Are inflation and real activity out of sync in the euro area ?

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Introduction

Over the past few years, many economies have experienced a combination of strong growth and subdued inflation. This "missing inflation" puzzle has led many to question if the Phillips curve relationship between inflation and economic slack had broken down.

This article analyses the situation in the euro area and poses the question whether it resembles more that in the US, where the expected achievement of the dual mandate has allowed monetary policy to normalise, or the situation in Japan, which suffers from chronic low inflation. To this end, we estimate a Phillips curve model for the euro area, Japan and the US that can take into account the fact that economic relationships have varied over time.

The first chapter of the article illustrates the low level of inflation and the perceived decoupling between inflation and economic growth in the recent period. The second chapter describes the Phillips curve framework that central bankers use to explain inflation. Finally, the third part examines the various explanatory factors for the recent weakness of inflation and draws conclusions in terms of monetary policy.

1. The missing inflation puzzle

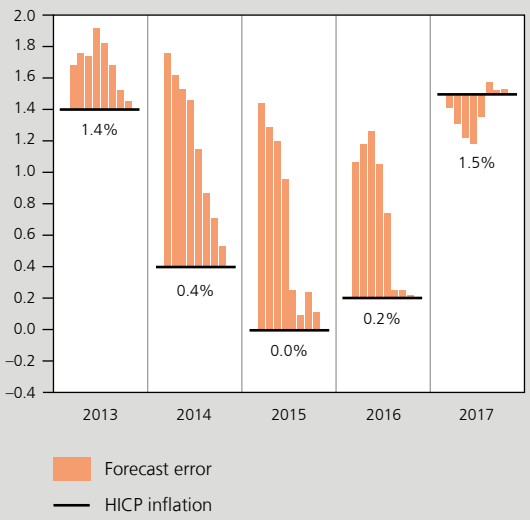
In the context of the economic recovery after the great recession, inflation forecasts for the euro area have turned out to be overly optimistic. In view of the dynamism of real economic variables such as GDP growth and the unemployment rate, nominal variables like wage growth and price increases were widely expected to be more vigorous from 2013 onwards.

In other words, traditional macroeconomic models and expert opinion, which are based on historical relations and various assumptions about the trend in raw material prices and exchange rates for instance, have been proved to be too high by observed inflation levels.

The weakness of inflation and the gap observed between real and nominal economic variables in the recent period is not specific to the euro area. In reality, it affects many advanced economies to varying degrees. Two cases stand out here, those of the United States and Japan.

(*) The authors thank Jef Boeckx and Paul Butzen for their remarks and suggestions.

CHART 1 FORECAST ERROR[1] AND INFLATION IN THE EURO AREA



Sources: ECB (Survey of Professional Forecasters), Eurostat.

(1) Difference between the forecast and average inflation observed respectively 24, 21, 18, 15, 12, 9, 6 and 3 months before the end of the target year. Total HICP inflation.

Protracted low inflation in the euro area

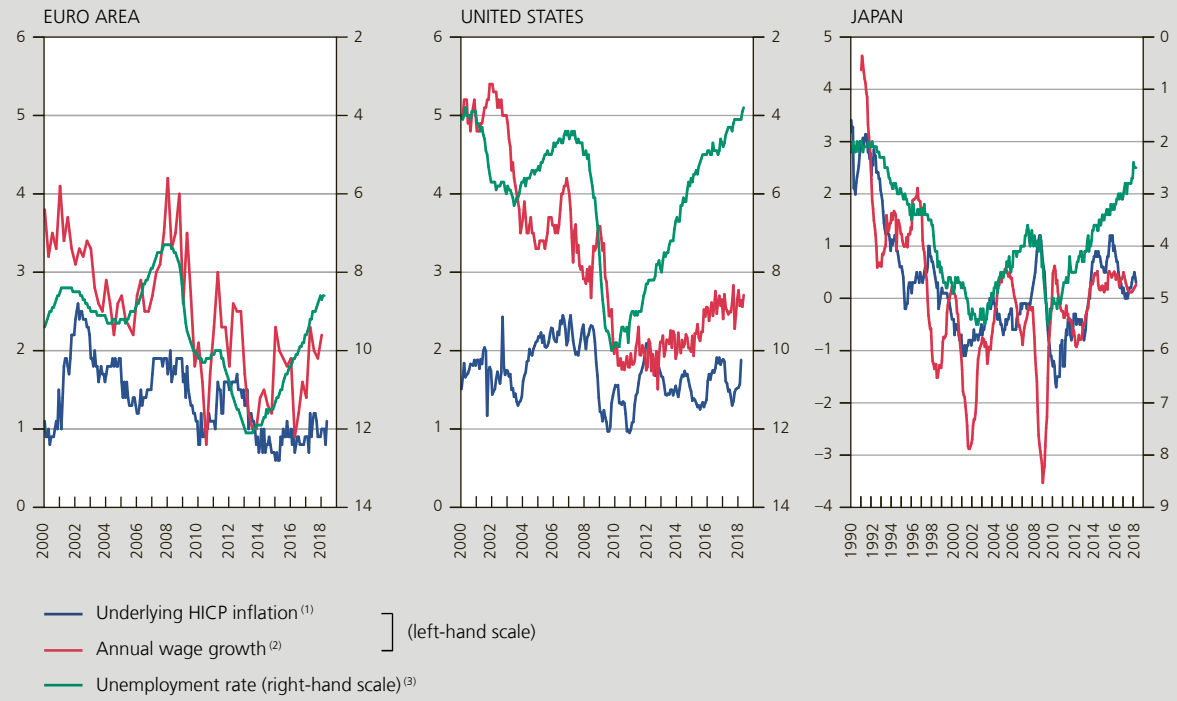
In the euro area, the economic recovery started in 2013, just after the sovereign debt crisis. Although unemployment has gradually ebbed away and economic growth has accelerated steadily since then, the nominal variables have still lagged behind.

Headline inflation has kept a good distance from the ECB Governing Council's target of below, but close to, 2 % in the medium term[1], reaching 0.7 % on average over the last five years. Underlying inflation, which measures the rise in prices excluding the most volatile components – energy and food product prices –, and thus reflects more closely the inflationary trend due to domestic supply and demand conditions, slowed down in the early stages of the recovery, before stabilising around 1 %. And lastly, wage growth has proven to be partially more dynamic, but well below its pre-crisis level.

