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The first twenty years of the European Central Bank: Monetary policy

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Philipp Hartmann, Frank Smets The first twenty years of the European
Central Bank: monetary policy

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Abstract:

On 1 June 2018 the ECB celebrated its 20th anniversary. This paper provides a comprehensive view of the ECB's monetary policy over these two decades. The first section provides a chronological account of the macroeconomic and monetary policy developments in the euro area since the adoption of the euro in 1999, going through four cyclical phases "conditioning" ECB monetary policy. We describe the monetary policy decisions from the ECB's perspective and against the background of its evolving monetary policy strategy and framework. We also highlight a number of the key critical issues that were the subject of debate. The second section contains a partial assessment. We first analyze the achievement of the price stability mandate and developments in the ECB's credibility. Next, we investigate the ECB's interest rate decisions through the lens of a simple empirical interest rate reaction function. This is appropriate until the ECB hits the zero-lower bound in 2013. Finally, we present the ECB's framework for thinking about non-standard monetary policy measures and review the evidence on their effectiveness. One of the main themes of the paper is how ECB monetary policy responded to the challenges posed by the European twin crises and the subsequent slow economic recovery, making use of its relatively wide range of instruments, defining new ones where necessary and developing the strategic underpinnings of its policy framework.

Key words: European Central Bank, monetary policy, European Economic and Monetary Union, euro area economy, inflation, crisis, non-standard measures, zero-lower bound

JEL codes: E52, E31, E32, E42, N14, G01

Non-technical Summary

This paper reviews the European Central Bank's monetary policy during its first twenty years of existence. Overall, the ECB has delivered on its price stability mandate despite the very challenging crisis times of the last decade. Average inflation over this period has been 1.7 percent, which is in line with the ECB's aim of maintaining inflation below but close to 2 percent over the medium term. However, this average number masks quite stable inflation around 2 percent before the outbreak of the financial and sovereign debt crisis and a much more volatile and on average lower inflation rate around 1.5 percent thereafter. Throughout the whole twenty years, average five-year ahead inflation expectations, as captured by the Survey of Professional Forecasters, have remained stable within a narrow range between 1.8 and 2.0 percent, underlining the ECB's credibility. But following the sovereign debt crisis when headline inflation and various core inflation measures declined significantly below 1 percent, a series of indicators pointed to the emergence of tangible deflation risks. They only disappeared after the ECB initiated a comprehensive easing package starting in June 2014 – including quantitative easing, targeted credit operations and negative policy rates – and thereby dispelled doubts about whether it had an effective tool kit to address risks of deflation in a close-to-zero interest rate environment. Headline inflation is currently 2 percent (August 2018) and underlying inflation, while still subdued, is slowly converging back to close to 2 percent.

One issue debated regarding this price stability track record is whether the ECB could have been more proactive in responding to the fall-out from the sovereign debt crisis in the period from mid-2010 to mid-2012. A fair assessment requires a real-time and not an ex-post perspective. The simple real-time policy reaction function used in the paper arguably suggests that both the policy rate tightening in 2011 and the subsequent easing were broadly in line with the ECB's own and other professional forecasters' growth and inflation projections at the time. Moreover, this period was increasingly characterised by solvency issues in both banking and government finances, which lingered on for too long and reinforced each other in the absence of sufficient institutions and tools for solving the related collective action problems in a highly integrated monetary union of sovereign states with primarily national fiscal and supervisory policies. The unresolved public and private balance-sheet problems and the resulting financial fragmentation in the euro area provided tremendous obstacles to the effectiveness of the ECB's monetary policy. At the same time, monetary policy cannot directly address such solvency issues. In fact, the prohibition of monetary financing forbids the ECB to directly finance governments or government tasks such as the recapitalization of banks. Against this background, the ECB's actions had to balance the need to address impairments in the transmission of monetary policy due to malfunctioning financial markets and self-fulfilling market dynamics with that prohibition. This may explain, in part, what some observers regard as initially timid interventions in the government bond market through the Securities Markets Programme in 2010 and 2011. Only when solutions to the main weaknesses of EMU in the prudential and fiscal fields were put on a credible path around the key European Summit in June 2012, the ECB could confidently step up its non-standard toolkit to the next level. This led to the powerful Outright Monetary Transactions programme in August 2012 and to the comprehensive easing package mentioned above.

Overall, the main building blocks of the ECB's original monetary policy strategy and framework, its quantitative definition of price stability, the two pillars of economic and monetary analysis, the communication and accountability framework and the broad-based and flexible operational framework have served the ECB well over the past twenty years. But, as described in the paper, it was important that they evolved in response to the challenges of the time.

For example, as initial doubts by some observers about the ECB's anti-inflation credibility during the early years turned into concerns about the ability to address downward risks to price stability in a low-rate environment, the quantitative inflation aim was clarified as being close to 2 percent, providing a buffer against the zero-lower bound. The analysis of the ECB's interest rate reaction function in the paper suggests that the ECB pursued this inflation aim symmetrically. Moreover, this analysis indicates that the economic analysis and the quarterly macro-economic projections formed the main basis for the monthly monetary policy decisions. At the same time, the monetary analysis provided a cross-check. It evolved from a narrower focus with emphasis on a reference value for M3 growth based on the quantity theory of money, which was useful in the first years to borrow the Bundesbank's credibility, to a broad-based assessment of monetary developments and the state of financial intermediation and bank lending in the euro area economy. Before the crisis, this broad-based analysis was useful for considering the build-up of financial imbalances, though the interest-rate analysis in the paper does not show evidence that the ECB pursued a leaning-against-the-wind monetary policy approach. At the time the ECB did have neither a microprudential nor a macroprudential policy mandate and the related tools to address the financial imbalances at the source. Only with the advent of Banking Union, did the ECB acquire an important banking supervisory role as of November 2014, which implied comprehensive microprudential and some limited macroprudential responsibilities. Following the outbreak of the financial crisis, the broadened monetary analysis was increasingly helpful in assessing fragilities in the banking sector and how they influence bank lending and the monetary policy transmission mechanism, as well as the effectiveness of some of the non-standard measures.

Also the communication and accountability framework adjusted, as the need for additional communication in a complex (non-standard) policy environment rose and forward guidance became an essential tool for easing policy in a low interest rate context. Finally, the ECB's operational framework was well suited to provide ample liquidity to the ECB's wide set of counterparties and against a wide set of collateral quickly when the money market froze. This helped addressing impairments in the early steps of the monetary transmission mechanism and also contributed to financial stability. Moreover, when the zero-lower bound became more and more a constraint after the sovereign debt crisis, the operational framework proved broad and flexible enough to allow the ECB to expand its tool set with other non-standard policy measures. A review of available research on the effectiveness of the ECB's non-standard measures in easing financial conditions, stimulating the economy and bringing inflation back to the ECB's inflation aim – also in comparison to the evidence from other constituencies having used similar instruments, such as the US or the UK – is quite encouraging and suggests that concerns that central banks may be powerless when interest rates hit the zero lower bound may be overdone.

All in all, the ECB has adjusted its monetary policy to the changing and challenging circumstances over time, making effective use of its strategy and framework and maintaining a clear focus on its primary mandate of price stability in the medium term. Broadening its tools over time it has become

more similar to many of its peers as well. At the same time, some elements of its policy framework seem to have inspired changes in other central banks' frameworks, including the medium-term orientation of its price-stability objective, the transparency and accountability associated with a press conference of the President and Vice-President soon after the formal monetary policy meetings and the broad and flexible operational framework.

A series of important reforms following the crises – in particular the establishment of the European Stability Mechanism, the implementation of the first two legs of the Banking Union – the Single Supervisory and Resolution Mechanisms –, the signing of the Fiscal Compact and the introduction of a European Semester with a Macroeconomic Imbalance Procedure – have addressed some of the incompleteness of EMU that complicated the ECB's mission to maintain price stability over the past decade. Looking forward, the ECB's monetary policy will benefit tremendously from a thorough implementation of these reforms, compliance with their objectives and rules and further progress with completing European Economic and Monetary Union along the lines of the 2015 Five Presidents report.

1. Introduction

European Economic and Monetary Union (EMU) is an unprecedented historical project in which initially eleven European Union (EU) countries introduced a common currency – the euro –, with a single central bank – the European Central Bank (ECB) – and a single monetary policy. By the time of writing nineteen quite diverse EU countries have joined the euro area, meaning that the ECB runs the monetary policy for 340 million citizens (compared, for example, to the 325 million citizens for the United States Federal Reserve System) or an economic area that constitutes 11% of world GDP (compared to 16% for the US or 18% for China, all in purchasing power parity terms). The motivation for this paper is that on 1 June 2018 the ECB celebrated its 20th anniversary. As two economists who have been on the staff of the ECB from the beginning, we take this opportunity to look back at the first two decades of our institution, describing and assessing its experience with monetary policy.

