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205 Report by Franziska Bremus, Geraldine Dany-Knedlik, and Thore Schlaak

Price stability and climate risks: sensible measures for the European Central Bank

- Report discusses changes to ECB's strategy focusing on price stability and climate change
- Adjustments of price stability to include tolerance intervals are reasonable
- Evaluation of climate risks needed to maintain price stability and portfolio performance

LEGAL AND EDITORIAL DETAILS



DIW Berlin — Deutsches Institut für Wirtschaftsforschung e. V.

Mohrenstraße 58, 10117 Berlin

www.diw.de

Phone: +49 30 897 89-0 Fax: -200

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DIW Berlin Leserservice, Postfach 74, 77649 Offenburg

leserservice@diw.de

Phone: +49 1806 14 00 50 25 (20 cents per phone call)

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AT A GLANCE

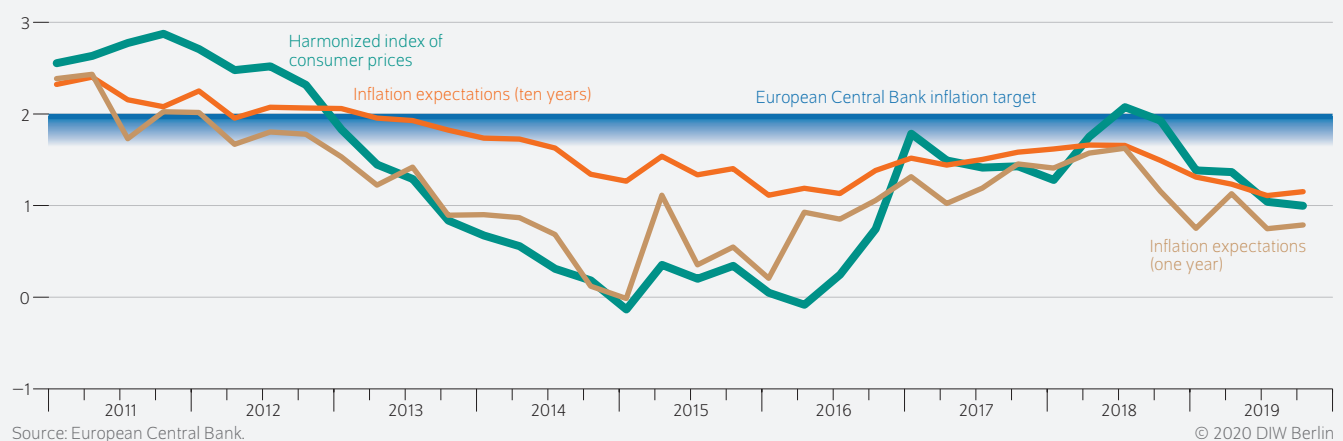
Price stability and climate risks: sensible measures for the European Central Bank

By Franziska Bremus, Geraldine Dany-Knedlik, and Thore Schlaak

- Report discusses possible changes to the ECB's strategy to achieve price stability and better assess effects of climate change
- Fundamental changes to price stability objective unlikely, but adjustments to include tolerance intervals would be reasonable
- Empirical study shows how physical climate risks affect the economy
- A stronger focus on climate risks to maintain price and financial stability is welcomed
- Portfolio management should also evaluate potential negative effects on the transition to a sustainable economy

Consumer price inflation and inflation expectations in the euro area are significantly below the ECB target of below but close to two percent

Year-on-year change of consumer prices and inflation expectations in percent



FROM THE AUTHORS

“The ECB should consider quantifying the tolerance interval of below but close to two percent more specifically as other central banks have done. This would be beneficial because the ECB could then better direct inflation expectations and more clearly communicate to what extent deviations from the inflation target are due to general uncertainty.” — Geraldine Dany-Knedlik —

Price stability and climate risks: sensible measures for the European Central Bank

By Franziska Bremus, Geraldine Dany-Knedlik, and Thore Schlaak

ABSTRACT

By the end of 2020, the European Central Bank (ECB) will present the results of its monetary policy strategy review. What changes are to be expected and what changes are needed? This report covers two areas of the strategy review. First, alternatives to the current definition of price stability are discussed. Current studies and the practices of other central banks indicate that supplementing the inflation target with a tolerance interval may be useful to enhance central bank credibility. Second, it is discussed to what extent climate risks play a role in the ECB's economic analyses and monetary policy measures. Empirical evidence shows that weather events such as extreme droughts or floods can influence business cycles in the euro area. Overall, climate risks should be assessed both as part of the ECB's macroeconomic and monetary analyses and as part of its portfolio and risk management.

The European Central Bank (ECB) has been battling low inflation in the euro area for almost a decade. Thus, the leeway for the ECB to provide stimulatory effects using conventional monetary policy instruments has been limited for years. In light of this ongoing challenge, the ECB, under the new leadership of Christine Lagarde, is reviewing its monetary policy strategy. The process, which is set to last until 2021,¹ is the ECB's second strategy revision since its inception. Key results of the last review in 2003 were the supplementary statement on price stability that the ECB is targeting an inflation rate of below but close to two percent and the reduced weight of monetary developments within the two-pillar strategy.²

In addition to the ECB, other central banks, such as the US Federal Reserve (Fed), have begun strategy reviews.³ The ECB and the Fed are focusing on reviewing the price stability objective; monetary policy instruments, in particular unconventional measures such as bond purchases; and communication practices. One unique aspect of the ECB's review is that it assesses the extent to which climate change will affect its ability to fulfil its mandate.

