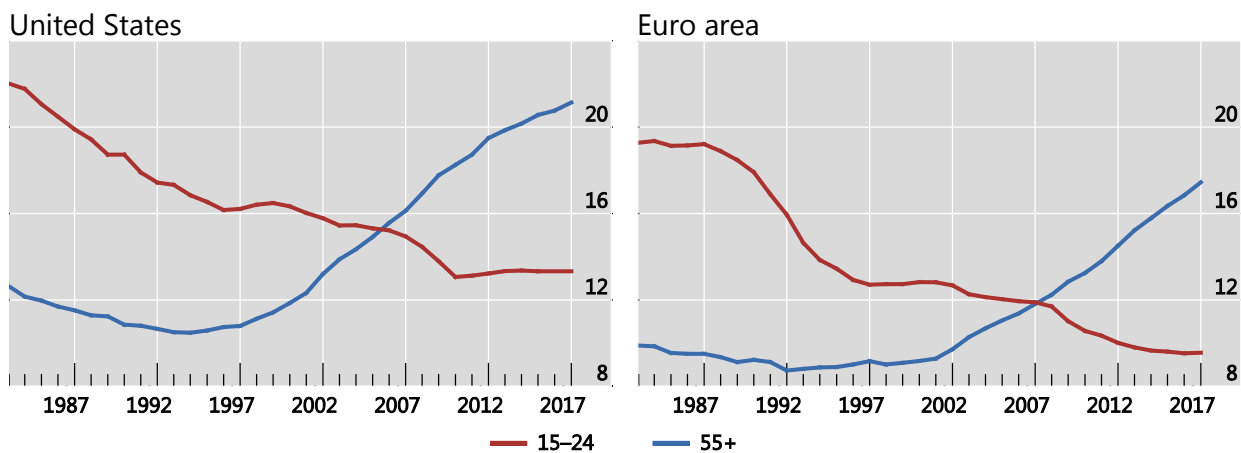In per cent   Graph 1

United States

Euro area
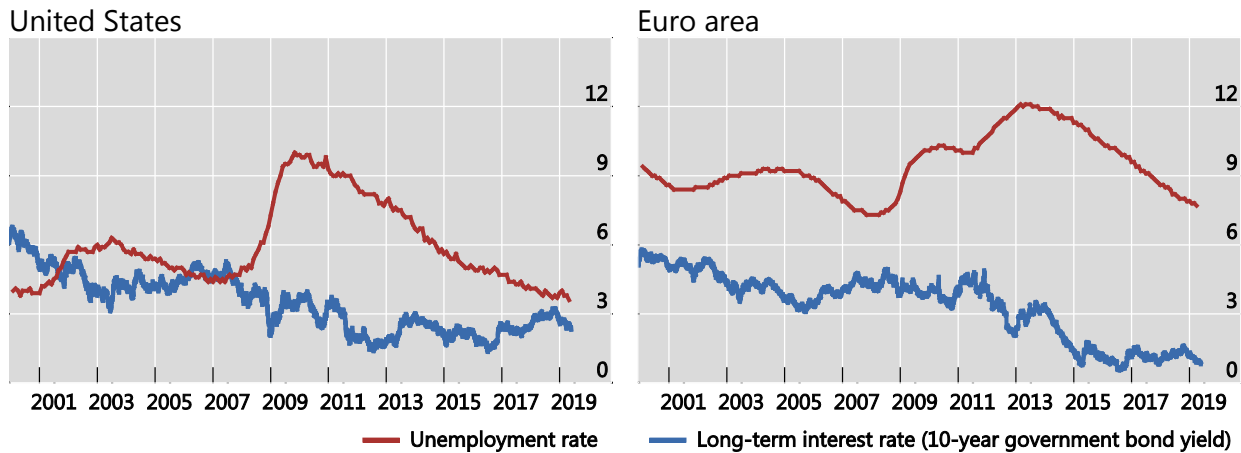
Sources: Bloomberg; Datastream; national data.

Employment by age cohort

As percentage of total employment   Graph 2

United States

Euro area

Source: Mojon and Ragot (2019).