An important starting point is the statutory objectives of the ECB, as laid down in the Treaty on the Functioning of the European Union and the Treaty on European Union (EU 2012a,b).¹ The ECB's primary objective is to maintain price stability. Without prejudice to the objective of price stability, the ECB shall also support the general economic policies in the European Union with a view to contributing to the achievement of the objectives of the EU. These (often called secondary) objectives include, for example, balanced economic growth and a highly competitive social market economy, aiming at full employment and social progress. This hierarchy of objectives is interpreted in lexicographic order (see e.g. Driffill and Rotondi, 2004 or Buiter in Touffut 2008, p. 178). Only to the extent that the primary objective is fulfilled can the ECB consider growth and full employment. Such "single" central bank mandates, focussing on price stability as the primary objective, are quite common in advanced economies. For example, they apply to all G-7 central banks, except the US Federal Reserve.

From the euro's introduction in January 1999 (the beginning of "stage 3" of EMU), the ECB started with a strong and self-contained mandate to define and implement monetary policy for the euro area. For other tasks that central banks often fulfil, however, it had more indirect or contributing roles, notably in the prudential and financial stability arena. (See EU 2012b,c for the full list of ECB tasks and functions.) In November 2014, however, the ECB was conferred the role as banking supervisor for the countries that joined the European Banking Union (congruent with the euro area). It has to conduct banking supervision and monetary policy separately.

This paper focuses on the ECB's experience with conducting monetary policy for the euro area.² Our overall goals are to provide a rigorous and comprehensive "inside" view of what the ECB was concerned with in this area, how its monetary policy evolved during its first twenty years and how it performed in achieving its primary objective of maintaining price stability. Obviously, one main theme of the paper is how the ECB responded to the enormous challenges posed by the European

¹ For simplicity we are abstracting from the legally precise distinctions between the ECB, the Eurosystem (comprising the ECB and the national central banks of countries that have joined EMU) and the European System of Central Banks (ESCB, comprising the Eurosystem and all other EU central banks). National central banks play an important role in ECB decisions, their preparation and implementation, but unfortunately we do not have the space in this paper to provide a proper account of these collective aspects of Eurosystem functioning.

² In a companion paper we discuss the ECB's experience with financial stability (Hartmann and Smets, in progress).

twin crises and the subsequent slow economic recovery, making use of its relatively wide range of instruments, defining new ones where necessary and developing the strategic underpinnings of its policy framework. But given the main motivation for our paper we should not limit the attention only to the second decade of the ECB's existence.

Before we delve deeper into the details of the ECB's monetary policy, we provide a perspective on the broader issues that the ECB was concerned with over the last twenty years via the themes that ECB Executive Board members addressed in their public communications.³ Figure 1 shows the number of public speeches Board members held every year between 1999 and 2017. The colours refer to the shares of these speeches that were dedicated to any of nine different themes respectively. We did not pre-determine the themes. We rather applied a machine learning approach to uncover them from the texts of the 1,892 Board speeches displayed on the ECB website for the period May 1998 to April 2018. (As of 2014, the data set also includes the speeches by the Chair, Vice-Chair and the four ECB representatives of the Supervisory Board of the Single Supervisory Mechanism at the ECB.) Using the Latent Dirichlet Allocation method for textual analysis (Blei et al. 2003) and the Cao et al. (2009) metric for the optimal number of topics, we identify 50 specific topics that have been addressed in these speeches over time. For the purpose of the first general overview in Figure 1 we group the rather large number of topics in the nine general themes displayed.⁴

[Insert Figure 1 around here]

The results give a good impression of the breadth of issues that the ECB was concerned with (via the external communication of Board members) and how they changed over time. First, the core theme of “monetary policy and inflation” covered a sizeable share most of the time, but it was particularly important at the start of the ECB (1999), when the financial crisis hit (2007-2009) and during the post-sovereign debt crisis, low-inflation recovery (2013-2017). Clearly, these were three periods with increased needs for monetary policy communication. Second, financial stability and supervisory issues received particular attention when the financial crisis struck and after the 2012 agreement about the European Banking Union that granted supervisory responsibility to the ECB. Third, growth and productivity, fiscal matters and international developments, which all have implications for the conduct of monetary policy, received regular attention. But the attention paid to public debt and sovereign risk was most pronounced when the financial crisis morphed into the European sovereign crisis. Structural and competitiveness issues were very much discussed before the breakout of the financial crisis.

Board members also addressed a number of other themes of great importance for the ECB that we will not touch upon at all in this paper. For example, one can see in Figure 1 that in 2001 – before the introduction of euro notes and coins in 2002 – Board members prepared the public for the cash changeover. In 2004 and 2005, at the time of the major eastern enlargement of the EU, they

³ The Board comprises the ECB President, Vice-President and four further members, which are appointed by the European Council usually for a period of 8 years (EU 2012b,c). They are collectively responsible for the current business of the ECB and play an important role in the Governing Council, the main decision-making body of the ECB and the Eurosystem. The other Governing Council members are the governors of the euro area national central banks.

⁴ For a more detailed description of the methodology applied and how Figure 1 has been derived, please see our companion paper Hartmann and Smets (in progress).

communicated more about accession and convergence issues. Finally, payment and settlement issues played a greater role in Board members' external communications (in 2006) shortly before the ECB's initial TARGET large-value payment system migrated to the single-platform TARGET2 system and during the year when the TARGET2-Securities project was launched to establish a single, pan-European platform for securities settlement (2008).

Returning to the main focus of the paper, Figure 2 shows only the speeches dealing with the core theme of "monetary policy and inflation" – the violet area in Figure 1, breaking it down in the shares of the ten underlying topics that fall under this theme (out of 50 found by our machine learning algorithm). In the beginning the largest focus was on explaining the monetary policy strategy of the new institution, including the monetary analysis part of it (see sub-section 2.1.1 below). In the financial crisis period, ECB market operations and liquidity management became an important focus, in line with the policy approach taken at the time (see sub-section 2.3.2 below). In the last period, the focus of Board members' public speeches moved to how the ECB used non-conventional monetary policy measures, such as large-scale asset purchases and negative interest rates (dark green and pink areas in Figure 2), to strengthen the fragile recovery and ensure that inflation returns to the ECB's objective (light blue area) in an environment of interest rates close to their effective lower bound (see sub-section 2.4.2 below).

[Insert Figure 2 around here]

The rest of the paper is organised in two main sections. Section 2 provides a chronological account of the macroeconomic, monetary and financial developments in the euro area since the adoption of the euro as well as of the ECB's monetary policy decisions. We divide the section in the four cyclical phases that "conditioned" ECB monetary policy between 1999 and 2018, namely the end of the technology cycle, the economic upturn with build-up of imbalances, the "double-dip" recessions associated with the financial and sovereign debt crises and the low-inflation recovery. Each of these four sub-sections in turn has three parts: a first on developments in the ECB's monetary policy strategy and operational framework; a second on the conjuncture and actual decisions; and a third ("discussion" sub-section) in which we highlight some key critical issues that were the subject of public debate.

In section 3, we try to assess selected key aspects of the ECB's monetary policy in the last twenty years. We first analyse the achievement of the price stability mandate and developments in the ECB's credibility and discuss possible implications for the ECB's inflation aim (sub-section 3.1). Next, we examine the ECB's interest rate decisions through the lens of a simple empirical interest rate reaction function (sub-section 3.2). This is appropriate until the ECB hits the zero-lower bound in 2013. Finally, we present the ECB's framework for thinking about non-standard monetary policy measures (many of which draw on its broad and flexible framework for market operations) and review the evidence on the effectiveness of the non-standard instruments that have been used (sub-section 3.3). Section 4 discusses some conclusions, including for how completing EMU could support the ECB's monetary policy.

2. Two decades of ECB monetary policy: from the two pillars to quantitative easing

This section discusses the ECB's monetary policy over the past two decades. It contains a chronological overview of the main macroeconomic, monetary and financial developments in the euro area since the adoption of the euro in January 1999 and how the ECB responded to them in pursuit of its price stability mandate. Taking a business cycle perspective, we use – inter alia – the euro area output gap estimates and unemployment rate shown in Figure 3 for identifying troughs and peaks (marked by dashed vertical lines). This leads to four episodes corresponding to cyclical downturns and upturns: the initial period of a growth slow-down following the collapse of the dotcom-bubble accompanied by a weak euro exchange rate (1999-2003); the boom period in money and credit growth accompanied by relatively stable inflation and accelerating growth (2004-2007); followed by the double-dip recession due to the outbreak of the US financial crisis and the emergence of the euro area sovereign debt crisis (2008-2013); and finally, the most recent low-inflation recovery period (2014-2017). Figure 4 provides an overview of the four periods for some main macroeconomic variables (upper panel) and two key monetary policy indicators (lower panel). The figure also marks major ECB monetary policy actions (lower panel) and other important events (upper panel) characteristic for the respective period.