It is still uncertain which changes in European monetary policy strategy to expect. This report focuses on two main points: how price stability is measured and defined, as this is the ECB's primary monetary policy task, and the implications of climate change for monetary policy.

Current definition of price stability

The objectives of the European System of Central Banks (ESCB) are laid out in the Treaty on the Functioning of the European Union (TFEU). Article 127, paragraph 1 of the TFEU defines the mandate of the ECB: "The primary

¹ ECB press release, "ECB launches review of its monetary policy strategy," January 23, 2020, (available online; accessed on March 2, 2020. This applies to all other online sources in this report unless stated otherwise.).

² The two-pillar strategy refers to inflation development and M3 growth. Cf. Jordi Gali et al., *The monetary policy strategy of the ECB reconsidered: Monitoring the European Central Bank* (London: CEPR, 2004).

³ The Fed has been reviewing its strategy since mid-2019, see the website of the Federal Reserve (available online).

Table

Price stability objectives of various inflation-targeting central banks

	Primary objective of price stability	Dual mandate	Inflation as price stability objective	Measure of consumer prices	Quantitative inflation target	Quantitative inflation interval	Accountability interval	Target interval	Tolerance interval	Qualitative inflation interval	Target horizon
ECB	Yes	No	Yes (annual change)	Consumer price index	Yes (two percent)	No				Yes	Medium term
Reserve Bank of Australia	Yes	No	Yes (annual change)	Consumer price index	No	Yes (one percent, three percent)		Yes		No	Medium term
Bank of Canada	Yes	No	Yes (annual change)	Consumer price index	Yes (two percent)	Yes (one percent, three percent)		Yes		No	Medium term
Czech National Bank	Yes	No	Yes (annual change)	Consumer price index	Yes (two percent)	Yes (one percent, three percent)			Yes	No	Not specified
Bank of England	Yes	No	Yes (annual change)	Consumer price index	Yes (two percent)	Yes (one percent, three percent)	Yes			No	Not specified
Federal Reserve (USA)	No	Yes	Yes (annual change)	Personal consumption expenditures price index	Yes (two percent)	No				No	Long term
Central Bank of Iceland	Yes	No	Yes (annual change)	Consumer price index	Yes (2.5 percent)	Yes (one percent, four percent)		Yes		No	Over a 12-month period
Bank of Japan	Yes	No	Yes (annual change)	Consumer price index	Yes (two percent)	No				No	Not specified
Reserve Bank of New Zealand	No	Yes	Yes (annual change)	Consumer price index	Yes (two percent as focus)	Yes (one percent, three percent)		Yes		No	Medium term
Sveriges Riksbank	Yes	No	Yes (annual change)	Consumer price index at fixed rates	Yes (two percent)	Yes (one percent, three percent)			Yes	No	Not specified

Sources: Websites of the respective central banks.

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objective of the European System of Central Banks (hereinafter referred to as ‘the ESCB’) shall be to maintain price stability. Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Union [...];” thus, the ECB’s primary task is to maintain price stability. However, the TFEU does not provide a concrete definition of price stability nor a monetary policy strategy for achieving it. The current definition of price stability according to the ECB’s Governing Council is “a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below two percent.”⁴

This report shows to what extent changes to this definition are possible and what advantages and disadvantages would come as a result.

Price stability objective: consumer price index (HICP) development

Since 1998, the ECB has defined price stability as the year-on-year increase in the Harmonized Index of Consumer Prices (HICP). In an international comparison, this is not unusual (Table). However, theoretically, price stability could also be linked to a nominal GDP target, a target that focuses on the development of both prices and real output. One advantage of a nominal GDP target over a target based on price development alone is that the central bank is better able to deal with supply-side shocks that cause prices to rise when economic

activity declines, such as short-term production shortfalls.⁵ However, a nominal GDP target implies that stabilizing prices and economic activity are equally important.

A nominal GDP target would be an alternative for central banks with a dual mandate, such as the Fed, which guarantees not only price stability but also maximum employment. The ECB’s mandate, however, explicitly defines price stability as its sole primary objective; subordinate to that is an implicit mandate to stabilize the economy. The ECB’s mandate cannot be changed over the course of the monetary policy strategy review, so it is unlikely there will be a switch to a nominal GDP target.

Price-level or inflation targeting?

Price-level targeting instead of inflation targeting would be an option were the ECB to select a different monetary policy strategy in line with its mandate. The main difference between price-level targeting and inflation targeting is what results when the inflation target is not achieved. With price-level targeting, the central bank is legally obligated to compensate for past inflation shocks.⁶ For example, were inflation to be unexpectedly high, the central bank would first aim for a below-average increase in prices.