According to the June 2018 macroeconomic projections compiled by the Eurosystem for the euro area, headline inflation is expected to reach 1.7 % in 2018, 2019 and 2020.

(1) For more information on the ECB's price stability mandate, see Deroose and Stevens (2017, Chapter 1).

CHART 2 DISCREPANCY BETWEEN REAL AND NOMINAL ECONOMIC VARIABLES



Sources: Thomson Reuters Datastream, ECB, Bureau of Labor Statistics (BLS).

(1) HICP for the euro area, CPI for Japan and PCE for the United States. Inflation excluding energy and food prices for the euro area and the United States. Inflation excluding energy and fresh food prices in Japan's case.

(2) Average hourly wages for the euro area and the United States, average monthly wages for Japan. Moving average over 12 months for Japan.

(3) Inverted scale.

Normalisation on the horizon in the United States

In the United States too, wage and price rises have remained out of step with the economic conditions seen over the last few years. Although rather slow, the recovery had already begun by mid-2009 across the Atlantic, and has held up ever since. However, headline inflation and underlying inflation have remained well below the Fed's target of 2 % since 2012 (1). Despite the constant decline in the unemployment rate, wage growth remained sluggish between 2010 and 2015, before gradually picking up.

Over the last few months, the prospect of seeing inflation return to its target has nevertheless firmed up. Various elements in fact suggest a gradual normalisation of price and wage rises:

(1) First of all, long-term inflation expectations have stayed well anchored at levels compatible with the inflation target. So, the US central bank's credibility as regards price stability has never been questioned.

(2) Secondly, over the last few years, inflation has been dragged down by specific price falls in some sectors like telecommunications or health care. Several of these price movements are perceived as temporary and therefore are not

(1) The Fed's target indicator is PCE (Personal Consumption Expenditure) inflation, which measures the change in prices of goods and services paid by or "on behalf of" households. CPI inflation only takes goods and services paid for directly by households into account. Apart from differences in the composition of the index's basket of goods and services, the weightings attributed to goods and services are also different. The general trend is fairly similar but, overall, CPI inflation is a little higher. The Fed's target is 2 % for headline inflation in the medium term, but underlying inflation logically gets a lot of attention.

likely to re-occur in the future. As far as health care[1] is concerned, inflation could fall further for some time to below the pre-crisis level (Mahedy and Shapiro, 2017), although some downward effects have already faded away since the end of 2017.

(3) Thirdly, in line with point (2) inflation and wages both accelerated at the beginning of 2018. Over the first four months of the year, for instance, hourly wage growth in the private sector reached an annual rate of 2.6 % and, last March, underlying PCE inflation fell back to 1.9 %.

(4) Lastly, the tax reform and fiscal easing adopted by the Trump Administration at the turn of the year are expected to encourage investment and private consumption over the coming quarters. In a context of full employment[2] where output is close to its potential and financial conditions are still favourable, this change should push up prices and wages.

For all these various reasons and although the degree of uncertainty remains high, it may be assumed that inflation will stabilise at around 2 % in the medium term. That, at least, is what the members of the Federal Open Markets Committee (FOMC) are expecting. According to the Committee's latest median projections, dating from June 2018, inflation and underlying inflation should reach 2.1 and 2 % in 2018, respectively, and then converge to 2.1 % in 2019 and 2020.

Structurally weak inflation in Japan

Japan stands out as a special case in that the current low inflation and weak wage growth displayed by its economy is nothing new. Its roots lay in the bursting of a major financial and real estate asset bubble at the beginning of the 1990s, following the archipelago's strong economic expansion in the 1980s.

The persistence of mild deflation or low inflation in the country for a quarter of a century bears witness to the structural rather than cyclical nature of the phenomenon. In reality, it could be argued that, between the beginning of the 1990s and early 2000, the Japanese economy shifted to a new low interest rate-low inflation equilibrium (Boeckx *et al.*, 2015).

However, this new equilibrium should not prevent the economy from growing to its full potential in the long term, as the record decline in its potential growth is largely due to demographic and productivity developments. The fall in the population, and especially the working-age population, has effectively dealt a heavy blow to the country's economic growth potential. Contrary to received opinion, its real economic dynamic is nevertheless far from listless when its demographics are taken into consideration. Since the beginning of the 2000s, for instance, GDP growth per working age person has been clearly higher in Japan than in the United States or the euro area.

Since the 1990s, the Japanese economy has not seen any net divergence between real and nominal trends. For example, it is surprising to note that the correlation between the unemployment rate and underlying inflation works out at –0.85 over the period 1990-2017.

However, over the last few quarters, despite a decidedly expansionary macroeconomic policy[3] and a highly favourable economic situation, inflation has remained adamantly anaemic. In 2017, GDP growth reached 1.6 %, against potential growth estimated at between 0.5 and 1 % by the Bank of Japan and, at the beginning of 2018, the unemployment rate had fallen back to 2.5 %, its lowest level for 25 years. Yet, inflation excluding energy and fresh food prices – the central bank's preferred consumer price yardstick – was no more than 0.5 %. Wage growth, on the other hand, was showing signs of gathering speed. One explanation of the persistent weakness of inflation in Japan in recent years seems to lie in the utmost caution that firms are taking in their price- and wage-setting decisions (Kataoka, 2018). According to the latest Tankan survey dating from March 2018, Japanese firms are expecting a headline inflation rate of around 0.8 % over the next year and they do not see inflation exceeding 1.1 % within the next three to five years. In April, the Bank of Japan was expecting to see underlying inflation go back up to between 1.5 and 1.8 % by the year 2020. The vast majority of

(1) Prices in the health care sector have been under pressure mainly as a result of adjustments made to the Medicare health insurance system (the federal health insurance intended for the over-65s and for disabled people), under President Obama's Affordable Care Act (Mahedy and Shapiro, 2017). As health care accounts for a large share of household consumption expenditure, the slow growth of prices in the sector has dampened headline inflation considerably.

(2) The unemployment rate had fallen to 3.8 % in May 2018, which is below the long-term unemployment rate, estimated at 4.5 % by the FOMC members.