[Insert Figure 3 around here]

[Insert Figure 4 around here]

2.1. The beginning of ECB monetary policy towards the end of the technology cycle (January 1999 – June 2003)

2.1.1 A new stability-oriented monetary policy strategy and operational framework for the ECB

As discussed in the introduction, the Treaty creating the monetary union established price stability as the primary objective of monetary policy in the euro area. Under the leadership of Otmar Issing, its first chief economist, the ECB early on developed a monetary policy strategy with the aim of providing a solid basis for the conduct and communication of monetary policy in pursuit of price stability.⁵ It also developed an elaborate operational framework for implementing monetary policy decisions.⁶ In addition to being operationally ready from day one, there were two main and interrelated challenges. The first challenge was to establish as quickly as possible the credibility of the newly established institution for maintaining price stability. A high level of initial credibility would facilitate the transition to EMU and reduce the potential costs of having to build such credibility.⁷ The second challenge was to ensure a consistent and systematic approach to the conduct of monetary policy in an uncertain economic environment following a fundamental regime

⁵ See ECB (1999) and Issing, Gaspar, Angeloni and Tristani (2001) for an extensive presentation and justification of the original two-pillar stability-oriented monetary policy strategy.

⁶ See ECB (2000b). The monetary policy strategy and operational framework were developed on the basis of extensive preparatory work carried out by the European Monetary Institute (the predecessor of the ECB).

⁷ Whether the ECB would have a deflationary bias in order to establish its anti-inflation credibility was hotly debated at the time. See, for example, Begg et al (1998, 1999).

change and where the NCBs preceding the ECB/Eurosystem had different frameworks and traditions. Robustness in the face of pervasive uncertainty and country heterogeneity was seen as an important guiding principle for the design of the new strategy (Issing et al, 2005, and Issing, 2008). In response to these two challenges, three main components were developed: first, a quantitative definition of the ECB's primary objective of price stability as a clear yardstick for accountability; second, a two-pillar framework as the organising principle for the analysis underlying the assessment of the outlook for price developments; and third, an elaborate communication and accountability framework. Before describing the economic and monetary developments in this initial phase, we briefly describe these three elements. We also briefly characterize the initial operational framework. As we will discuss in subsequent sections, elements of these building blocks have evolved over time responding to the challenges of the time (see also Constancio, 2018).

The quantitative definition of price stability

In December 1998, the Governing Council of the ECB adopted a quantitative definition of price stability, which reads: "Price stability shall be defined as a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%. Price stability is to be maintained over the medium term." This definition allows economic agents and observers to assess the ECB's performance at any time and over any horizon. It enhances the ECB's accountability by forcing the central bank to explain why inflation has at times deviated from its definition and it thereby helps anchoring medium- to long-term expectations. The definition focuses on the euro area as a whole, reflecting the fact that, within a monetary union, monetary policy cannot address country-specific inflation developments. It makes clear that medium-term inflation above 2% is not consistent with price stability. However, it also implies that very low inflation rates, and especially deflation, are not consistent with price stability either. Following criticism of the perceived asymmetry of the quantitative definition, this was clarified, for example, by President Duisenberg in an early speech explaining the new strategy.⁸

Another important feature is the medium-term orientation of the ECB's strategy. Since monetary policy can affect price developments only with significant and variable time lags, and only to an extent that is uncertain, it is impossible to maintain a specific predefined inflation rate at all times or to bring it back to a desired level within a very short period of time. Consequently, monetary policy needs to act in a forward-looking manner and focus on the medium term. This also helps to avoid excessive activism and the introduction of unnecessary volatility into the real economy thereby contributing to the stabilisation of output and employment. See, for example, Batini and Nelson (1999) and Smets (2003) for showing the equivalence between the length of the policy horizon and the weight on output gap stabilisation. Against the background of inflation forecast targeting strategies that were popular at the time, two aspects of the ECB's medium-term orientation are worth mentioning. First, the ECB has always emphasised that there is no fixed-time -horizon over

⁸ Duisenberg (1999): "Some observers have criticised the strategy as "asymmetric". In other words, they argue that the Eurosystem is more concerned about inflation than it is about deflation. In their view, such asymmetry will impose a drag on the overall performance of the euro area economy as a whole because monetary policy will be overly restrictive on average, and risks triggering a damaging deflationary spiral in some circumstances. ... I reject this criticism. The use of the word "increases" in the definition imposes a floor of at least zero for the lower bound. ... Let me state categorically, as I have often done in the past, that neither prolonged inflation nor prolonged deflation in the euro area would be deemed by the Governing Council to be consistent with the maintenance of price stability."

which price stability has to be re-established, as monetary policy should react differently to different sources of economic shocks (e.g. demand versus supply shocks).⁹ Secondly, the medium-term orientation implies a lengthening of the monetary policy horizon beyond the usual two years typically associated with the horizon of inflation forecasts and the lags in monetary policy transmission. For example, Trichet (2003b) states that, “Monetary policy needs to focus on the period covering the whole transmission process, bearing in mind that this may sometimes span a protracted period of time”. As a result, also the horizon for evaluating the credibility of the central bank should extend beyond two years. In section 3.1 we will take an admittedly somewhat arbitrary 5-year horizon which typically should be enough to let the effects of the shocks the central bank cannot control wash out.

The two-pillar framework

In the original formulation, the “two pillars” of the strategy were described as i) a prominent role for money, as signalled by the announcement of a quantitative reference value for the growth rate of a broad monetary aggregate (M3), and ii) a broadly based assessment of the outlook for price developments and risks to price stability in the euro area as a whole, which includes the macro-economic projections.¹⁰ The two-pillar framework was a unique feature of the ECB’s monetary policy strategy and seen as a partial answer to the two challenges described above. First, the prominent role for money would help the ECB to gain rapid credibility by borrowing some of the elements of the Bundesbank’s stability-oriented monetary policy strategy. Second, the two-pillar framework would allow bringing different traditions under one roof and providing a robust framework in an environment of large uncertainty, pervasive structural change, cross-country heterogeneity and convergence. It would also bring together perspectives from the two leading economic paradigms, Keynesianism and monetarism, that had very much shaped macroeconomic debates in the decades before, rather than focusing mainly on one of them.

The reference value for M3 growth underlined both the relative importance of the role of money as well as the medium-term orientation of the ECB’s strategy. At the press conference of October 13, 1998, President Duisenberg was asked about the relative weight of the two pillars and replied: “... it is not a coincidence that I have used the words that money will play a *prominent* role. So if you call it the two pillars, one pillar is thicker than the other is, or stronger than the other, but how much I couldn’t tell you”. The choice of M3 was based on the evidence that this monetary aggregate exhibited a close relationship with the price level. At the same time, it was made clear from the very beginning that monetary policy would not react mechanically to deviations of M3 growth from the reference value; it was not a monetary growth target (ECB, 1999). The monetary pillar also involved an analysis of different monetary aggregates and the asset side of the banking system, in particular developments in credit to firms and households.

The reference value for M3 growth of 4.5% implicitly also revealed that the ECB was aiming at the upper half of the below 2 percent price stability definition. As in this period the trend growth rate of

⁹ This feature of the ECB’s monetary policy strategy was eventually also adopted in inflation-targeting central banks, which have also recognised the need for a more flexible policy horizon. See, for example, Bean (2003).

¹⁰ In fact, the internal briefing process supporting the Governing Council’s monetary policy decisions was, and still is at the time of writing, organised along the two pillars, later called economic and monetary analysis (see Section 2.2.1).

GDP was assumed to lie in the range of 2 to 2.5% and the trend rate of decline in the velocity of circulation of M3 in the range of -0.5 to -1%, the arithmetic of the quantity equation of money suggests an operational inflation aim between 1 to 2%. While it was never explicitly acknowledged, this was consistent with the emphasis on positive, but uncertain measurement biases in HICP inflation (up to 1%) as one of the explanations for why the ECB did not formulate a clear lower bound in the quantitative definition of price stability (Issing et al, 2001).