Recent studies (OECD (2015a, 2015b), Brown and Guttman (2017)) show this ageing of the workforce is most likely the side effect of pension reforms conducted in AEs in the last decades. Such reforms, which improved the solvency of many pension schemes, also reduce the take-out pension for seniors. Faced by an increasing cost of living for incompressible items such as rents, insurance etc, these seniors have been returning to the work force and, despite their age, might still be more employable in semi-skilled or low-skilled jobs than the 15–24 year-old

cohort. Recent social unrest in some AEs (ie the surge in populism in some countries) have also been associated to this type of explanation.[5]

An important and somewhat overlooked effect of work force ageing is the implied decline in U*, the equilibrium rate of unemployment. As employed work forces have been ageing, the inflow rate into unemployment, ie the number of jobs destroyed as a share of the total number of jobs, has been trending down. This stands in contrast to the flow of workers out of unemployment, which remains highly cyclical. Taken together, these two evolutions imply a declining path for the equilibrium rate of unemployment (Graph 3, left-hand panel and Crump et al (2019)).

Another key force that can help explain wage moderation has been that of globalisation, which increases competition between local and foreign labour and changes the bargaining power of workers. At the same time, workers face increasing competition from automation and digitalisation. In addition, the "Uberisation"[6] of the labour market changes long-held institutional setups for wage bargaining in fundamental ways. It may also lead to a reduction of labour market frictions and thus further reduce equilibrium unemployment (U*). These trends were also reinforced by structural labour market reforms that led to a higher proportion of temporary workers. Indeed, in the euro area, 45% of young-age work contracts are now temporary (Graph 3, right-hand panel). Finally, the crisis itself, with a sharp increase in unemployment in the United States and the periphery of the euro area, may have left persistent scars on the functioning of the labour market. The aversion of workers to unemployment risk may have increased as a result.

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[5] Those movements are naturally also the result of the stagnation of disposable income during the GFC even after significant levels of social transfers.

[6] By "Uberisation", we mean the usage of digital technologies in an increasingly higher number of businesses organisations such as Uber, Grab, Lyft and Airbnb etc. More broadly, this changes the employer-employee relationship by eliminating semi-skilled jobs, since digitalised platforms enable peer-to-peer, or quasi-peer-to-peer transactions.
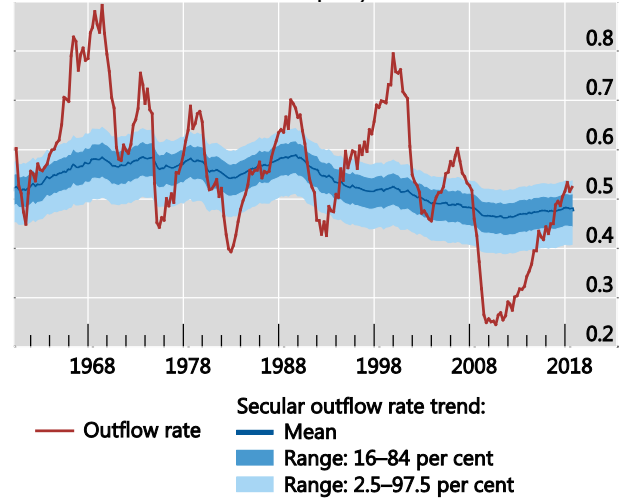
Declining inflows into unemployment...   Graph 3
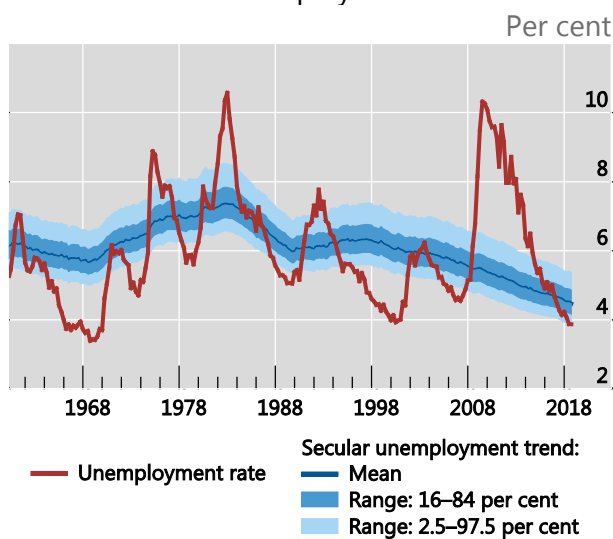
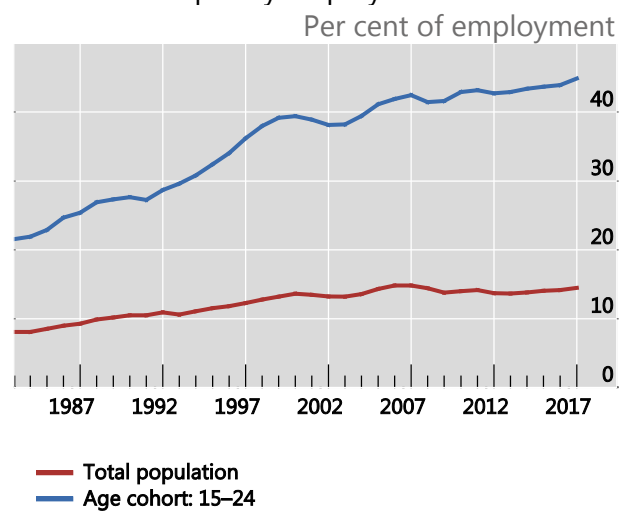### Inflow rate into unemployment
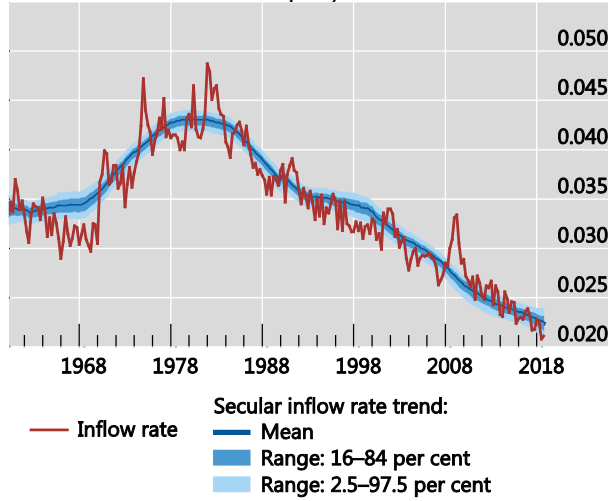
Outflow rate into unemployment