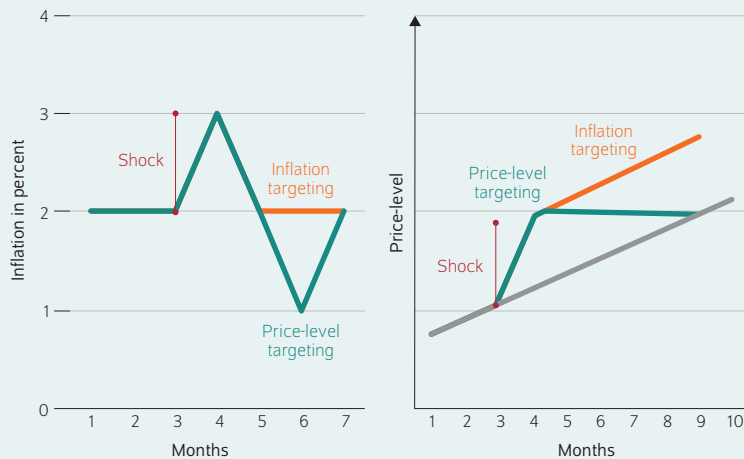
⁵ Robert Hall and N. Gregory Mankiw, “Nominal income targeting,” in *Monetary Policy*, ed. N. Gregory Mankiw (NBER: 1994); Scott Sumner, “The case for nominal GDP targeting,” Mercatus Research, Mercatus Center, George Mason University (2012).

⁶ Michael Woodford, *Interest and Prices: Foundations of a Theory of Monetary Policy* (Princeton University Press: 2003).

⁴ Cf. the website of the European Central Bank (available online).

Figure 1

How price-level targeting and inflation targeting function Schematic depiction



Source: Hatcher and Minford (2016).

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Price-level targeting as a monetary policy strategy is history dependent: Inflation may fall below the inflation target if it exceeded it in the previous period and vice versa.

In contrast, with inflation targeting, a price increase corresponding to the target rate is pursued (Figure 1). Although theoretical studies show that price-level targeting can better stabilize prices because it is history dependent,⁷ the resulting improvements in welfare significantly depend on whether market participants act rationally (i.e., well informed and proactively) and trust the central bank. However, several empirical studies challenge this assumption.⁸ Furthermore, analyses by central banks point to risks and costs of switching to price-level targeting.⁹ Most importantly, there are significant doubts that the general public would understand the history dependent aspect of price-level targeting. If this is not the case, no positive effects can be achieved by steering expectations. In view of these uncertainties, it can be assumed that the ECB will maintain a strategy of inflation targeting.

Measuring price stability: with or without owner occupied housing?

The ECB, like almost all inflation-focused central banks, uses the increase in the consumer price index (Table) to measure purchasing power. However, consumer price indices worldwide differ significantly in their composition and survey methodology. The inclusion of housing costs, especially owner-occupied housing costs, is particularly controversial. At only eight percent, housing costs (excluding costs for water and electricity) are a comparatively small part of the European HICP (Figure 2) because owner-occupied housing costs are excluded. There is still no uniform method for European countries to collect data on housing costs; therefore, changes in housing costs are only partially reflected in the ECB's target. The international average share of housing costs in the consumer price indices is almost 20 percent.

Since 2016, Eurostat has been publishing a separate price index for owner-occupied housing, the Owner-Occupied House Price Index (OOHPI).¹⁰ When compared with the HICP, it is evident that prices for owner-occupied housing have increased significantly more than consumer prices have in recent years (Figure 3). If the prices for owner-occupied housing were included in the index used, inflation would have been higher in recent years.¹¹

However, it is unlikely the ECB will change to an HICP including prices for owner-occupied housing in 2021 or use a different price index.¹² For one, it is unclear if the OOHPI violates the conceptual principles of the HICP, which is designed to cover consumption expenditure, not changes in asset prices.¹³ Moreover, the OOHPI is currently only published quarterly.

Narrow definition: below but close to two percent in the medium term

So far, the ECB's inflation target has consisted of three components: a quantitative point target (two percent), a qualitative range of deviation from the point target (below but close), and a qualitative description of the target horizon (in the medium term). In addition to the ECB, many other central banks in highly developed economies have set an inflation target of two percent over the medium term, if not the long term.¹⁴

⁷ Cf. David Vestin, "Price-level versus inflation targeting," *Journal of Monetary Economics* 53, no. 7 (2006): 1361–1376. Theoretically, the resulting welfare gains are particularly large if, as a result of an economic slump, the central bank has to provide such strong expansionary stimuli that it reaches the zero lower bound. In theory, rational market participants would then expect the price level to be exceeded in the near future after falling below the inflation target. This expectation lowers the real interest rate and increases demand and thus also upward pressure on prices. Cf. Gauti B. Eggertsson and Michael Woodford, "The zero bound on interest rates and optimal monetary policy," *Brookings Papers on Economic Activity* 1 (2003): 139–211; Anton Nakov, "Optimal and simple monetary policy rules with zero floor on the nominal interest rate," *International Journal of Central Banking* 4, no. 2 (2008): 73–127.

⁸ Cf. Michael Hatcher and Patrick Minford, "Stabilisation policy, rational expectations and price-level versus inflation targeting: A survey," *Journal of Economic Surveys* 30, no. 2 (2016): 327–355 and references therein.