(3) In 2013, Japan's Prime Minister Shinzo Abe launched a major stimulus plan widely referred to as 'Abenomics'. It is based on fiscal expansion, as well as implementation of structural reforms and running an accommodating monetary policy. Five years after its launch, the plan is still going. It has generated a recurrent government deficit and an unprecedented expansion of the Bank of Japan's balance sheet. With the aim to bring inflation up to its target of 2 %, the central bank currently applies a negative interest rate of –0.1 % on current account deposits with financial institutions. In addition, it is doing its utmost to keep the 10-year rate close to 0 % through a programme for purchasing Treasury bonds to the tune of 80 000 billion yen annually (more than € 600 billion). It also buys up other types of assets, such as exchange-traded funds and real estate investment funds.

its Monetary Policy Committee members nevertheless acknowledge that the risks are biased downwards. Again, the idea of an atypical macroeconomic equilibrium, characterised by a particularly moderate rise in prices and wages, is emerging.

What can the euro area expect in the future ?

One question that crops up is whether the euro area will shift more towards an American-style scenario, with the prospect of inflation returning to more normal levels, or whether it could slide towards a Japanese scenario, where low inflation becomes a structural feature of the economy. The remainder of this article tries to answer this question with a more in-depth analysis of the origin of the current weaknesses of inflation in these three economies.

2. How do central bankers think about inflation ?

2.1 The Phillips curve framework

What is the link between inflation and economic activity ? And should inflation be higher today given the decline in the unemployment rate ? To answer such questions, economists typically turn to the Phillips curve framework. Metaphorically speaking, the framework tells us that inflation is a kind of thermometer that indicates if the economy is running hot or cold. The thinking goes back to the seminal work of Phillips (1958), which shows an inverse (downward sloping) relationship between the unemployment rate and wage inflation for nearly 100 years of UK data. Put differently, wage inflation was found to be high when unemployment was low, and vice versa. Similar negative relationships between inflation and the unemployment rate have also been noted for other countries in the subsequent period. In the euro area, for instance, a negative relationship is also visible between the unemployment rate on the one hand, and wage or underlying inflation on the other hand (see chart 3).

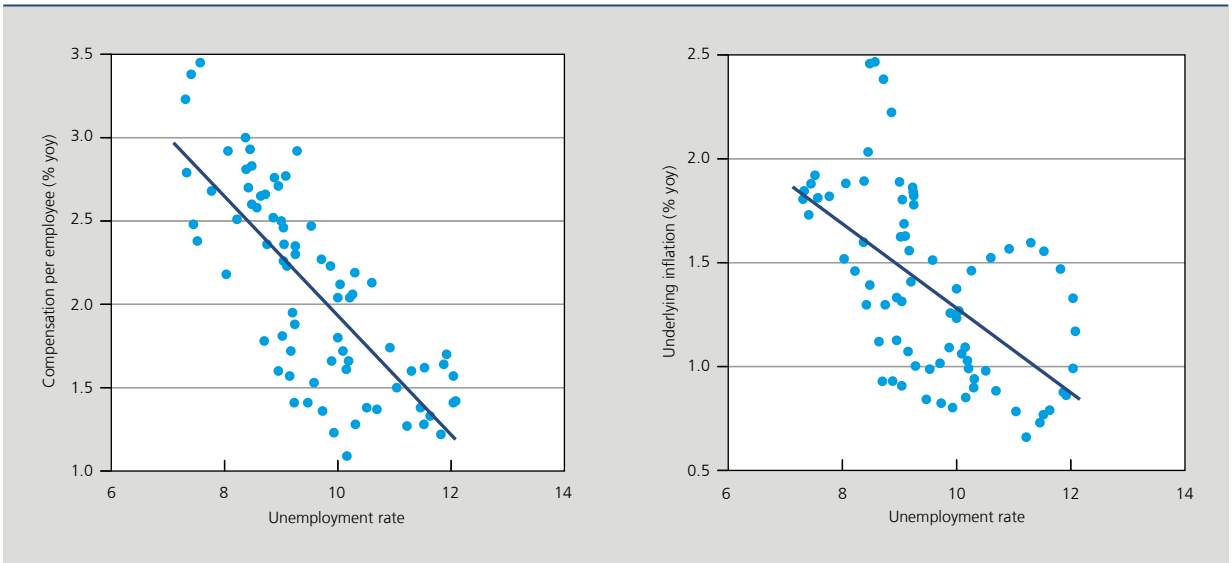
The Phillips curve can be intuitively explained by using the law of supply and demand. When the economy is buoyed up by strong demand, firms will try to produce more goods and services. To do so, they will outbid each other in order to attract available workers. Increased scarcity of labour lowers the unemployment rate and puts upward pressure on wage inflation. In turn, higher input costs and strong demand for final products induces firms to raise their output prices. The reverse is true, however, when weak demand leads to an economic downturn. In that case, firms will cut back their production and lay off workers. This will raise the unemployment rate and put downward pressure on wage and price inflation. These aggregate demand effects cause movements along the downward sloping Phillips curve.

Taken at face value, the Phillips curve seems to suggest that policymakers can select a specific inflation and unemployment outcome by stimulating or restraining aggregate demand. However, once inflation expectations and the supply side of the economy were included into the theory, it became clear that this view is misguided. It is now thought that the central bank can use monetary policy measures to influence inflation and economic activity in the short run, but, in the long run, these measures cannot permanently affect economic activity. Specifically, the reasoning goes that there is a certain "natural" rate of unemployment that ensures stable inflation. This is the unemployment rate where the economy is running neither hot nor cold. When the economy is overheating, the "unemployment gap", or difference between the unemployment rate and its natural rate, will be negative, and upward pressure will follow on inflation. When the economy is running cold, the opposite should hold. The natural rate of unemployment depends on supply-side factors in the economy, which the central bank does not control. Therefore, the central bank cannot permanently keep the unemployment rate below its natural rate, because the resulting pressure will continuously push up inflation expectations and actual inflation while the unemployment rate converges to its natural level again. The outcome would be higher inflation without lower unemployment. Graphically, the Phillips curve (intercept) shifts upwards [1].