Communication and accountability

Legally the ECB is probably one of the most independent central banks in the world. Its independence is not simply a result from domestic law, but is based on an international treaty (the Treaty on European Union, EU 2012a). Changing this treaty would require the agreement of every signing country.¹¹ Transparency and clear communication are a natural complement to strong independence, as it makes it easier to hold the central bank accountable, which in turn is a key element to maintain the political support for the high degree of independence.¹² Clear communication is also important for an effective conduct of monetary policy as it helps anchoring inflation expectations, reducing policy induced uncertainty and making the transmission process of policy decisions more effective.

From the very outset, the ECB put great emphasis on communicating its policy actions and the economic rationale underlying its decisions to financial market participants and the general public in a transparent and timely manner. Since the start the main communication vehicle has been the monetary policy press conferences held by the President and the Vice-President immediately after each monetary policy Governing Council.¹³ On this occasion, the introductory statement is presented by the President on behalf of the Governing Council. It provides a summary of the policy-relevant assessment of economic and monetary developments, as well as the monetary policy stance, and it is structured along the lines of the ECB's monetary policy strategy. The press conference includes a question-and-answer session, which is attended by key media representatives from across the euro area and beyond. The press conference was seen as an effective means of presenting and explaining in a very timely manner the discussions in the Governing Council, and thus the monetary policy decision-making process. In the context of a global trend towards more detailed and transparent communications by central banks, this feature of the ECB's communication strategy has increasingly been adopted by other central banks (such as the Fed). Other important communication channels used by the ECB are the Monthly Bulletin (Economic Bulletin since January 2015, with a lower frequency than monthly) with a detailed and comprehensive analysis of the economic environment and monetary developments, the quarterly appearances of the ECB President before the European

¹¹ The Treaty gives the ECB and the members of its decision-making bodies (the Governing Council) a very high degree of institutional (vis-à-vis Community institutions or bodies and any government of a Member State), personal (relatively long fixed-term contracts), financial (own budget) and functional (exclusive competence for monetary policy in the euro area and prohibition of monetary financing) independence.

¹² See Tucker (2018) for a recent in-depth discussion of the political economy of central bank independence.

¹³ The frequency of the monetary policy Governing Council meeting was monthly (the first Governing Council meeting of the month) till December 2014 and was changed to eight times a year as of 2015 (a frequency very similar to the US Federal Reserve's Federal Open Market Committee meetings). One reason for this was that after one month often only a limited amount of new information was available but the fact that a new monetary policy decision had to be taken could lead to some market volatility.

Parliament's Committee on Economic and Monetary Affairs (Fraccaroli et al, 2018) and a large number of public speeches (see Figure 1) and interviews by members of the Executive Board.

The operational framework

The monetary policy stance decided by the Governing Council is implemented through ECB market operations. As a matter of fact, the Council delegated the conduct of these operations to the ECB Executive Board from the start of the euro, creating some separation of the operational decisions from the general monetary policy debate. The operational decisions are further executed in a decentralised way between the counterparties and their respective national central banks. Originally, the market operations aimed primarily at keeping very short-term money market rates close to the policy rate decided by the Council. More goals were only added much later when the policy rate came close to its effective lower bound and other means than short-term interest rates needed to be used for easing monetary policy further (see sub-section 2.4 below). In designing its operational tools the ECB prioritises what is needed for the smooth implementation of its monetary policy. Next, it considers what is good for market functioning, neutrality and risk control.

One important feature of the ECB's operational framework is its breadth, despite a focus on banks related to the predominant financial structure in the euro area (e.g. Hartmann et al. 2003). Given the diversity of euro area countries' financial systems, a very broad framework was needed to meet the above criteria. The very long experience of many euro area national central banks was particularly helpful in this regard. Until the present day the ECB's operational framework contains four types of instruments: 1) open market credit operations; 2) standing facilities; 3) minimum reserve requirements; and 4) outright asset purchases.¹⁴

Initially, only the first three were actively used. Reserve requirements extended the liquidity deficit of the banking sector vis-à-vis the central bank that bank note issuance and government deposits create. Euro-area banks have to hold a small share of their short-term liabilities (2% until January 2012, 1% thereafter) on their Eurosystem accounts and these required reserves are remunerated at the rate set by the ECB for main refinancing operations (MRO rate). This has to be the case only on average over a reserve maintenance period of a few weeks. Normally, the averaging procedure has a stabilising effect, because it encourages liquidity planning and helps mitigating the effects of unexpected short-term liquidity shocks – the main purpose of the reserve requirements.

Open market operations allow ECB counterparties to acquire the liquidity needed to close the aggregate deficit, so that short-term money market rates stay close to the policy rate decided by the Governing Council. Before the European crisis the bulk of the liquidity was provided through the main refinancing operations (MROs), so that the MRO rate (MROR) constituted a key policy rate for the Governing Council. MROs started as weekly tenders of two-week collateralised credit operations with Eurosystem counterparties in which the ECB fixed the MROR, estimated the overall liquidity needed by the banking system and allocated the amounts pro-rata according to the bids received. After some internal and external discussion about over-bidding and under-bidding phenomena (e.g.

¹⁴ The complete formal description of the framework is published in the Official Journal of the European Union as guideline of the European Central Bank on the implementation of the Eurosystem monetary policy framework, originally often called "General documentation of Eurosystem monetary policy instruments and procedures". An updated version can be found on the ECB website here: https://www.ecb.europa.eu/ecb/legal/pdf/celex_02014o0060-20180416_en_txt.pdf.

Ayuso and Repullo 2001, Bindseil 2005, Ehrhart 2001 or Nautz and Oechsler 2006), the ECB switched in June 2000 to variable rate tenders, with the minimum bid rate constituting the policy rate. In March 2004 the maturity of MROs was shortened to one week. A second type of open market operations from the start were long-term refinancing operations (LTROs) with a maturity of three months. In the early times the third type, fine-tuning operations, were used quite sparingly.

The ECB's two standing facilities create a corridor for very short-term money market rates around the MROR. At the deposit facility counterparties can "park" unused liquidity overnight, receiving an interest rate – the Deposit Facility Rate (DFR) – lower than the MROR. At the marginal lending facility counterparties can borrow overnight (against eligible collateral) any liquidity that they are missing at the end of a day paying a penalty rate – the Marginal Lending Facility Rate (MLFR), which is set above the MROR. Before the financial crisis the corridor defined by the standing facilities was set most of the time symmetrically around the MROR with a width of 200 basis points. Figure 5 shows the three policy rates – MROR, DFR and MLFR – between January 1999 and August 2018.

[Insert Figure 5 about here: Policy rates]

The breadth of the ECB's operational framework is not only defined by the set of different instruments that can be used but also by the number of counterparties entitled to transact with the ECB and by the range of assets eligible as collateral. Any euro area credit institution that is financially sound, supervised in the EU (or under a comparable third country regime) and fulfils some operational criteria can become an ECB counterparty. The number of effective counterparties is around 2,000, which amounted to a quarter of all euro area banks during the early years of the euro and about a third of them more recently.

Its Statutes stipulate that the ECB can lend to counterparties only against "adequate" collateral (Art. 18 of Protocol IV in EU 2012c). Given the wide-ranging differences in member countries' banking and financial systems, the ECB has decided from the start that a rather broad set of collateral assets need to be eligible for its operations. But they have to fulfil a number of criteria relating, inter alia, to currency denomination, the location of the issuer, issuance or any guarantor and, notably, the risks involved. Risk control for collateral and counterparties is, of course, important for protecting the central bank from losses that could impair its credibility, hinder its operations or even endanger its independence. It also shields euro area treasuries from reduced revenues originating from lower transfers of central bank monetary income (which ultimately means to protect tax payers). Therefore, the ECB uses a risk management framework that was adapted and improved over time, depending on new experiences made. For example, like many other central banks it applies haircuts to riskier assets and does not accept collateral below a certain credit quality in its credit operations (not below a rating of A- before October 2008).¹⁵ Although the assets used as collateral for Eurosystem monetary policy operations changed over time, public sector debt securities, corporate bonds, asset-backed securities and covered bonds as well as various forms of credit claims always played significant roles.

During the crisis starting in 2007 it turned out that the overall operational framework of the ECB was not only quite broad for dealing with the specific difficulties encountered but also quite flexible to be

¹⁵ This also applies to government bonds, because EMU does not include a fiscal union between member states.

adapted to new challenges. Preparing the monetary policy discussion for those times later in the paper, we included here this relatively elaborate description of the framework.

2.1.2 The ECB's first interest rate cycle

Against this background, we next describe the first business cycle experienced by the ECB.¹⁶ When describing the economic developments we take the ECB's perspective as also reflected in the introductory statements of the monthly press conferences and its Monthly Bulletin. The main macroeconomic, monetary and financial developments we will refer to are depicted in Figures 3 to 15.