⁹ Cf. Bank of Canada, *Renewal of the inflation-control target* (Ottawa: 2011) (available online).

¹⁰ Like the HICP, this index is based on the purchase concept.

¹¹ ECB Economic Bulletin, Issue 8 (2016).

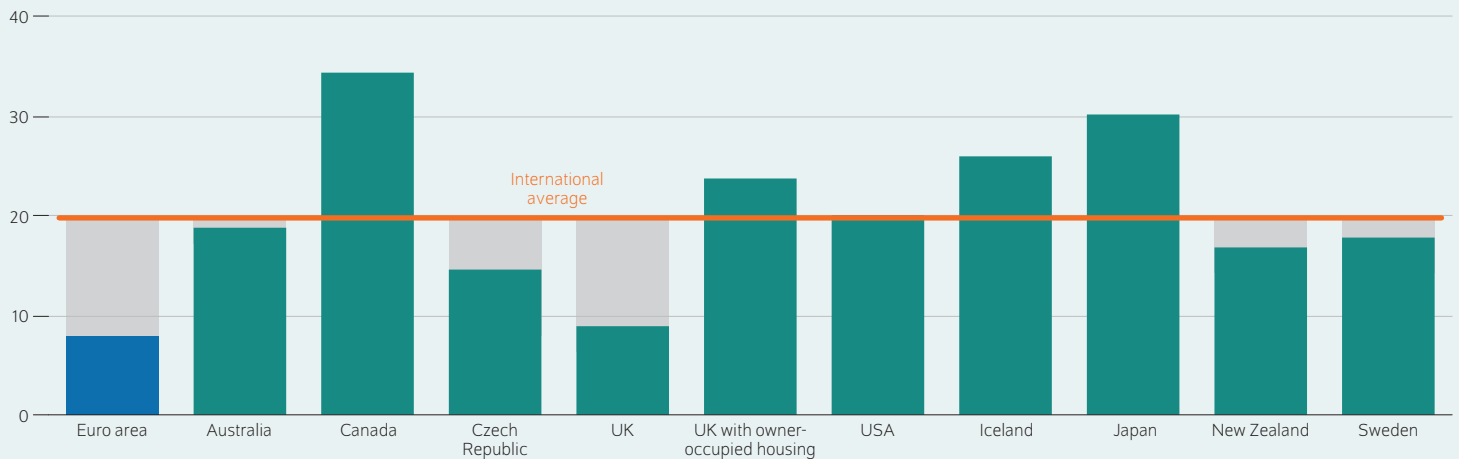
¹² The HICP is subject to EU regulations. Any change must be approved by the European Parliament. In a report by the European Commission to the EU Parliament in 2018, integrating this index into the HICP was rejected upon the recommendation of the ECB.

¹³ Home ownership is a mixed commodity, partly consumption and partly asset/investment. It counts as an investment according to the national accounts.

¹⁴ In general, a positive inflation target is based on the assumption that the data overestimates actual inflation because it is difficult to record data on product substitution, new products, and product quality. In addition, a safety margin against a deflationary spiral should be ensured.

Figure 2

Shares of housing costs in the consumer price indices In percent



Note: The shares represent the market basket shares of rented properties and, if available, owner-occupied housing costs. Costs for regular maintenance and repairs are also included.

Sources: National Statistical Offices.

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At eight percent, the share of housing costs in the European Consumer Price Index is significantly below the average of 20 percent of other international price indices.

As key interest rates in different countries are or were zero percent, prominent economists have spoken out in favor of increasing inflation targets.¹⁵ Support of this increase is based on the observation that the longer-term real interest rate of advanced economies has been declining for several years.¹⁶ If average inflation remains constant, a low longer-term real interest rate may lead to running into the lower bound more frequently. This would interfere with the ability of monetary policy to stabilize the economy and could lead to more frequent and protracted recessions. A higher inflation target would allow the long-term nominal interest rates to increase, as market participants increase their inflation expectations accordingly with a higher target. If market participants' expectations rise, it is reflected in rising inflation. This reduces the risk of repeatedly running into the zero lower bound.

However, it is unclear by how much the inflation target must be increased; estimates range from 2.2 to 4.0 percent.¹⁷

¹⁵ Laurence M. Ball, "The Case for a Long-Run Inflation Target of Four Percent," *IMF Working Papers* 14, no. 92 (2014); Olivier Blanchard et al., "Rethinking Macroeconomic Policy," *Journal of Money, Credit and Banking* 42 (2010): 199–215; John C. Williams, "Monetary Policy in a Low R-star World," *FRBSF Economic Letter* 23 (August 2016).

¹⁶ This decline can be for various reasons: lower productivity growth overall or an increased preference for secure assets, for instance. Cf. Kathryn Holston, Thomas Laubach, and John C. Williams, "Measuring the natural rate of interest: International trends and determinants," *Journal of International Economics* 108 (2017): 59–75; Thomas Laubach and John C. Williams, "Measuring the Natural Rate of Interest Redux," *Finance and Economics Discussion Series* 11 (2016), Board of Governors of the Federal Reserve System.