Source: Crump et al (2019).

Declining u*, but rising temporary contracts...

Secular trend of unemployment

Per cent

Euro area temporary employment

Per cent of employment

Sources: Crump et al (2019); OECD.

The above developments would seem to imply that the steady decline in recorded unemployment rates since the GFC does not translate into a proportional change in labour market tightness. As a consequence, wage demands have been much more muted than what would be suggested by headline unemployment numbers. In other words, simple specifications of the wage Phillips curve, which do not control for above mentioned trends in labour markets, would appear flatter.

One useful statistic that should arguably receive larger attention given the above changes is the rate of "voluntary job quits". Graph 4 shows that, in the case of the United States, this rate

has recovered very slowly after the crisis. For much of the post-crisis period, employees have not seen improved outside offers that would make them quit their existing jobs on a voluntary basis. After a decade with a low voluntary quits rate, the rate has now finally surpassed pre-crisis levels. Workers now appear sufficiently confident to change jobs again in the United States.[7]

Slow healing in US labour markets

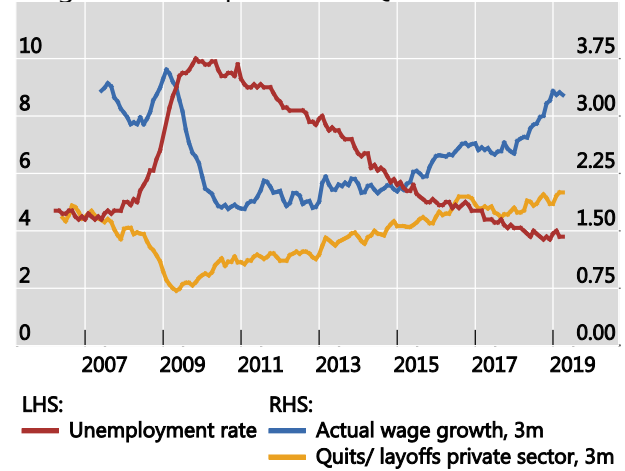In per cent   Graph 4

Voluntary quits rate back to pre-crisis levels
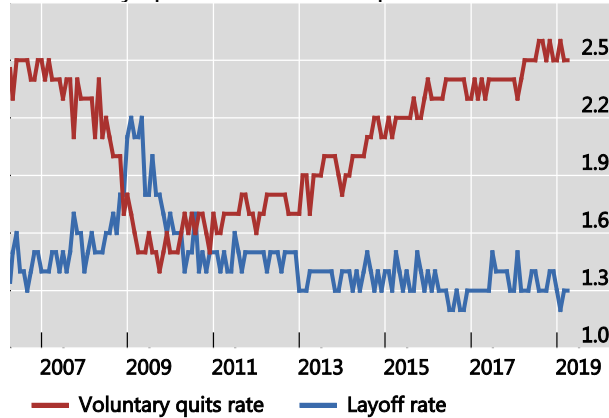
Wages more responsive as Q/L rate rises

Source: JOLTS survey; BLS.