Although the Phillips curve framework is widely used, it remains a source of controversy among macroeconomists. The negative relationship between inflation and the unemployment rate tends to disappear and reappear in the data, and Phillips curve models have a patchy track record in forecasting inflation. Nevertheless, it is still one of the main frameworks for explaining inflation, and modern empirical models typically contain an unemployment gap or output

(1) For an overview of the Phillips curve framework and its history, see Lacker and Weinberg (2007) and Gordon (2011).
(2) The output gap is the percentage deviation between actual real output and "potential" real output. The latter is the level of output that is consistent with stable inflation. Thus the output gap and unemployment gap both express whether the economy is running hot or cold, but they have opposite signs.

CHART 3 PHILLIPS CURVES IN THE EURO AREA (1999Q1-2017Q4)



Source: ECB Statistical Data Warehouse.

gap in an equation that explains inflation[2]. We now turn to an empirical application with a model that enables, among other things, the Phillips curve relationship to change over time. This model sheds light on our main question: why do inflation and real activity appear out of sync in the euro area?

2.2 Explaining low inflation within a Phillips curve framework

Three driving factors

In our empirical application, we consider three categories of factors to explain persistently low inflation in the euro area, namely real, nominal, and external factors. The real factors represent the Phillips curve relationship between economic activity and inflation. We classify effects that relate to the formation of inflation expectations as nominal factors. Finally, the external factors consist of effects which are beyond the direct influence of the central bank. This category contains such things as shocks to oil and other commodity prices. The way they propagate and ultimately affect inflation in the longer run is, however, influenced by the central bank's monetary policy.

Model specification

Our empirical model is based on Wauters (2018), who extends the time-varying parameter Phillips curve model proposed by Chan *et al.* (2016) and estimates it on euro area data. The model is described briefly below and the reader is referred to Appendix 1 for further technical details.

The empirical model decomposes headline price inflation in each period "t", π_t, into the three driving factors as follows:

$$(1) \qquad (\pi_t - \pi_t^*) = \rho_t (\pi_{t-1} + \pi_{t-1}^*) + \lambda_t \left(\frac{Y_t^* - Y_t^*}{Y_t^*}\right) + \gamma_t (\pi_t^m - \pi_t^{m*}) + \epsilon_t^\pi$$

The group of nominal factors contains two elements in the above equation, namely trend inflation π_t^* and inflation persistence ρ_t. Trend inflation π_t^* represents the expected rate of inflation in the long run and is commonly interpreted in the literature as the central bank's implicit inflation target. The deviation of inflation from this trend $(\pi_t - \pi_t^*)$ is defined as the "inflation gap". Equation (1) assumes that the inflation gap is a process that mean-reverts to zero. The current inflation gap is linked to the past inflation gap through a persistence parameter ρ_t. This parameter allows for differences

in either the central bank's tolerance for inflation deviations from target, or the central bank's ability to direct inflation towards its target (Chan *et al.*, 2016). All else being equal, a high degree of persistence implies a slower convergence of inflation towards its target once shocks have occurred.

The real factors represent the typical Phillips curve relationship. They arise from the multiplication of a time-varying Phillips curve slope λ_t with the output gap $(Y_t - Y_t^*) / Y_t^*$. The latter measures the percentage difference between actual and potential output, and is analogous to the unemployment gap in the sense that it measures the degree of over- or underutilisation of economic resources.

Finally, the external factors comprise the time-varying impact γ_t of the gap between inflation in the relative price of imports and its trend $(\pi_t^m - \pi_t^{m*})$. Import price inflation is included in order to incorporate the effect of supply shocks. The accompanying time-varying coefficient γ_t allows for measuring, for e.g., a larger effect from imported inflation due to globalisation (IMF, 2013). All remaining effects are captured by the model residual ε_t.

The model parameters $(\pi_t^*, \rho_t, \lambda_t, \pi_t^{m*})$ including the variance of the residual ε_t , evolve according to a random walk process, where the ρ_t and λ_t elements are bounded to lie between 0 and 1. Potential output Y_t^* follows a random walk with a stochastic drift term in order to capture changes in the economy's potential growth rate (see Appendix 1 for details).

The model is related to several recent papers that estimate a time-varying parameter Phillips curve relationship for the US or other countries. Our approach differs from these papers in several ways. First, relative to Stevens (2013) and Riggi and Venditti (2015), we estimate the Phillips curve parameters and the driving variables like economic slack and trend inflation jointly rather than taking official output or unemployment gap measures from institutions as given inputs. Second, relative to Blanchard *et al.* (2015) and Dany-Knedlik and Holtemöller (2017), we use the output gap as a measure of slack because it has been pointed out that the unemployment rate could understate the level of slack in the economy (see below).

We refer the reader to Appendix 2 for details on the data used in the empirical exercise.

3. Empirical Phillips curve estimates

This section discusses the empirical results for the euro area and makes a comparison with the estimates for the US and Japan. First of all, it looks at how the real, nominal and external factors dragged inflation down during the crisis period, then summarises the relative contributions of these factors for the euro area, and concludes with some implications for monetary policy.