¹⁷ Using a New Keynesian model, some studies agree on an inflation target of 2.2 percent for the euro area and 2.4 percent for the USA. Cf. Philippe Andrade et al., "The optimal inflation target and the natural rate of interest," *NBER Working Paper*, no. 24328 (2018). Others argue for an inflation target of around four percent for advanced economies. Cf. Ball, "The Case for a Long-Run Inflation Target of Four Percent."

It must also be noted that the central bank rarely runs into the zero lower bound during periods of average economic growth. A higher inflation target, in contrast, may lead to permanently higher inflation, which causes permanent dead-weight loss.¹⁸ In addition to these uncertainties, it is questionable if the ECB would succeed in anchoring inflation expectations at a higher level in the coming years. Since 2013, inflation in the euro area, measured by multiple indicators, has been significantly below two percent (Figure 3). Long-term inflation expectations also deviate from this. Some studies point out that inflation expectations are no longer in line with the ECB's objective and have weakened its credibility.¹⁹

Fixed interval instead of a point target

In an international comparison, combining a quantitative point target and a qualitative tolerance interval is not a strategy frequently taken. Instead, many central banks have defined quantified intervals (tolerance intervals or tolerance bands) around the target, usually of one percentage point, in addition to a quantitative point target.

However, the meaning of these intervals differs. The Reserve Bank of Australia and the Reserve Bank of New Zealand define an inflation tolerance interval as a quantitative

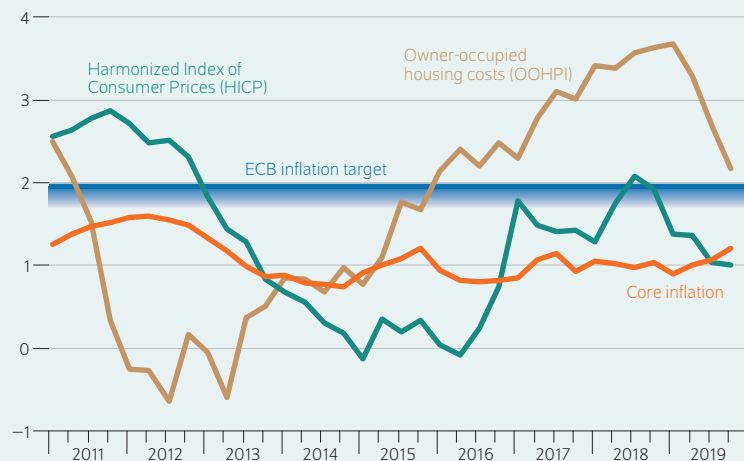
¹⁸ Ben Bernanke, *Modifying the Fed's policy framework: Does a higher inflation target beat negative interest rates?* Blog post, September 2016.

¹⁹ Cf. Dieter Nautz, Laura Pagenhardt, and Till Strohsal, "The (de-)anchoring of inflation expectations: New evidence from the euro area," *The North American Journal of Economics and Finance* 40 (2017): 103–115; Geraldine Dany-Knedlik and Oliver Holtemöller, "Inflation dynamics during the financial crisis in Europe: Cross-sectional identification of long-run inflation expectations," *IWH Discussion Papers*, no. 20 (2017).

Figure 3

Development of consumer prices and owner-occupied housing costs

Year-on-year change in the indices in percent



Note: For the overall euro area OOHPI, the country-specific OOHPIs for Austria, Belgium, Germany, France, Spain, Italy, and the Netherlands have been aggregated on the basis of HICP country weights.

Sources: Eurostat; European Central Bank; authors' own calculations.

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Owner-occupied housing costs have risen much faster in recent years than the HICP (with and without energy and food costs).

objective of price stability. The main reason for implementing tolerance intervals is the assumption that monetary policy cannot control inflation precisely but can only keep it within an interval due to the transmission lag of monetary policy and short-term shocks. However, tolerance intervals can lead to fluctuating inflation expectations. By contrast, the quantitative tolerance bands of the Bank of England and the Central Bank of Iceland are used solely to hold their respective governments accountable and are not a direct part of the price stability objective. The *Sveriges Riksbank* and Czech National Bank have upper and lower bounds for how much inflation may deviate from the point target. Tolerance intervals are intended to illustrate that even with a normal level of uncertainty, inflation can vary around the point target. It could be advantageous for the ECB to set a quantitative tolerance interval to make it clear to what extent any deviation from the point target is due to general uncertainty and the delayed impact of monetary policy.

Climate change poses monetary policy risks

The ECB is also analyzing climate risks and their implication for monetary policy as a part of its strategy review.²⁰ Climate change will entail broad structural change and poses considerable financial risks for private households, businesses, and financial institutions. Thus, it is a part of the ECB's mandate

²⁰ See the website of the European Central Bank (available online).