One implication is that, as the voluntary quits to layoffs ratio has increased (yellow line in Graph 4), nominal wage growth has started to gain momentum (blue line) – after a very long period of rather anaemic growth. When employees start moving between jobs on their own, pressure increases for employers to raise the wage of the employees who stay in order to retain their workforce. While it is still early days to call the re-emergence of the wage Phillips curve, the odds for a normalisation of conditions have clearly improved. On that metric, the wage Phillips curve appears to be alive and well.

More careful econometric analysis confirms that wage growth can be predicted in a much more precise way when the unemployment rate is interacted with the quits/layoffs ratio than when using the unemployment rate alone (Table 1, adjusted R2s). Wages rise strongly whenever the unemployment rate is low and the Q/L ratio is high. This is not the case when the voluntary quits rate is low.

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[7]   While there are cyclical reasons for the rise in the Q/L ratio, it is important to note that there may also be structural reasons for its long-term decline – such as the ageing of the workforce.

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Drivers of private sector wage growth

Dependent variable: nominal wage growth, private sector, United States (in logs, times 100)

Table 1

|	(1)	(2)	(3)	(4)	(5)	(6)
Unemployment rate	−0.12***		0.05	−0.10***		0.05
	(7.92)		(0.78)	(6.64)		(0.07)
Q/L ratio		0.19	0.41		0.24***	0.40
		(1.49)	(1.27)		(2.10)	(1.15)
Interaction of unemployment rate * rate and Q/L ratio			−0.32***			−0.31***
			(6.52)			(5.67)
PCE inflation	−0.00	0.02	0.05***	0.18***	0.23*	0.08*
	(0.09)	(0.34)	(1.96)	(4.05)	(4.73)	(1.80)
Productivity growth				0.15***	0.18***	0.02
				(5.17)	(6.55)	(0.85)
Constant	3.16***	2.08***	4.21***	2.70***	1.60***	4.06***
	(30.25)	(8.71)	(7.40)	(20.31)	(8.62)	(6.73)
Observations	135	135	135	134	134	134
Adjusted R2	0.21	0.01	0.61	0.36	0.23	0.61
Log-likelihood	−77.2	−92.9	−28.7	−62.7	−74.5	−28.6

Time span is from March 2006 to April 2018. Robust t-statistics are reported in parentheses. ***/**/* denotes results significant at the 1/5/10% level.

Source: BIS calculations.

US Unemployment rate * Q/L ratio vs. wage growth

In per cent   Graph 5
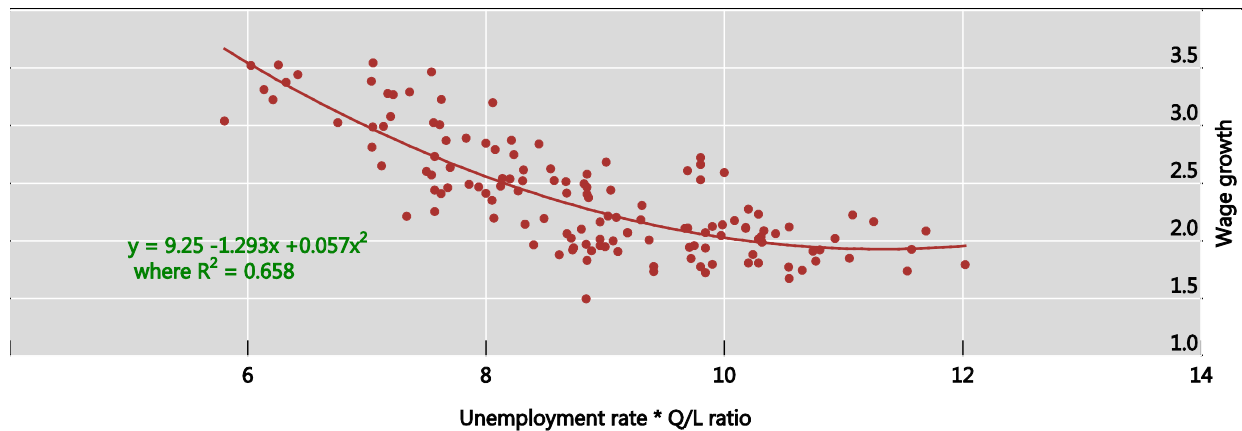
Sources: US JOLTS survey, BLS, BIS computations.