When (the third stage of) EMU started in January 1999, the ripples of the financial crises in Asia in 1997 and Russia in August 1998, together with the near collapse of the LTCM hedge fund in September 1998, were still visible in high volatility in financial markets. The high level of uncertainty clouded the prospects for economic growth in the euro area. In a coordinated move on 3 December 1998 all the NCBs in the euro area had lowered their key central bank interest rates to 3%, which de facto determined the level of short-term interest rates with which the ECB started Stage Three of EMU. In early 1999, it became increasingly clear that, on balance, the risks to price stability over the medium term were mainly on the downside. Inflation rates were very low by historical standards (below 1%; Figure 6) and significantly below the ceiling of the ECB's definition of price stability amidst emerging signs of a strong economic slowdown, which eventually did not materialise (Figure 7). In spite of rising oil prices from mid-February 1999 (Figure 8), a depreciating effective euro exchange rate, buoyant loan growth around 10% and headline M3 growth above the reference value (Figure 9), the Governing Council reduced the policy rate by 50 basis points on 8 April 1999, from 3.0% to 2.5% (Figure 5).

[Insert Figure 6 around here: Headline and core inflation]

[Insert Figure 7 around here: Growth and components]

[Insert Figure 8 around here: Food, oil and metals prices]

[Insert Figure 9 around here: Growth of M3 and credit]

However, as sharp increases in oil prices and a general rise in import prices continued to exert upward pressure on prices in the short term in the context of robust economic growth, the risks of indirect and second-round effects on consumer price inflation via wage-setting rose significantly in the course of 2000. These concerns were compounded by a trend depreciation of the euro exchange rate, especially in the second half of 2000 when it moved further out of line with the sound fundamentals of the euro area (Figure 10). Economic activity in the euro area expanded very rapidly in early 2000, heading above a 4% growth rate, and was set to continue along this path (Figure 7) due to the strong dynamism of the world economy, especially in the sectors of the "new economy". Also the protracted monetary expansion above the reference value was increasingly pointing to upside risks to price stability at medium to longer-term horizons over the course of 1999 and in early 2000 (Figure 9). Against this background, the Governing Council raised the key ECB interest rates by

¹⁶ See ECB (2008) for a review of the first 10 years of the ECB.

a total of 225 basis points in a series of interest rate hikes between November 1999 and October 2000, bringing the main policy rate to a level of 4.75% in October 2000 (Figure 5).

[Insert Figure 10 around here: Exchange rates]

As of 2001 the prospects for economic growth deteriorated in the wake of severe shocks that hit the world economy and global financial markets such as the collapse of the dot-com bubble and associated corporate scandals, the terrorist attacks in the United States on 11 September 2001 and the escalation of geopolitical tensions related to Iraq, all of which increased the degree of economic uncertainty and undermined confidence. Overall, economic growth in the euro area turned rather weak in 2002 and this performance did not change fundamentally in 2003 (Figure 7).¹⁷ Initially annual HICP inflation rose further in 2000 and the first half of 2001, despite a marked fall in oil prices and a significant appreciation of the euro exchange rate against all major currencies after concerted foreign exchange interventions by the ECB, the Fed and the Bank of Japan in September 2000.¹⁸ The concerns about second-round effects gradually dissipated over time as the outlook for the euro area economy continued to deteriorate. Average annual HICP inflation remained slightly above 2% from 2000 to the first half of 2003, but the subdued pace of economic activity and the significant appreciation of the euro since spring 2002 were expected to dampen inflationary pressures. Looking at the monetary developments, annual M3 growth accelerated strongly from mid-2001 onwards. However, this increase was not interpreted as implying risks to price stability at medium to longer horizons as it was mostly due to sizeable shifts in private investors' portfolios from shares and other longer-term financial assets towards safe and more liquid monetary assets included in M3 in the aftermath of the global stock market correction and the terrorist attacks of 11 September 2001 (Figure 9). This assessment was supported by the fact that annual growth of credit to the private sector continued to decline, especially to non-financial corporations, in a context of rather subdued economic activity. In this period, the Governing Council lowered the key ECB interest rates by a total of 275 basis points. This included a joint 50 basis point cut coordinated with the US Fed on 13 September 2001 in response to the adverse confidence effects of the US terrorist attacks.¹⁹ The policy rate reached an – at that time - historically low level of 2% in June 2003. At the same time, the sustained growth in M3 corrected for the estimated impact of portfolio shifts was seen as an important indicator arguing against the emergence of deflationary risks for the euro area in 2002 and 2003 and served to resist a further easing of policy rates as advocated by a number of analysts.

2.1.3 Discussion

Overall, the ECB's first interest rate cycle contained a first test of the ECB's anti-inflation credibility as the euro exchange rate depreciated – only stopped by the foreign exchange interventions –, and annual headline inflation peaked at 3%. The sources of the initial depreciation of the euro against the dollar (from a peak of 1.19 in January 1999 to a historic low of 0.83 in October 2000) were heavily discussed. Corsetti and Pesenti (1999) and Alesina et al (2001) pointed to fundamentals such

¹⁷ Note that in contrast to the NBER business cycle dating committee for the United States, the CEPR committee never called a recession in the euro area in the early years of the new millennium.

¹⁸ The ECB and several Eurosystem NCBs also intervened several times during the first half of November.

¹⁹ The days following September 11, the ECB also undertook a series of other crisis management operations in order to deal with the substantial effects of the severe damage to the US financial market infrastructure on the euro area financial system. This included overnight finetuning operations and a swap line with the Fed New York that allowed Eurosystem national central banks to provide dollar liquidity to their banks.

as revisions in the forecasts of the output growth rate differential in the US and in the euro area as the main source. In May 2000 President Duisenberg nevertheless addressed a press release to the European citizens reassuring them of the stability of the euro (ECB 2000a). And, ultimately, the ECB intervened together with the U.S. Federal Reserve and the Bank of Japan based on “a shared concern about the potential implications of recent movements in the euro exchange rate for the world economy”. The underlying concern was that a disorderly depreciation would add to the inflationary pressures in an environment of relatively high oil prices, and affect its credibility (Figure 8, Section 3.1).

Once the cycle turned, following the breakdown of the dot-com bubble in stock markets, the perspective reversed. As interest rates dropped to a historically low level in the euro area, and even more so in the US, the policy and academic debate turned to the consequences of the lower bound constraint on interest rates for the fulfilment of monetary policy objectives (see, for example, Bernanke, 2002).

The other feature of this period was the decoupling of money and credit growth (Figure 9), which questioned the prominent role for money in the ECB’s monetary policy strategy. From the start the prominent role for money was a controversial feature of the ECB’s strategy. For example, Alesina et al (2001) thought the ECB should abandon the two pillars and adopt a flexible inflation-targeting strategy, which they regard as simpler. In their view, the M3 pillar stood in the way of effective communication. The ECB nevertheless used robust money growth to argue against further cuts in interest rates in 2003. Both issues featured in the review of the strategy in 2003, which we will discuss in the next section.

Another discussion related to the ECB’s transparency and predictability. Although opinions differ about the degree of the ECB’s transparency (also compared to other central banks), the ECB generally scores quite high on that front and over time has increased its transparency also in response to demands from the European Parliament and other advocacy groups (Geraats, 2002). For example, in December 2000 the ECB started to publish its macro-economic projections (ECB, 2013b). Nevertheless, two elements of criticism coming mostly from the inflation targeting proponents were prominent in the early years. First, the ECB did neither release the minutes of its policy deliberations, nor the votes and their attribution to members of the Governing Council (see e.g. the debate between Buiter, 1999 and Issing, 1999). It argued that the press conference gave a real-time account of the discussion and could therefore be seen as a substitute, and that publishing the minutes could expose the individual members of the Governing Council to pressures from their national constituencies and undermine the consensual nature of the ECB’s decision making and the “one voice” communication strategy. As communication became more complex following the financial crisis, this was partly addressed in January 2015 when the Governing Council decided to publish an account of its monetary policy deliberations approximately four weeks after the meeting (Draghi, 2014a).

The second criticism was that the ECB did not publish its own interest rate forecasts (e.g. Alesina et al, 2001 or Geraats et al, 2008). Instead the ECB focussed on trying to explain its reaction function. It argued that in view of the effects of various unexpected shocks that can hit the economy and the long and variable time lags with which monetary policy actions are transmitted to prices, the precise timing, and sometimes even the direction, of an interest rate decision is difficult to predict. Instead,

by publicly announcing its monetary policy strategy and communicating its regular assessment of economic developments in a transparent manner, it could clarify its reaction function, achieve a high degree of predictability and thereby make monetary policy more effective (Blattner et al, 2008). In fact, although the 50 basis point sizes of the first and second interest rate decision in April (a cut) and November 1999 (an increase), somewhat surprised market participants, various empirical studies showed that already relatively early ECB interest decisions were usually predicted quite well by the market, at least as well as the decisions of the US Federal Reserve or the Bank of England for example (e.g. Hartmann et al 2001, Bernoth and von Hagen 2004 or Wilhelmsen and Zaghini 2011). Still, the ECB often emphasised the need to maintain a full-information, state and data-driven policy approach and that it did not want to communicate or commit to future policy actions given the large uncertainties about the state of the economy in the future. This changed in 2013 when the ECB started giving forward guidance on its future policy actions (Section 3.3).