Box

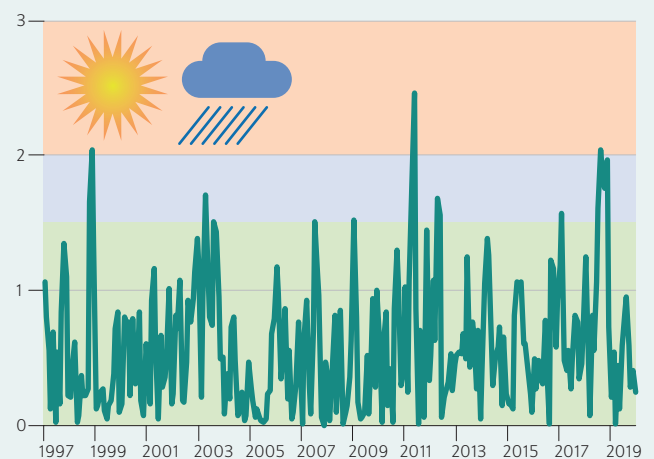
Macroeconomic effects of extreme weather events in Europe

Extreme weather events, such as extremely high temperatures, droughts, and persistent precipitation affect agricultural prices and yields as well as the economy. Over the past decades, the frequency of extreme weather events has also increased significantly in Europe.¹ To quantify the economic effects of extreme droughts and precipitation, vector autoregression (VAR) models were estimated for Germany, France, and Italy. In each case, industrial production (excluding construction), two-year government bond yields, the HICP (excluding energy and food), and construction output at monthly frequency are taken into account. For Germany, a model which includes the producer price index for agricultural goods and short-time work is used to estimate further economic effects.² The Standardized Precipitation Index (SPI) is used to measure precipitation abnormalities and is available at a regional level according to the European NACE-3 regions. The SPI is an indicator for measuring precipitation anomalies in a specific location.³ If the SPI declines to below

Figure 1

Standardized Precipitation Index (SPI) for Germany

Index in points, absolute deviation from normal monthly rainfall



Note: A value above two indicates extreme drought/rain, a value between 1.5 and two indicates conditions are very dry/wet, a value below 1.5 is dry/wet from a moderate to a normal degree.

Sources: European Commission; European Drought Observatory.

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In Germany, precipitation anomalies last occurred during the 2018 drought.

¹ Cf. European Academies Science Advisory Council, "Trends in extreme weather events in Europe: implications for national and European Union adaptation strategies," *EASAC Policy Report 22* (2013) (available online).

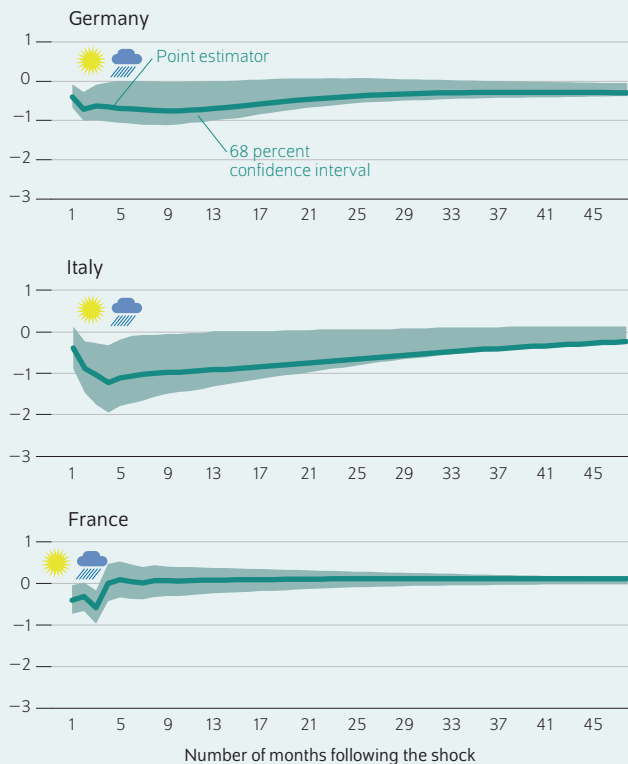
² This data is not available or only available for brief time periods for other countries.

³ Daniel C. Edwards and Thomas B. McKee, "Characteristics of 20th century drought in the United States at multiple time scales," *Climatology Report*, no. 97-2 (Colorado State University: 1997).

Figure 2

Industrial production in different countries' reaction to an extreme weather event

In percent



Source: Authors' own calculations.

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The effects of extreme weather on industrial production are particularly marked in Italy.