Graph 5 shows the relatively good fit in predicting wage growth when this interaction term is considered. While this phenomenon is very striking in the United States, one may conjecture that it may also play a role in other AEs, in particular given that their workforces are also ageing. As older workers tend to have longer tenures in their jobs than younger ones, the proportion of voluntary quits is most likely trending down.

Thus, when we take into account the changes in labour markets, the low inflation conundrum might not necessarily be a conundrum any longer. The combined lasting effects of the GFC (captured for example by the quits/layoffs ratio) and structural shifts (for example, demography and the rising share of temporary employment) constitute a set of credible explanations for wage moderation. The policy implication is that the assessment of labour market tightness needs to include additional information. It appears that the room for manoeuvre for maintaining or even adding stimulus might be higher than the conventional focus of changes in the unemployment rate. If the economy continues to be weak, this additional policy space is worth exploring, regardless of all other efforts to boost productivity and implement the structural reforms that will increase long-run growth potential. But how to buffer a weakening of the economy when rates are already at or near historical lows? That is what we address in the next section.

### 4. The post-GFC policy mix and changing fiscal space

The countercyclical policy space during the GFC was occupied first by fiscal policy, which was intensively used in the aftermath of the Lehman failure in 2008–09 (see Graph 6). Subsequently, monetary policy (including UMP, as mentioned above) became the predominant instrument for stimulating the economy in AEs, to the point that it was seen as "the only game in town". The accommodative monetary policy stance in AEs played a major role in the recovery and, given the renewed weaknesses in 2019, in some AEs the maintenance of such a monetary policy stance might be appropriate. But lower rates imply that the zero lower bound should be expected to be hit more frequently than in the past. The use of non-conventional monetary

policy tools may thus become more common. Indeed central bank asset purchase programmes have proven successful in averting deflation and bringing down long-term rates. However, these actions run the risk of eventually falling into an area of diminishing marginal returns in the case of any further action. Indeed, even if central banks were able to significantly reduce further long-term interest rates, it is an open question whether private agents (commercial banks, households and firms) would respond in a significant way to such a stimulus, by increasing credit supply, consumption and investment. In addition, using UMP for a prolonged period of time might also exacerbate risks for financial stability without necessarily adding much to stimulus. The most effective policy mix to stimulate demand after so many years of UMP may need to include other ingredients, especially if monetary policy cannot be materially eased. Therefore, rebalancing the policy mix might be a better way to avoid overburdening monetary policy. In that sense, a re-assessment of the role for fiscal policy is warranted.

General government net lending/borrowing   Graph 6

Percentage of GDP
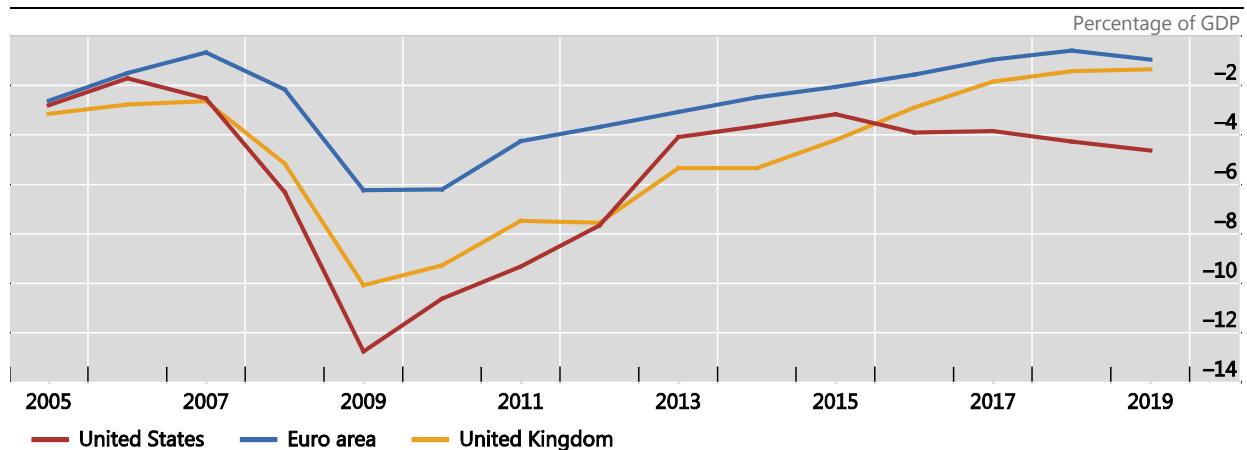
[1] Data for 2019 are estimates.

Source: IMF, *World Economic Outlook*.