3.1 Real factors have weighed down on inflation…

Output gap and Phillips curve slope estimates

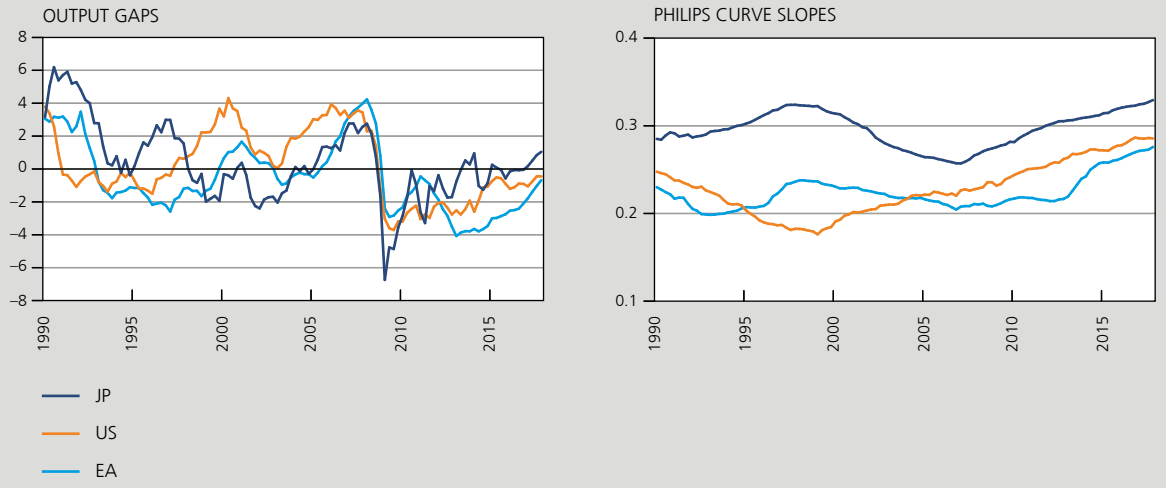
The left-hand plot of chart 4 shows the estimated output gaps $(Y_t - Y_t^*) / Y_t^*$ for the three areas. The euro area output gap is estimated to have been large and negative in recent years, and it is still returning to zero. Slack also appears larger in the euro area than in the US over the past five years due to the euro area sovereign debt crisis. The Japanese output gap is slightly positive at the end of the sample, which suggests that protracted low inflation is not driven by real factors there. The right-hand plot, which shows the trend of the Phillips curve slope λ_t, indicates that slack continues to have an economically relevant effect on inflation in the three regions. The slopes have turned upwards in recent years in the three regions. This could be related to recent structural reforms that reduced the degree of nominal rigidities (e.g. through lower collective bargaining coverage), and therefore made the economies more flexible [(1)].

The combination of a negative output gap and a steeper (or stronger) Phillips curve slope in the euro area might be surprising to some. Several observers have interpreted the absence of high inflation in the face of strong growth during

(1) In line with several studies (e.g. IMF, 2013), the Phillips curve slopes flatten (follow a long-run downward trend) for the US and euro area between the mid-1970s and 2000 (not shown).

the recovery as a sign that the Phillips curve has either flattened (weakened) or that it has broken down completely (Miles *et al.* 2017). Our estimates lead to the opposite conclusion. Although the economy has grown strongly in recent years, output has not yet caught up with its potential level. The gap between actual and potential output persists because the crisis has not had the same impact on potential output as on actual output. Moreover, inflation remains subdued because of a *more active* Phillips curve relationship from slack to inflation. So although slack is gradually disappearing, the remaining idle resources are weighing more on inflation since the slope has got steeper.

CHART 4 ESTIMATED OUTPUT GAPS AND PHILLIPS CURVE SLOPES



Source: Own estimates.

Despite strong growth, EA slack might be larger than presumed

Since the output gap is typically estimated with a large degree of uncertainty, it is hard to take a strong stand on its size and sign. Nevertheless, policymakers are discussing whether slack in the euro area economy is larger than generally presumed (Reuters, 2018), and there is evidence pointing in that direction.

First, the level of unemployment might understate the true degree of unemployment in the economy. The left-hand-side plot of chart 5 shows the headline unemployment rate (U) in the euro area and the so-called "U6" broad unemployment measure. The difference between them is that the latter also includes part-time employees who are looking for full-time work in the broad unemployment measure, as well as workers who have left the labour market because they have become too discouraged to seek employment[(1)]. During the financial crisis, the gap between U and U6 got wider as the broad unemployment group increased substantially. So although the unemployment rate declined in the euro area, its level might still understate the "true" degree of unemployment in the economy (as people work fewer hours than desired or are still too discouraged to enter the labour market).

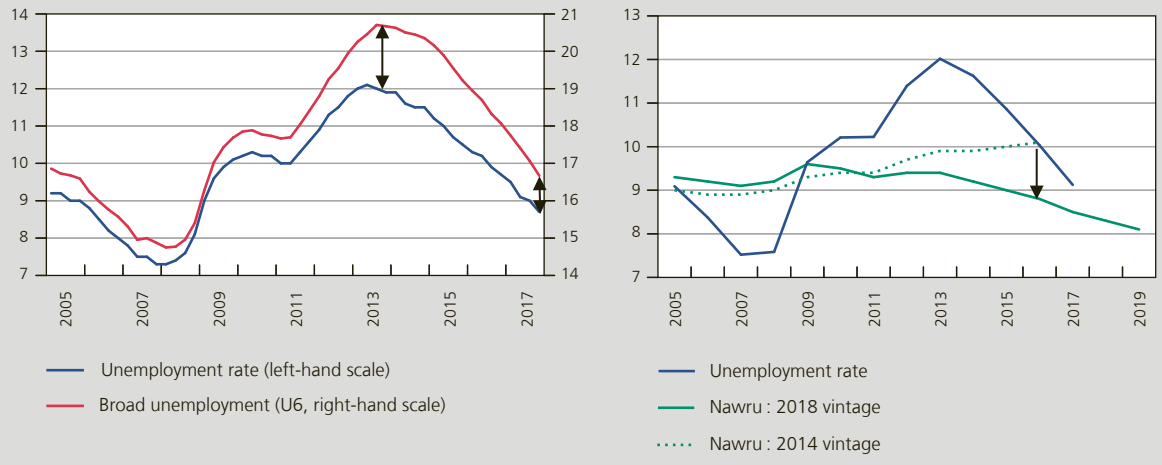
Second, the deterioration of the economy's supply potential may have been overestimated in the wake of the crisis. The right-hand-side plot shows the evolution of the unemployment rate in the euro area, together with the 2014 and 2018 vintages of the European Commission's estimated non-accelerating wage rate of unemployment (NAWRU). This is a measure of the level of the unemployment rate that is consistent with stable wage inflation, and indicates some form of "natural" unemployment rate. Since 2014, the EC's forecasts have systematically revised the NAWRU downwards – a change that is consistent with

(1) To be precise, the unemployment rate is the number of people unemployed as a percentage of the labour force. The U6 measure of broad unemployment also includes under-employed part-time workers (who want to work full time) in the numerator, and the group of "potential labour" in the numerator and denominator. The group of potential labour includes those who are seeking work but are not available (e.g. students finishing their studies), and those who are available but are not seeking work (the latter includes discouraged workers).

a stronger supply potential of the economy. The implication of these revisions is that, for a given unemployment rate, the unemployment gap was actually larger. Both assumptions in chart 5 – a higher "true" unemployment rate and a lower natural unemployment rate – are consistent with slack in the euro area being larger than initially presumed.