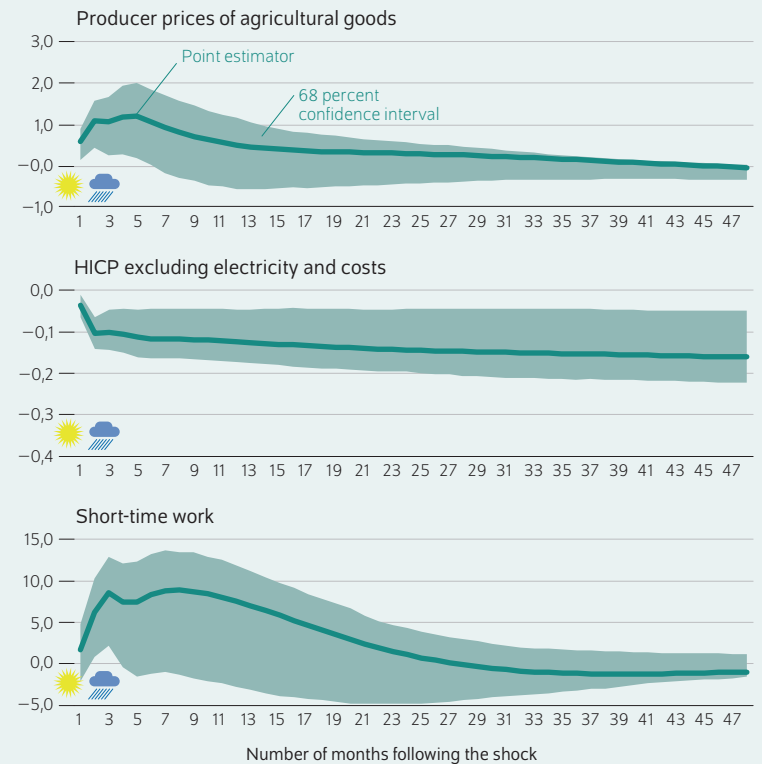
–1.5, this indicates very low rainfall; values below –2.0 indicate extreme drought. Positive values, on the other hand, indicate unusually wet conditions. To achieve an SPI index at a country level, the arithmetic average for all regional indices of a country is calculated. Subsequently, this displays the absolute values of the SPI, as both (extreme) droughts and (extreme) precipitation can affect economic activity (Figure 1). These index values are used as the first variable in the VAR models. All other variables, with the exception of yields on government bonds, are in log levels. The models are estimated with six lags. An exogenous increase (shock) in the SPI is identified upon the assumption that extreme weather events are not influenced by other variables. The shock is scaled so that it represents the occurrence of an extreme drought or extreme precipitation, so an increase of at least two SPI points in absolute values.

The empirical results show that a country's industrial production significantly declines in reaction to an extreme weather event (Figure 2). Over the first four quarters after the event, industrial production in Germany declines by 0.6 percent, in France by 0.1 percent, and in Italy by 0.9 percent.

Figure 3

The reaction of various macroeconomic variables in Germany to an extreme weather shock

In percent



Source: Authors' own calculations

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Extreme drought or rain especially affect agricultural and consumer prices.

The expanded model for Germany shows that after a weather shock, short-time work expands alongside the slowdown in the real economy (Figure 3). Over the course of the slowdown, consumer prices decline. However, as expected, the prices of agricultural goods increase significantly. The construction sector shows no significant reaction to weather changes. This is likely due to the fact that drought is unlikely to cause construction delays and excessive rainfall is likely to only partially restrict construction activity.

Overall, the estimates show that weather events can influence business cycle dynamics in Europe. Thus, weather events are playing an increasing role in the ECB's macroeconomic analysis.

to assess climate risks.²¹ According to the EU Treaties, the ESCB should support the general economic policies of the EU provided that price stability is not affected. One important economic policy objective is explicitly stated as being “a high level of protection and improvement of the quality of the environment” (Article 3(3)).²²

The ECB is currently advocating for a sustainable financial system and the financing of a low-carbon economy, for example via the Network for Greening the Financial System (NGFS). As part of its strategy review, the ECB is expected to further analyze how climate risks affect monetary policy via price and financial stability. Building on this, climate-related factors should be included in the macroeconomic and financial stability analyses.²³

Climate risks to price stability

Extreme weather events such as heat waves, storms, or floods, referred to as physical risks, can directly affect prices and the real economy. Different studies show that the inflation rate can increase following a natural catastrophe.²⁴ Simultaneously, growth and productivity can decline due to a loss of physical capital, supply chain interruptions, and reduced labor supply (Box). Such supply shocks carry the risk of inflation and output developing in opposite directions, which makes economic stabilization more difficult.²⁵

On the demand side, extreme weather events affect consumption in the form of asset losses by private households. If certain risks can no longer be insured, the consequences of climate change could result in, for instance, a greater propensity to save. Furthermore, migration can lead to changes in demand. Uncertainty regarding the future development of demand as well as climate risks in general may in turn hamper investment activity. Climate policy can also influence price stability, for example through increases in prices of emission-intensive goods and services or through structural changes from investments in individual sectors.

Climate risks to financial stability

Climate risks directly affect the real economy and have consequences for the financial system as well. On the one hand, extreme weather events and long-term climate changes such as sea level rise or changes in precipitation can have economic costs. Uninsured losses can affect the solvency of private households, companies, and governments, and result in losses of

value on loans, bonds, and shares. If financial intermediaries do not have enough cushioning to carry these losses, they may end up in a precarious situation and potentially trigger contagion effects through the banks. An increase in insured losses may in turn put pressure on the insurance sector.

On the other hand, despite the opportunities offered by transitioning to a low-carbon economy, risks arising from political and regulatory uncertainties, technological shocks, or changes in consumer preferences cannot be ignored. Furthermore, stranded assets can cause systemic risks. For example, to achieve the climate target, a significant share of existing coal, gas, and oil must remain unused, causing the value of the companies involved to plummet. Financial institutions that are heavily involved in these sectors could thus come under pressure and trigger contagion effects in the financial system through emergency asset sales.