Such a re-assessment should look at several factors that determine the sustainability of public debt. These factors are related to the cost of public debt servicing but naturally also to its relative size (vis-à-vis available resources in the economy, say assets and flows such as GDP) and more importantly to its dynamics. Regarding the cost of public debt, low inflationary pressures and reduced potential output, due to ageing and the slowing of productivity in AEs, and an increase in the demand for safe assets, have depressed interest rates on the sovereign debt of AEs. In major economies, real interest rates have declined by 300–400 basis points over the last 20 years (Graph 7, left-hand panel). And so have natural interest rates. Holston et al (2017) show that r* dropped precipitously during the crisis years and remains near zero in both the United States and the euro area, down from 200–300 basis points before the GFC (right-hand panel). Marx et al (2019) show that the combined increase in debt levels and the decline

in interest rates are likely to reflect a growing shortage of safe assets as the risk aversion of global investors has increased.

Such conditions are more favourable to a more active use of fiscal policy in countries whose public debt is in high demand. In August 2019, $17 trillion in public debt carries negative nominal interest rates. The 30-year interest rate on Dutch, German and Swiss bonds is negative and no fewer than 13 OECD countries issue 10-year maturities at negative rates.

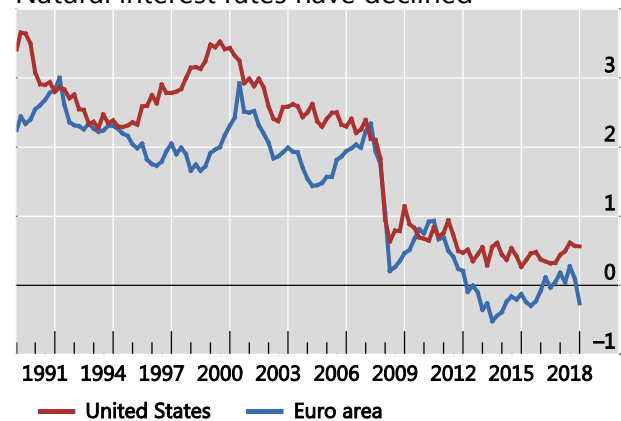Real and natural interest rates has fallen considerably

In per cent   Graph 7

Real interest rates[1]

Natural interest rates have declined

United States   Germany   United Kingdom   United States   Euro area
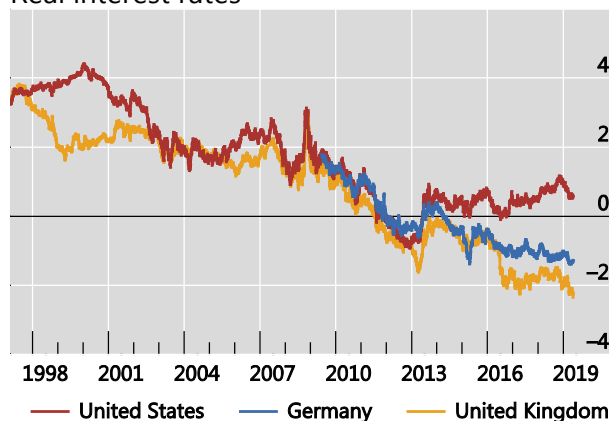
[1] Ten-year inflation index linked bonds.

Sources: Bloomberg; San Francisco Fed.