Third, the notion that slack might be larger resonates with the conclusions from recent studies. Lenza and Jarocinski (2016) compare several models in terms of their ability to predict euro area core inflation in real time, and find that the best-performing model delivers a much wider gap between actual and potential output than institutional measures. Coibion *et al.* (2017) argue that institutional estimates of US potential output are too procyclical, so it was revised downwards too much during the crisis. As a result, slack in the economy is now underestimated. Finally, Hong *et al.* (2018) estimate wage Phillips curves for several countries and conclude that there is greater slack in the labour market than suggested by headline unemployment rates.

CHART 5 EURO AREA UNEMPLOYMENT RATES AND NAWRU



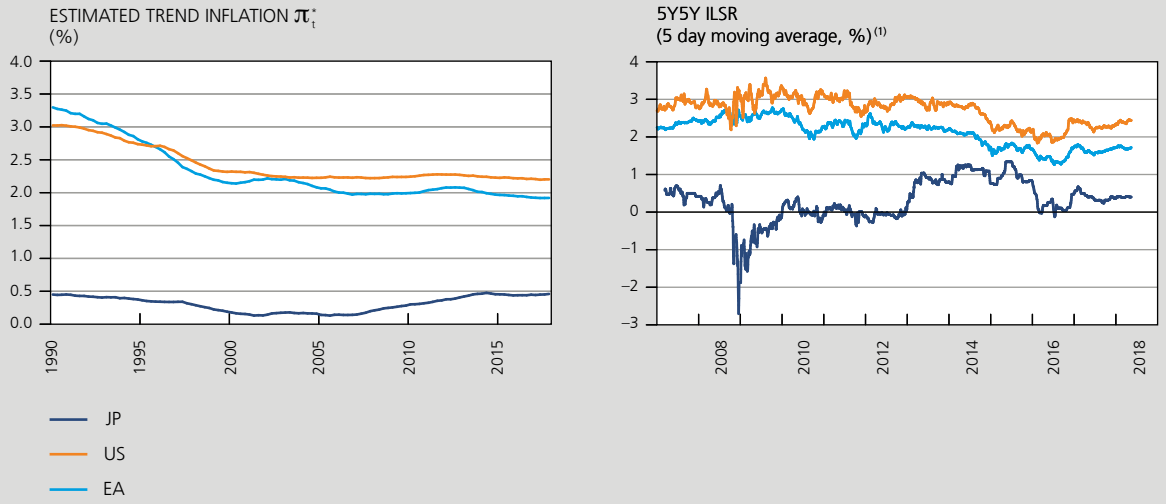
Sources: Ameco, Eurostat, SDW.

3.2 … nominal factors have acted as an additional drag…

Trend inflation levels are different

We now discuss the nominal factors, namely trend inflation π_t^* and intrinsic inflation persistence ρ_t, in turn. For the euro area, trend inflation was initially stable around 2 % from 1999, but drops slightly below 2 % at the end of the sample (chart 6, left-hand side). In contrast, trend inflation has been remarkably low in Japan for the past two decades, while in the US it has been slightly above 2 %. It is interesting to note that data on long-run inflation expectations, which are absent from the model, tell a similar story (chart 6, right-hand side plot). The series shown are financial market inflation compensation measures covering the five-year period starting five years from now (5-year 5- year-forward Inflation-linked swap rates [5y5y ILSR]). Roughly speaking, the three series co-move similarly in both plots: the Japanese readings are low and close to zero, and those for the US and euro area lie close to 2 %. It should be noted that differences between both plots in terms of the *levels* could also be due to, *inter alia*, inflation risk premia in the compensation measures (see box 1 in Deroose and Stevens, 2017). The takeaway is that low inflation seems to be a chronic issue in Japan, but not in the US and the euro area. For the latter two regions, the series are consistent with inflation returning to the central bank's target in the long term.

CHART 6 ESTIMATED TREND INFLATION RATES AND MARKET INFLATION EXPECTATIONS

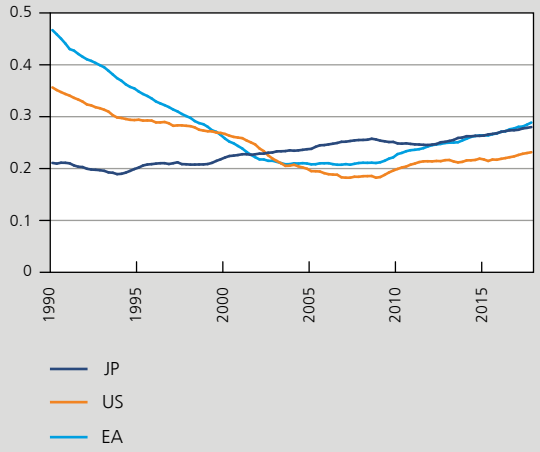


Sources: Own estimates, Bloomberg. The ILSR series start in 2007 and end on 16 May 2018.
(1) Implicit inflation rate derived from swap contracts hedging the inflation risk in the euro area during a five-year period starting five years after conclusion of the contract.

Intrinsic inflation persistence is on the rise again

Although trend inflation appears stable in the euro area, the degree of intrinsic inflation persistence ρ_t has risen in recent years, just like in the other areas (chart 7). Higher inflation persistence implies, all else being equal, a slower return of inflation to its trend. This rise could be due to more backward-lookingness in wage and price formation, for instance. For example, backward-looking indexation of wages has returned in Italy and covered around one-third of private sector employees in 2016 (Banca d'Italia, 2017). The more people use past inflation to form their expectations of future inflation, the harder it gets for monetary policy to bring inflation swiftly back to the target.