2.2. Recovery and growing imbalances (July 2003 – July 2007)

2.2.1 The 2003 review of the strategy

In 2003 after approximately four years of experience with the new strategy, Otmar Issing initiated a review of the strategy, which led to three main changes: i) a clarification of the definition of price stability: the Governing Council would aim at a year-on-year HICP inflation rate of below, *but close to* 2% over the medium term; ii) the end of the annual review of the reference value for M3 growth; and iii) a restructuring of the introductory statement of the President at the monthly monetary policy press conference which now started with the economic analysis followed by the monetary analysis (ECB 2003a,b).

The *first change* was a response to the strengthened need to establish a sufficient inflation buffer as a discussion of deflation risks took place in 2002-2003. Such a buffer was deemed to be necessary for two reasons. First, a small positive steady state inflation rate would reduce the probability of hitting the lower bound on nominal interest rates. Second, a positive inflation rate also greases the wheels of the labour market particularly in a monetary union with still segmented labour markets as it reduces the need for wage deflation in the face of asymmetric economic developments. Such wage deflation was thought to be costly in the presence of widespread evidence of downward nominal wage rigidity (DNWR) in the euro area.²⁰ A number of studies had shown that an inflation buffer of close to 2% would significantly reduce the probability of hitting the zero lower bound on nominal interest rates or DNWR constraints (e.g. Issing, 2003a and Reifschneider and Williams (2000)).

The specific formulation of the inflation aim of “below, but close to 2% over the medium term” was the result of a compromise that maximised the buffer, while remaining consistency with the definition of price stability and not giving a “sense of unwarranted precision” associated with inflation targeting regimes. The sense of continuity was made clear by Otmar Issing at the press conference in May 2003 explaining the outcome of the review. When asked whether the aim of “below but close to 2%” is a change, he replied: “This “close to 2 percent” is not a change, it is a

²⁰ See, for example, the findings of the Wage Dynamics Network in ECB (2009b).

clarification of what we have done so far, what we have achieved – namely inflation expectations remaining in a narrow range of between roughly 1.7 and 1.9% - and what we intend to do in our forward-looking monetary policy” (see also ECB, 2003b). While all this should have removed (or reduced very significantly) the room for interpretation about how low the lower bound of the price stability definition was, the reformulation did not extinguish perceptions by some observers of an asymmetric inflation objective. Symmetry was seen as important by the proponents of inflation targeting (e.g. Bernanke et al, 1999), but even German monetarists like Manfred Neumann thought that “... the lack of a lower bound as part of the definition was an unnecessary drawback” (Neumann, 2008).

The *second and third changes* mentioned above de facto meant a downgrade of the prominent role of money relative to the weight put by Duisenberg as cited earlier. This reflected the reality that on a monthly basis monetary policy decisions were mostly driven by the broadly based assessment of the outlook for price developments and the risks to price stability (the “economic analysis”), of which the macro-economic projections were an important part.²¹ It also reflected emerging evidence on instability in money demand and the need to explain “distortions” or “portfolio adjustments” in M3 growth which were not linked to medium-term risks to price stability as discussed above.²² A revamped monetary analysis was now presented as a cross-check of the economic analysis from a medium to long-term perspective given the long-run monetary nature of inflation. It clarified that the main challenge facing the monetary analysis is to see through the inevitable short-term disturbances of the underlying relationship between money and prices, so as to extract the longer-term inflationary risks. This was also reflected in the changed structure of the introductory statement at the monetary policy press conferences which now started with the economic analysis and ended with a cross-check from the monetary analysis.

The rearrangement of the pillars was applauded by academics favouring inflation targeting (e.g. Svensson, 2003), while at the same time it was acknowledged that the money pillar had been useful during the first years of the ECB as it made it easier for it to gain credibility as a sign of “the new institution’s fidelity to principles stressed earlier by the Bundesbank, which had in turn played a critical role as the anchor of the previous European Monetary System” (Woodford, 2008). But the debate around the role of the monetary analysis and the need to have two separate pillars continued (Issing, 2005). On 9-10 November 2006, the ECB held a symposium to discuss this from both an academic and practitioners’ point of view (Beyer and Reichlin, 2008). At the conference, Fischer et al (2008) reviewed the actual ECB experience with its monetary analysis from 1999 till 2006 and emphasised the real-time and comprehensive nature of the monetary analysis that was performed in the quarterly monetary assessments since December 1999. These authors described the tools used making a distinction between money demand equations, judgemental analysis and money-based inflation forecasts. They also assessed the forecasting performance of money-based tools and found that there was information value in addition to the BMPE forecasts. Finally, based on an in-depth analysis of the monetary analysis input, they concluded that the economic pillar prevailed in influencing the decision when the monetary pillar gave a blurred signal. This finding will be confirmed in the analysis of Section 3.2 below.

²¹ See also the evidence presented in Section 2.2.2 below.

²² For alternative views on money demand stability see Alves, Robalo, Marques and Sousa (2007) and Bruggeman, Donati and Warne (2003).

The broader discussion at the symposium pointed to two ongoing developments in the nature and the role of monetary analysis. First, the monetary analysis was evolving from a narrower perspective based on the quantity theory of money to a broader set of analyses including also the role of financial frictions and financial intermediation in macroeconomic developments. This revamped the debate on why the two pieces of analysis should be kept separately given the intimate linkages between financial and real factors. At the symposium, Vice President Lucas Papademos conjectured that if “in the future, we will be in a position to develop and reliably estimate a single empirical approximation of a general theoretical framework in which money is of central importance” ... “it may be possible to merge the two pillars of our analysis into a single one. But this will be a larger pillar in which money will continue to play a prominent role in guiding our monetary policy decision-making” (Papademos, 2008). The Governing Council in 2007 endorsed a research programme to further enhance monetary analysis including by developing methodologies for cross-checking and building structural models that embody an active role for money and credit in the determination of inflation dynamics (Papademos and Stark, 2010).

The second theme that received increasing attention during this period was the link between money and credit, asset price developments and financial stability. While this financial stability angle was not taken up as an explicit justification for the two-pillar approach in the 2003 review, the ECB paid increasing attention both in research and policy communication to this link and the associated view promoted by the Bank for International Settlements that it may be necessary for monetary policy to lean against the wind of growing financial imbalances (See, for example, Detken and Smets, 2004 and Issing, 2003b). This also became part of the research programme mentioned above (Detken, 2010). In a speech on “Asset price bubbles and monetary policy”, President Trichet (2005) conjectured that while “a leaning against the wind” approach is “compelling in many theoretical aspects, in practice ... it is likely that the circumstances in which a policy-maker will embark with confidence upon an explicit leaning against the wind policy will occur rarely.” But he also argued that the monetary analysis helps incorporating emerging financial stability risks with implications for price stability from a medium term perspective: “The fact that our monetary analysis uses a comprehensive assessment of the liquidity situation that may, under certain circumstances, provide early information on developing financial instability is an important element ...”. This became part of the rationale for the monetary analysis (e.g. Issing, 2005).

2.2.2 Stable rates, monetary tightening and no additional “leaning against the wind”

As from June 2003, the ECB kept interest rates steady for two and a half years. So, the previous decision to lower the MROR to a historically low level of 2.0% nurtured the economic recovery for quite a while. The overall picture of economic activity brightened during the second half of 2003 when euro area exports increased significantly as a result of the renewed dynamism of the world economy. Also domestic demand and investment picked up, not least in view of the low level of interest rates and the generally favourable financing conditions (Figure 5 and Figures 14 and 15 below). The recovery in economic activity moderated somewhat in the second half of 2004 and the first half of 2005, partly on account of rising oil prices (Figure 8), lower consumer confidence, a temporary deceleration in world economic growth and the lagged effects of the past appreciation of the euro (Figure 10). However, in the second half of 2005, the expansion of economic activity in the euro area regained momentum. On the price side, HICP inflation did not fall as swiftly and strongly as previously expected, largely due to adverse food price developments and higher than expected oil

prices – although the latter were attenuated by the appreciation of the euro. Annual HICP inflation remained above 2% in 2005, but underlying domestic inflationary pressures were contained throughout 2004 and most of 2005 (Figure 6), justifying the prolonged accommodative monetary policy stance.