Regarding the long-term sustainability of public debt, one should consider the relationship of the stock of debt vis-à-vis available resources in the economy (output or GDP) and re-assess their respective dynamics. Currently interest rates are below expected growth rates in most advanced countries. An analysis can be done using the law of motion of the public debt. For example, a lower funding cost for the government simply means that previously accumulated debts will be cheaper to refinance. Put differently, lower government funding costs mean that the primary balance required to stabilise public debt as a ratio of GDP also falls, down to the point where governments could even run primary deficits and keep public debt (as a share of GDP) constant. Unfortunately, the bond market suggests that investors are very pessimistic on the outlook for growth, so much so that they would rather lend to governments than invest
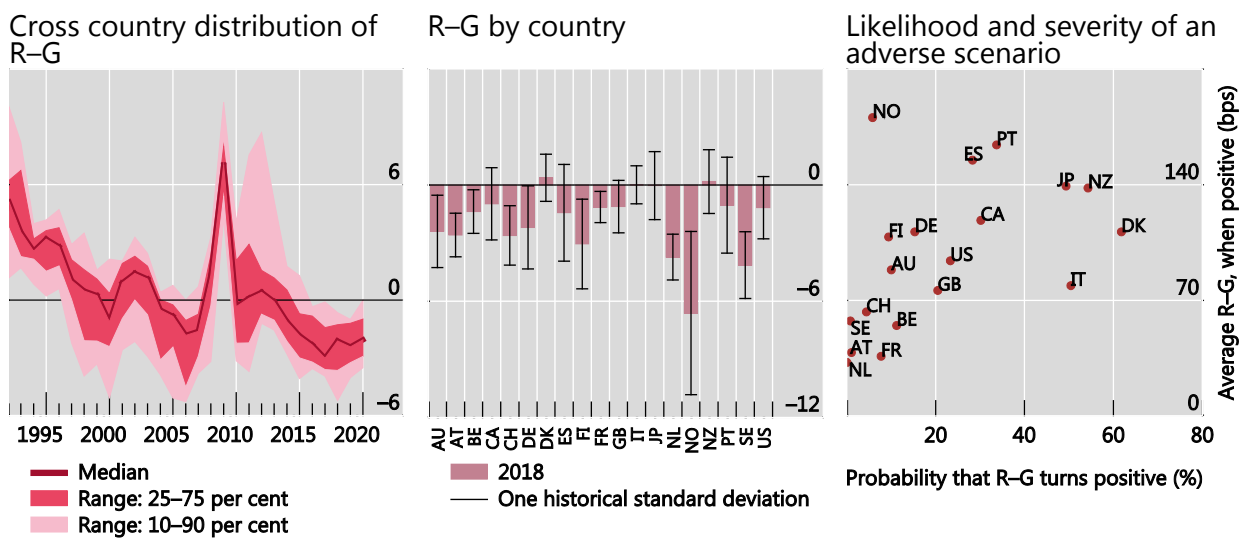
(Marx et al (2019)). And a side effect of these very low real interest rates is to limit the space of monetary policy to stimulate the economy.

In fact, looking at AEs over the last 25 years shows a secular downward trend in government funding costs relative to nominal growth. Graph 8 shows that the difference between government effective funding costs and nominal growth became negative for the median AE around 2013 (left-hand panel) and has since then gone deeper and deeper into negative territory. And, according to the most recent data available (2018), almost all AEs now pay an effective interest cost of debt that is below their nominal GDP growth rate.

Government interest burden has fallen below nominal growth, and snapback risk appears limited.

In percentage points   Graph 8

Cross country distribution of R–G

R–G by country

Likelihood and severity of an adverse scenario

Median
Range: 25–75 per cent
Range: 10–90 per cent

2018
One historical standard deviation

Using current government yields. AU = Australia; AT = Austria; BE = Belgium; CA = Canada; CH = Switzerland; DE = Germany; DK = Denmark; ES = Spain; FI = Finland; FR = France; GB = United Kingdom; IT = Italy; JP = Japan; NL = Netherlands; NO = Norway; NZ = New Zealand; PT = Portugal; SE = Sweden; US = United States.

Sources: OECD, *Economic Outlook*; BIS calculations.

Going forward, the key question for policymakers is how to manage this phase of anxiety on the part of investors. On the one hand, the trust of investors in government debt provides favourable conditions to foster debt management in order to lower the cost of public debt. It is also an opportunity to lock in low interest rates to finance infrastructure and growth enhancing spending in areas such as education and the transition to renewable energies.

On the other hand, cheap debt today could become difficult to refinance tomorrow. How likely it is that interest rates and government funding costs will increase above the economy's nominal growth rate in the near future? To answer this question, one can extract the global and the country-specific components from the difference between government interest costs and nominal growth (see Technical annex). And by doing so, we can check on the basis of historical experience how much the observed gap between government effective interest costs and nominal growth differs on average from the central tendency, ie the sum of the global and the country-specific component.

Evidence in the centre panel of Graph 7 shows that the vast majority of AEs are unlikely to face a situation where government funding costs would actually increase up to the point where they would exceed nominal growth. This is confirmed in the right-hand panel of Graph 7, which shows the precise likelihood that the government interest cost would exceed nominal growth as well as the average interest-growth differential in the case that it turns positive. These simulations suggest that, except for countries such as Denmark, Italy, Japan and New Zealand, the likelihood of an adverse scenario is limited, typically below 35%. And, in addition, an adverse scenario could potentially be more benign than usually foreseen, as government interest costs would exceed nominal growth by only 1 percentage point or less for most countries.

Policymakers in some AEs therefore have space to adopt more countercyclical fiscal policies and take more action to buffer any weakening of economic activity in the short run. Obviously, in countries where changes from the current favourable conditions could put the dynamics of public debt at risk, fiscal prudence should be maintained. In any event, if and when a more aggressive countercyclical fiscal policy is implemented, it should be accompanied by measures that reinforce public debt solvency in the long run, such as structural reforms that contribute to raise potential growth rates.