CHART 7 ESTIMATED INTRINSIC INFLATION PERSISTENCE

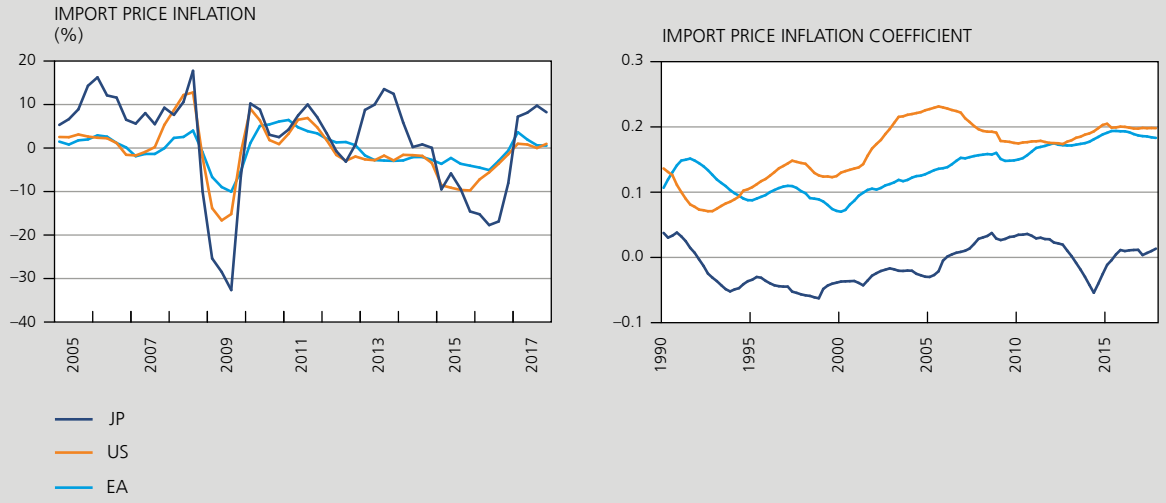


Source: Own estimates.

3.3 … and external factors were also negative contributors

Finally, we find that the external factors also had a negative impact on inflation. Relative import price inflation π_t^m trended downward during the post-2010 period in all three regions, but rebounded sharply at the end of the sample (chart 8, left-hand plot). Underlying inflation rates have actually been rather stable in the developed world in recent years, with the difference between headline and underlying inflation driven by commodity price movements (Miles *et al.*, 2017). The right-hand-side plot of chart 9 shows that the impact effect γ_t of the relative import price inflation gap $(\pi_t^m - \pi_t^{m*})$ has increased in the last three decades for the euro area and the U.S. Hence, the stronger impact of weak commodity price inflation has also kept inflation down after 2013. This is consistent with an impact from increased globalization, which means that economies are becoming more open and interdependent.

CHART 8 RELATIVE IMPORT PRICE INFLATION AND IMPACT COEFFICIENT WITH RESPECT TO THE RELATIVE IMPORT PRICE GAP



Source: See Appendix 2, own estimates.

3.4 Summing up the Phillips curve perspective

Chart 9 shows the estimated contributions of trend inflation, the output gap, the relative import price gap, and the residual on euro area inflation [1]. Trend inflation has not driven inflation away from 2 %: the trend has been close to 2 % since 2005, and declined only slightly after 2013. In contrast, the output gap and the relative import price inflation gap have played a crucial role since 2013 in explaining the period of protracted low inflation. The impact of relative import prices has recently become positive again, which explains the recent rebound in headline inflation. Overall, this means that low inflation in the euro area has been driven by cyclical factors (Phillips curve effect of the output gap) rather than structural forces (low trend inflation) [2]. In this respect, we can conclude that the euro area situation resembles more that of the US than that of Japan. Indeed Japan is characterised by low trend inflation, while the economy appears to be running above its potential level. In contrast, trend inflation is stable around 2 % in the US, but they are somewhat further in the economic recovery cycle compared to the euro area.

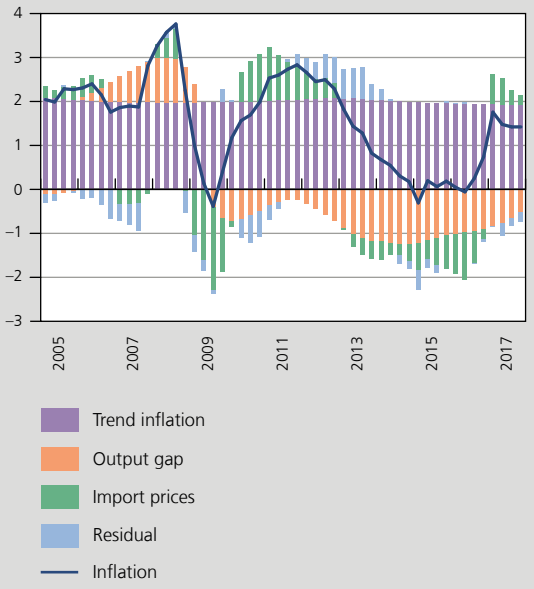
Note that the empirical results from this section provide an *ex-post* interpretation of the puzzle of protracted low inflation, while the forecast errors that were shown in section 1 showed a problem of understanding the inflation process

(1) These calculations take the time variation of the parameters into account. As the model is estimated in terms of annualised quarter-on-quarter inflation, the implied contributions to year-on-year inflation were calculated as the 4-quarter moving averages of the contributions to annualised quarter-on-quarter inflation.

(2) Using a similar model for the unemployment gap, Dany-Knedlik and Holtemöller (2017) also find that real, nominal and external factors have driven down euro area inflation. However, they find a more pronounced decline in trend inflation than we do.

in real time. But both are not necessarily inconsistent with each other. In fact, the time variation of the parameters could be one of the reasons why inflation has been difficult to forecast in real time (Riggi and Venditti, 2015). Other reasons relate to the usual problems of real-time estimation uncertainty surrounding the output gap, and (possibly multiple) *ex-post* revisions of real-time data.

CHART 9 ESTIMATED CONTRIBUTIONS TO EURO AREA INFLATION



Source : Own estimates.

3.5 Implications for monetary policy

From these results, we can draw several implications for euro area policymakers. First, the Phillips curve relationship still remains economically relevant for explaining inflation. We can expect that as the output gap closes, inflation will return to its trend level. However, the higher intrinsic persistence of the inflation gap implies that this process will likely take more time than before.

Second, the notion that economic slack is the main driver of subdued inflation implies that monetary policymakers are not faced with a trade-off scenario. Indeed, by supporting demand through accommodative policies, the central bank can both align aggregate demand with the economy's supply potential and – by doing so – bring inflation in line with the price stability mandate. By contrast, if low trend inflation were the main driver behind subdued inflation, monetary policymakers would have to consider overheating the economy above its potential level in order to raise inflation and inflation expectations. Even though this would be consistent with the ECB's primary objective, it is a less benign situation for the central bank.