As 2005 progressed, the economic analysis suggested that upside risks were increasing, especially due to potential second-round effects in wage and price-setting that stemmed from higher oil prices. But this time it was the monetary analysis that carried the day. As of mid-2004, robust credit and monetary expansion reflected the stimulating effect of the then prevailing very low level of interest rates in the euro area and, later on, renewed dynamism of the euro area economy, rather than portfolio shifts (like between 2001 and 2003), indicating increasing upside risks to price stability at medium to longer horizons towards the end of 2005. In response, the ECB started raising its policy rate as of December 2005 eventually by a total of 200 basis points to a level of 4% by the end of June 2007 (Figure 5).

The gradual withdrawal of monetary accommodation took place against the background of solid economic growth and a continued strong money and credit expansion in the euro area. The economic expansion gained momentum in the first half of 2006 and became gradually more broad-based and self-sustaining, with domestic demand as the main driver. Notwithstanding the impact of high and volatile oil prices, real GDP rose by 2.8% in 2006, compared with 1.6% in 2005 and 2.1% in 2004 and continued to expand at a solid rate of 2.7% in 2007 (Figure 7). As regards prices, average annual HICP inflation was slightly above 2% in 2006 and 2007, mainly driven by domestic demand as underlying inflation developments were largely in line with the ECB's inflation aim (Figure 6). Money and credit expansion became increasingly vigorous throughout this phase, supported by a persistently strong growth of bank loans to the private sector (Figure 9).

2.2.3 Discussion

Overall, this second phase was characterised by an increasingly solid expansion of economic activity and increasingly vigorous money and credit growth (double the reference value towards the end) following a longish period of low interest rates. Against the background of the discussion on the “leaning against the wind” approach above and with the benefit of hindsight, the question emerges to what extent the monetary analysis was used in guiding monetary policy in the face of growing financial imbalances. At the time ECB Board members warned of the potential for emerging misalignments in asset prices, notably in housing, due to strong money and credit growth.²³ And Trichet (2008) pointed to the December 2005 episode as one where the monetary pillar was crucial in driving the monetary policy decision. Indeed, based on a reading of the introductory statements at the end of 2005, Neumann (2008) argues that monetary analysis was one of the driving forces behind the decision to start raising interest rates in 2005. As we will argue in Section 3.2 below, it is however difficult to detect significant deviations from the ECB's usual reaction to the growth and inflation outlook in this period. This suggests that the tightening of policy rates in 2005 did not go beyond what would be suggested by the usual economic analysis, contrary to what would have been

²³ E.g. Issing (2005): “Moreover, strong money and credit growth in a context of already ample liquidity in the euro area implies that asset price developments, particularly in housing markets, need to be monitored more closely, given the potential for misalignments to emerge.”

the case under an active leaning against the wind approach trying to enhance financial stability through restrictive monetary policy action.

While this does not prove conclusively that low monetary policy rates did not play any role in strong credit growth and bank risk-taking – in fact, to some extent they are a natural and desired effect of an expansionary monetary policy stance –, the institutional setup for financial supervision in the euro area at the time located the primary responsibility for containing the build-up of financial risks with national prudential authorities. The ECB could only “contribute to the smooth conduct of policies pursued by the competent authorities relating to the prudential supervision of credit institutions and the stability of the financial system” as long as price stability was ensured (Art. 127.5 of the Treaty, EU 2012b). But not being a regulatory or supervisory authority itself, the ECB did not possess any prudential policy instruments that could address emerging financial imbalances. The available prudential instruments were all with national prudential authorities, subject to some cooperation through EU committees.²⁴ Moreover, before the climax of the financial crisis in 2008 the macro-prudential approach to maintaining financial stability was not very well developed in the competent prudential authorities.²⁵

A related important feature of this period is that underlying the aggregate euro area output and credit boom there were diverging intra-euro area current account balances. These imbalances played an important part in the propagation of the subsequent euro area twin-crises (financial and sovereign), which we will discuss in the next section. As shown in Figures 11, the countries that, leading up to 2007, had accumulated large current account deficits as well as high unit labour cost and credit and house price growth differentials relative to their euro area peers were also among the ones that suffered the highest fall-out from the financial crisis, as for example measured by the subsequent level of the unemployment rate in 2013 (Constancio, 2013; Smets, 2013 and Martin and Philippon, 2017). Or put differently, all the countries that ultimately ended up in macroeconomic adjustment programmes – Greece, Ireland, Portugal and Spain – ran substantial current account deficits in 2007. The ECB’s communication focused particularly on the need to address divergences in productivity and competitiveness across the different euro area countries (e.g. Trichet, 2006 or also the light orange area in Figure 1).

[Insert Figures 11 around here]

Preparing the ground for sub-section 2.3, one narrative behind these boom and bust developments (put forward after the fact) runs as follows (Baldwin and Giavazzi, 2015). Easy global financial conditions (partly driven by the global savings glut) as well as greater integration of wholesale financial markets within the monetary union (with disappearing risk premia) encouraged cross country capital flows from the “core” to the “periphery” (Blanchard and Giavazzi, 2003 and Lane, 2015). Although the aggregate euro area current account was in balance throughout most of this

²⁴ See our companion paper Hartmann and Smets (in progress) for a description of the evolving prudential framework since the introduction of the euro and the ECB’s role in it. Some of the national central banks were banking supervisors but not as part of their Eurosystem roles. The ESCB Banking Supervision Committee brought all EU banking supervisors at one table. While the ECB hosted its secretariat, it could not oblige the members to take any action.

²⁵ The De Larosière report (High-level Group on Financial Supervision 2009) led to the establishment of the European Systemic Risk Board in 2010, a macro-prudential body whose secretariat is provided by the ECB but which can only make risk warnings or policy recommendations without having own policy instruments.

period, large intra-euro area current account imbalances were building up, feeding non-tradable sectors like government consumption and housing in the “periphery” countries, driving up wages and costs and resulting in competitiveness losses that undermined the traded goods sectors and validated the current account deficit. With the exception of Greece, (explicit) public debt was not the first problem, according to this narrative, although ex post building up of higher buffers may have been advisable, as shown by Martin and Philippon (2017). Instead the private debt build-up was very significant, mimicking some of the developments in the US and other OECD countries.²⁶ Moreover, there was a mismatch between the longer-term loans to households and firms made by domestic banks and the short-term cross-country interbank funding that financed this debt.

Other observers (e.g. Feld et al. 2016) put more weight on the fiscal vulnerabilities of some euro area countries even before the breakout of the financial crisis. The Stability and Growth Pact had been regularly broken by a variety of countries since the introduction of the euro. The aggregate debt-to-GDP ratio of the euro area hovered around 70%, 10 percentage points above the SGP limit of 60% for individual countries. The countries that had entered the euro with very high public debt levels (significantly above 100% of GDP) were Belgium, Greece and Italy. They all gradually reduced these levels in the early years, helped by strong nominal GDP growth and low interest rates, but because of rapidly eroding primary surpluses this process stopped at levels of about 100% of GDP or slightly above, except for Belgium. In other words, the euro area entered the financial crisis with one large and one smaller fiscally vulnerable country.²⁷

In sum, among the countries that turned out to be stressed during the European twin-crises (see next section) beforehand Cyprus, Ireland, Portugal and Spain were more vulnerable in terms of private debt and Greece and Italy more in terms of public debt. Both groups together account for more than a third of euro area GDP (39% of its total population), but the latter is a bit larger than the former. But as we shall see further below, many more than these two important fundamental factors came together for determining the severity of the European twin-crises and the obstacles that they implied for a successful monetary policy.

[Insert Figure 12 around here: fiscal policy]

The start of the global financial crisis in September 2008, which revealed the exposure of European banks to some of the toxic sub-prime mortgages in the US, and the revelation of the Greek deficit deceit in October 2009 were the triggers that led to a sudden stop in the cross-country capital flows and exposed the private and public debt overhangs in the respective euro area countries. Several negative propagation mechanisms then took place. First, the need to back-stop the weakened banks in the absence of a European resolution framework undermined the credit rating of a number of

²⁶ Euro area countries with particularly high and increasing household debt levels in the years before the crisis included Cyprus, Ireland, the Netherlands, Portugal and Spain. (Germany’s household debt was high in the early years of the euro but then consistently declined.) Countries with particularly high and increasing debt levels of non-financial corporations included Ireland, Luxembourg, the Netherlands (not increasing), Portugal and Spain. Interestingly, neither Greece nor Italy had particularly high private debt levels even though they increased in both cases. In many cases the increases in private debt levels were part of a long-term trend, at least since the start of the euro.