5.   Concluding remarks: a "way out"?

The departure point of our analysis was an apparent conundrum: low unemployment coexisting with low inflation for a prolonged period of time despite low interest rates. Under closer scrutiny, the transformation of labour markets indicates that they may be much less tight than suggested by the unemployment level. At the same time, the analysis recognised that the continuous and intensive usage of unconventional monetary policies to support demand is at risk of yielding decreasing returns, given the proximity of current interest rates to their effective lower bound. Therefore, a rebalancing of the policy mix towards more fiscal stimulus needs to be considered, especially in an environment of very low interest rates.

What sort of fiscal stimulus? A way out from low growth and low inflation in AEs should not consist solely of additional fiscal spending, period. In the long run, productivity has to increase and that requires thinking of the stimulus in terms of the structure of taxes and the composition of demand. That, in turn, puts the focus on investment rather than consumption. In addition, those investments should spur productivity. They could also be economically and financially attractive in the current low interest rate environment, as suggested by Blanchard (2019) or DeLong and Summers (2012).

When we think along these lines, the investments that would foster productivity in the long run include long-overdue infrastructure spending, in urban projects that improve the quality of life in overpopulated large agglomerations, in projects that provide public goods and/or even that enable to develop a greener economy and address climate change. Obviously, the efforts to address climate change-related challenges are much broader. But there is little doubt that they will limit the collateral effects of climate change on growth, public finance and the financial system (Carney (2015)). They will need support from many other public policies conducted by other actors.

However, we might currently be at a special juncture for considering a link between the needed stimulus through public investment spending and climate change. And it does not need to be investment only in physical capital. It could also be in new skills and human capital. For example, this type of fiscal stimulus, can help to create the necessary new science-technology-engineering-maths or STEM jobs in new green industries, services and infrastructure. These jobs might be able to compensate for the jobs that will most likely be significantly curtailed by technological progress in the new digital economy. And where fiscal space is available, financing the transition to a lower-carbon economy with public debt could build greater social consensus for eventually accepting taxation on carbon.

Some of the changes outlined here are daunting. Technological developments and growing challenges such as climate change will pose additional fundamental questions as to how we think about the role of an effective state. These are complex issues with great technical and political economy difficulties. But given the current state of affairs in the global economy, a dispassionate and thorough discussion on the various policy options to restore growth with financial stability may be necessary to live up to these challenges.

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Technical annex

Let us denote the difference between the government interest burden r_i, and nominal growth g_i, in country i in year t as

$$x_{i,t} = r_{i,t} - g_{i,t}$$

One can then extract the country specific component c_i and the time-specific component d_t and write

$$x_{i,t} = c_i + d_t + \varepsilon_{i,t}$$

Then denoting σ_i the volatility for each country of the residual $\varepsilon_{i,}$, ie

$$\sigma_i^2 = \frac{1}{T} \sum_1^T \varepsilon_{i,t}^2$$

it follows that $x_{i,t}$ follows for country i at time t, a normal distribution of mean $c_i + d_t$ and of variance σ_i^2

$$x_{i,t} \rightarrow N(c_i + d_t; \sigma_i^2)$$

The variable x can hence be written as

$$x_{i,t} = c_i + d_t + \sigma_i y \qquad \text{with} \qquad y \rightarrow N(0; 1)$$

Based on this result, we can compute the probability that x_i, is negative or positive as

$$P(x_{i,t} < 0) = F\left(-\frac{c_i + d_t}{\sigma_i}\right) \text{ and } P(x_{i,t} > 0) = 1 - F\left(-\frac{c_i + d_t}{\sigma_i}\right)$$

where *F(.)* denotes the cumulative function of a normal distribution with zero mean and unit variance. And we can compute the average value of x when x is positive as

$$E(x_{i,t}|x_{i,t} > 0) = c_i + d_t + \sigma_i \frac{f\left(-\frac{c_i + d_t}{\sigma_i}\right)}{1 - F\left(-\frac{c_i + d_t}{\sigma_i}\right)}$$

where *f(.)* denotes the density function of a normal distribution with zero mean and unit variance. Similarly, the average value of x when x is negative writes as

$$E(x_{i,t}|x_{i,t} < 0) = c_i + d_t - \sigma_i \frac{f\left(-\frac{c_i + d_t}{\sigma_i}\right)}{F\left(-\frac{c_i + d_t}{\sigma_i}\right)}$$