Conclusion

Our analysis shows that low inflation in the euro area can be explained mainly by economic slack, slightly lower trend inflation, and downward drag from relative import price inflation. In this sense, the euro area situation resembles more that of the US, where low inflation is also mainly a cyclical phenomenon. In contrast, the fact that Japanese trend inflation is found to be very low indicates that low inflation is a chronic issue there. In all three regions, there has been a tendency in recent years towards a steeper Phillips curve and higher intrinsic inflation persistence.

The implications from these findings are the following. First, the Phillips curve relationship remains active and economically relevant in the euro area. As economic slack dissipates, we can expect euro area inflation to return towards its trend rate which stands close, but below, 2 %. Second, for this to happen, monetary policy should continue to support the economic recovery. This will help to absorb the remaining slack and, in its wake, bring inflation in line with the price stability mandate.

Appendix 1 – A time-varying parameter Phillips curve model

This appendix complements the description of the empirical model specification from section 2.2 with additional details.

The model belongs to the class of state-space models and consists of two measurement equations. The first one specifies that inflation depends on trend inflation, the past inflation gap, the output gap, and the relative import price inflation gap:

$$(\pi_t - \pi_t^*) = \rho_t (\pi_{t-1} - \pi_{t-1}^*) + \lambda_t (y_t - y_t^*) + \gamma_t (\pi_t^m - \pi_t^{m*}) + \varepsilon_t^\pi$$

Real output enters the equation as $y_t = 100LN(Y_t)$, where Y_t is the real GDP index. All variables with * superscripts represent the trends of their counterparts which do not bear the superscript. Thus, $(y_t - y_t^*)$ forms the output gap, which in equation (1) of the main text is written as $((Y_t - Y_t^*)/Y_t^*)$ for purposes of exposition. This model is based on Chan *et al.* (2016), but adds a relative import price inflation gap, and measures slack using an output gap instead of the unemployment gap $(U_t - U_t^*)$.

The second measurement equation is a second-order autoregressive process for the output gap:

$$(y_t - y_t^*) = \rho_1^y (y_{t-1} - y_{t-1}^*) + \rho_2^y (y_{t-2} - y_{t-2}^*) + \varepsilon_t^y$$

where the autoregressive parameters ρ_1^y and ρ_2^y are restricted in order to imply stationarity. In Chan *et al.* (2016), the above autoregressive process was used for the unemployment gap $(U_t - U_t^*)$.

The state equations define all model parameters $(\pi_t^*, \rho_t, \lambda_t, \gamma_t, \pi_t^{m*})$ and the variance ε_t^π of as random walks (e.g. $\pi_t^* = \pi_{t-1}^* + \varepsilon_t^{\pi*}$), with the exceptions that ρ_t and λ_t follow bounded random walk processes that lie between 0 and 1. Potential output (y_t^*) is assumed to follow a random walks with stochastic drift as:

$$y_t^* = y_{t-1}^* + g_t + \varepsilon_t^*$$
$$g_t = g_{t-1} + \varepsilon_t^g$$

Ergo, g_t captures the trend quarter-on-quarter growth of potential output. The model is estimated using Bayesian techniques. For more details on the implementation and the priors, see Wauters (2018).

The prior settings follow those from Chan *et al.* (2016) for the shared model components. For the new parameters, we use relatively uninformative priors.

We run the Gibbs sampler for sixty thousand draws, discard the first ten thousand as burn-in sample, and keep one in ten draws of the remaining fifty thousand draws for posterior inference.

Appendix 2 – Overview of the data used in the empirical analysis

All inflation rates in the empirical exercise are defined as annualised quarter-on-quarter growth rates of the price index. For instance, $\pi_t = 400LN(P_t/P_{t-1})$, where P_t is the price index and is the natural logarithm. Headline inflation is the Harmonised Index of Consumer Prices (HICP) in the euro area, and the Consumer Price Index (CPI) in the US and Japan. We follow Matheson & Stavrev (2013) and define the relative price of imports as the import-price deflator relative to the gross domestic product (GDP) deflator. The samples range from 1970Q4 for the euro area, 1948Q1 for the US, and 1986Q1 for Japan, and end in 2017Q4. Data for the euro area are taken from the ECB's Statistical Data Warehouse (SDW) and are backdated until the 1970s using the corresponding series from the Area Wide Model database. The table below provides more details on the exact series used.

Country	Variable	Source *(and code)*	Transformations
Euro area	Inflation	SDW *(ICP.M.U2.Y.000000.3.INX)* AWM *(HICP)*	AWM price index seasonally adjusted following the X13 procedure with JDEMETRA+ software SDW price index backdated with AWM price index using growth rates
	Real GDP	SDW *(MNA.Q.Y.I8.W2.S1. S1.B.B1GQ._Z._Z._Z.EUR.LR.N)* AWM *(YER)*	SDW output index backdated with AWM output index using growth rates
	GDP deflator	SDW *(MNA.Q.Y.I8.W2.S1. S1.B.B1GQ._Z._Z._Z.IX.D.N)* AWM *(YED)*	SDW price index backdated with AWM price index using growth rates
	Import price index	SDW *(MNA.Q.Y.I8.W1.S1. S1.C.P7._Z._Z._Z.IX.D.N)* AWM *(MTD)*	SDW price index backdated with AWM price index using growth rates
US	Inflation	FRED *(CPIAUCSL)*	
	Real GDP	FRED *(GDPC1)*	
	GDP deflator	FRED *(GDPDEF)*	
	Import price index	FRED *(A021RD3Q086SBEA)*	
Japan	Inflation	Datastream *(JPCONPRCE)*	
	Real GDP	Datastream *(JPGDP…D)*	
	GDP deflator	Datastream *(JPGDP…B: JPGDP…D)*	JPGDP…B/JPGDP…D
	Import price index	Datastream *(JPIMNGS.B: JPIMNGS.D)*	JPIMNGS.B/JPIMNGS.D

Notes: The acronyms and their weblinks are as follows. SDW: ECB's Statistical Data Warehouse (http://sdw.ecb.europa.eu), AWM: Area Wide Model database (https://eabcn.org/page/area-wide-model), FRED: Federal Reserve Bank of St. Louis Economic Data (https://fred.stlouisfed.org).

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