Economic analysis and portfolio management

All of these factors play a role in the macroeconomic analysis as well as in how the ECB manages its portfolio. To ensure price stability during a time of increasing climate risks, it is necessary to develop and monitor indicators of transition and physical climate risks to the real economy and the financial system.²⁶ Such indicators should then become a standard part of the ECB’s forecasting models and financial stability analysis. Stress tests could also be extended to include climate risks.²⁷

Financial risks related to climate change are also likely to be increasingly incorporated into the ECB’s asset management activities, such as managing public service pensions, to improve the risk-return profile.²⁸ In addition, the question arises to what extent climate risks should be taken into account when purchasing bonds during quantitative easing or in the collateral eligible for central bank loans to commercial banks. To date, monetary purchases of securities are performed according to the principle of market neutrality to avoid market distortions. According to a 2017 study, this leads to a high share of CO₂-intensive companies in the political portfolio of central banks.²⁹ Empirical findings indicate that the market does not fully assess climate risks.³⁰ Not only

²¹ Mark Carney, “Breaking the Tragedy of the Horizon—Climate Change and Financial Stability,” Speech at Lloyd’s of London (London: September 2015) (available online).

²² Treaty on European Union (consolidated version). *Official Journal of the European Union* C 326 (2012) (available online).

²³ Cf. Committee on economic and monetary affairs, Monetary dialogue with Christine Lagarde (pursuant to article 284(3) TFEU), Brussels, December 2019 (available online).

²⁴ Patrick Bolton et al., “Central banking and financial stability in the age of climate change,” Bank for International Settlements (2020); Marcel Fratzscher, Malte Rieth, and Christoph Grosse-Steffen, “Inflation targeting as a shock absorber,” *Journal of International Economics* (forthcoming).

²⁵ Cf. François Villeroy de Galhau, “Climate Change: Central Banks Are Taking Action,” *Banque de France Financial Stability Review*, no. 23 (2019): 7–16.

²⁶ Therefore, it is necessary to generate consistent data on the emission intensity of companies in addition to consistent methodical aspects. Cf. Task Force on Climate-related Financial Disclosures, *Status Report*, June (2019).

²⁷ Cf. Stefano Battiston et al., “A Climate Stress-Test of the Financial System,” *Nature Climate Change* 7, no. 4 (2017): 283–288. In 2021, the Bank of England will test the resilience of the largest British banks and insurers to climate risk. Cf. Press release from December 18, 2019 (available online).

²⁸ Cf. Network for Greening the Financial System, *A sustainable and responsible investment guide for central banks’ portfolio management* (October 2019) (available online).

²⁹ Sini Matikainen, Emanuele Campiglio, and Dimitri Zenghelis, “The climate impact of quantitative easing,” Policy Paper, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science. However, the ECB has since acquired “green” shares, cf. ECB Economic Bulletin, no. 7 (2018).

³⁰ Cf. Sandra Batten, Rhiannon Sowerbutts, and Misa Tanaka, “Let’s talk about the weather: the impact of climate change on central banks,” *Bank of England Staff Working Paper*, no. 603 (2016); José Manuel Marqués Sevillano and Luna R. González, “The risk of climate change for financial markets and institutions: challenge, measures adopted and international initiative,” *Bank of Spain Financial Stability Review* 34 (2018): 111–134.

could financial risks be underestimated if a central bank's bond portfolio focuses too heavily on emission-intensive sectors. This investment strategy can also slow the structural change to a low-carbon economy if companies whose shares are used for monetary policy measures profit from more favorable financing costs. Different observers therefore call for greater consideration to be given to "green" securities, both in bond purchases and in eligible collateral for central bank credit.³¹ On the one hand, the consequences of climate change are not sufficiently included in current ratings, which leads to the possibility of underestimating the risks of bonds issued by emission-intensive companies, for example. On the other, the question arises as to whether market-neutral bond purchases, i.e., purchases in line with market capitalization, are appropriate, as they mean that large, emission-intensive companies are overrepresented in the central bank portfolio in terms of their contribution to value added.

³¹ Cf. Paul de Grauwe, "Green Money without Inflation," *Vierteljahreshefte zur Wirtschaftsforschung* 2 (2019): 51–54; Matikainen et al., "The climate impact of quantitative easing."

Franziska Bremus is a research associate in the Macroeconomics Department at DIW Berlin | fbremus@diw.de

Geraldine Dany-Knedlik is a research associate in the Macroeconomics Department and the Forecasting and Economic Policy Department at DIW Berlin | gdanyknedlik@diw.de

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Conclusion: Modify the definition of price stability, evaluate impact of climate change

The ECB's review of their monetary policy strategy offers the opportunity to gauge the effectiveness of European monetary policy, incorporate risks more effectively and comprehensively, and evaluate potential side effects of current monetary policy. It is likely that the ECB's definition of price stability will change in accordance with its mandate of maintaining price stability. It would be reasonable to set an explicit, quantitative tolerance interval around the inflation target. Moreover, housing costs should be incorporated more widely when measuring inflation.

In regards to assessing the impact of climate change, as far as the data allows it, it should be evaluated to what extent the market is currently underestimating climate risks and how the ECB's monetary policy measures affect the financing conditions of "green" and "brown" economic sectors. This is important to ensure adequate ECB risk management as well as to accurately estimate how the ECB's current investment strategy will affect the transition to a more sustainable economic and financial system.

Thore Schlaak is a research associate in the Forecasting and Economic Policy Department at DIW Berlin | tschlaak@diw.de