²⁷ Other euro area countries whose public debt levels increased before the crisis and cut through the 60% limit included France, Germany and Portugal. Austria fluctuated around 70% without a clear trend. Portugal had some vulnerabilities through weak state-owned enterprises whose debt was not included in the SGP debt figures but migrated to them during the crisis.

national governments. Second, weakened sovereigns and a faltering economy further increased the fragility and the undercapitalisation of national banking sectors, leading to further deleveraging and “closing” the doom loop between national sovereign and banking instabilities. Third, the results of the Deauville summit of France, Germany and Russia in October 2010 that included a Franco-German agreement to promote “private sector involvement” in handling a public debt overhang and associated discussions on a Greek debt restructuring that was only implemented in 2012 – while good for ex ante incentives of controlling public deficits – facilitated contagion towards other sovereigns ex post, as a euro area back-stop for governments was lacking. Finally, weakened sovereigns also led to a pro-cyclical fiscal policy from 2011 to 2014, deepening the recession in the absence of fiscal policy coordination and a common budget. As shown in Figure 12, the coordinated fiscal expansion of 2008-2010 turned into a significant and protracted tightening of the fiscal policy stance in from 2010 to 2013. As a result, the sudden stop turned into a crisis and a prolonged double-dip recession (Corsetti (2015) and Corsetti and Dedola, 2016), which we turn to in the next section.

2.3. The financial crisis, the sovereign-debt crisis and the double-dip recession (August 2007 – June 2013)²⁸

2.3.1 The ECB’s monetary policy moving to crisis management mode

In the early phase of the financial crisis the ECB’s operational framework took the centre stage. The reason was that wider problems first emerged in interbank and other short-term funding markets (e.g. Figure 13), which could largely be addressed with liquidity management tools. Moreover, it allowed the ECB to continue to follow the so-called “separation principle”, meaning that the conduct of monetary policy focused on setting policy rates for achieving price stability over the medium term and market operations focused at ensuring that market turbulences would not disturb the transmission of the policy rates to the economy. Another way of saying this is that those operations acted as complements to conventional interest rate policy (and were not intended to act as substitutes). The separation principle was in line with the traditional analysis in Poole (1970), according to which stabilising the short-term interest rate in the face of purely financial shocks is the best way to insulate the real economy from the effects of those shocks (Fahr et al, 2011 and ECB, 2008). In the early phase the operations were mainly focused on money and other bank funding markets, but when the sovereign debt crisis emerged in 2010 they also started to address malfunctioning government bond markets and extended liquidity beyond one year. This included asset purchases of both covered and government bonds (see Table 2 in sub-section 3.1.1 for an overview of the main ECB monetary policy measures during the two crises and following recovery).

[Insert Figure 13 around here]

As monetary policy moved into crisis management mode, the two-pillar approach took a backseat in communication. While the introductory statements at the regular monetary policy press conferences remained structured along the two pillars including a cross-checking section, also in line

²⁸ For a recent description and chronology of the ECB’s monetary policy responses since the onset of the crisis, see Camba-Mendez and Mongelli (2018).

with how staff analyses still supported the Governing Council's decision making process, few speeches by Executive Board members dealt with the two-pillar structure of the ECB's strategy (Figure 2 above). The crisis nevertheless had a big impact on the ECB's monetary analysis. The focus turned to how to identify and address the impairments in the transmission mechanism of monetary policy from the crisis. The financial crisis necessitated a comprehensive further broadening of the monetary analysis towards a detailed macro and micro-economic analysis of the financial system and the bank lending channel in particular (given the euro area's financial structure). For example, the ECB's Bank Lending Survey – already launched in 2003 – became a prominent tool to understand supply side restrictions in bank credit markets.²⁹ More generally, a deep analysis of the capital, leverage and liquidity positions of banks became important, as well as a comprehensive and disaggregate look at both bank and non-bank financing conditions in the economy. This led to a thorough revamping of the ECB's quarterly monetary assessments. At the same time, given the intimate interaction between financial and real factors, it also blurred the distinction between the economic and the monetary analysis.

2.3.2 From liquidity operations to decisive rate cuts and early asset purchase programs

The third cyclical phase in the ECB's history can be divided in three sub-periods. The first period from August 2007 to September 2008 is often denoted as financial market turmoil. The collapse of the US subprime mortgage market led to a general re-pricing of risk in the asset-backed securities (ABS) and other structured credit markets of developed countries, which seriously impaired interbank and other short-term funding markets. The second period from October 2008 to May 2010 covers the intense systemic financial crisis affecting many developed countries, following the failure of Lehman Brothers, the Great Recession and the associated collapse of international trade. The third period from June 2010 to June 2013 starts with the emergence of the sovereign debt crisis specific to the euro area, when the Greek fiscal situation deteriorated significantly and subsequently several other euro area countries became distressed.

Financial turmoil impairing money market functioning (August 2007 – September 2008)

Financial turmoil first erupted in Europe with the emergence of money market tensions on 9 August 2007, following the announcement that a number of investment funds had to close as they could no longer value their portfolios owing to the illiquidity of ABS markets. The uncertainty about the values of ABS and other structured credit products and the asymmetric information about their location among banks led to adverse selection, liquidity hoarding and the freezing of interbank and other short-term funding markets (such as asset-backed commercial paper and repos; e.g. Cassola et al. 2008 or Gorton and Metrick 2012). Despite these difficulties large bank failures did not occur in the euro area during this period. Only a few mid-sized German banks, who had been particularly engaged in structured credit practices and wholesale funding, received public support. One indicator of the difficulties in bank funding markets (mixing credit and liquidity risks) is the spread between the unsecured interbank rate and the overnight swap rate, which is only subject to a minimum amount of counterparty risk (Figure 13). After remaining very close to zero for years, this spread rose to around 60 bps.

²⁹ https://www.ecb.europa.eu/stats/ecb_surveys/bank_lending_survey/html/index.en.html.

Reacting immediately on 9 August with a fixed-rate overnight finetuning operation (FTO) allotting the full demand of EUR 95 billion to counterparties, the ECB was the first major central bank responding to the turmoil. In the following days, weeks and months the series of operational measures addressing the euro money market disturbances included further FTOs, intra-maintenance period “frontloading” (meaning that the ECB provided very ample liquidity early in each reserve maintenance period which then ran down until the end of each maintenance period) and a relative extension of the maturity profile of aggregate market operations (e.g. by running supplementary 3-month LTROs; ECB 2007). In line with the separation principle, however, the measures were designed to keep the overall monetary policy stance unchanged. In the second half of December 2007 the ECB also joined forces with the Fed by providing US dollar liquidity to Eurosystem counterparties through a swap arrangement. The Bank of Canada, the Bank of England and the Swiss National Bank made parallel similar arrangements “to address elevated pressures in short-term funding markets”. Interestingly, none of these measures were mentioned in any of the introductory statements of the Governing Council press conference at the time, which only contained references to financial market volatility and reappraisals of risk and to the ECB paying great attention to them. They were announced in separate press releases and later summarised in the ECB’s Monthly Bulletin.

With the advent of the financial turmoil, the outlook for future economic activity became clouded and the balance of risks to the growth outlook tilted to the downside. Nevertheless, euro area growth remained way above 2% for a while (Figure 7), with corporate profitability sustained, employment growth strong and the unemployment rate declining to 7.4%, a level not seen for 25 years (Figure 3). At the same time, annual inflation rose sharply towards the end of 2007, reaching levels significantly above 2% (above 3% still in the same year and above 4% in the summer of 2008; Figure 6), driven largely by sky-rocketing commodity including oil prices (Figure 8). While moderate wage developments and anchored medium to longer-term inflation expectations helped to dampen inflationary pressures, the risks to price stability over the medium term were still judged to be on the upside. A cross-check with the monetary analysis appeared to confirm this (Figure 9). The ECB paid particular attention to monetary developments, also with a view to better understanding the shorter-term response of financial institutions, households and firms to the financial market turmoil in the second half 2007. At the time there was little evidence that the turmoil had strongly influenced the overall dynamics of money and credit expansion, also thanks to the effectiveness of ECB liquidity management containing volatility in money market rates. Accordingly, the ECB decided to raise the MROR by 25 bps in July 2008 to avert the risk of second-round effects on wages.

*The financial crisis, the collapse of bank intermediation and the Great Recession (October 2008 – April 2010)*³⁰

This increase in the policy rate was quickly reversed when the financial turmoil escalated in a systemic financial crisis after the collapse of the US investment bank Lehman Brothers on 15 September 2008. At that time it became clear that even prominent and systemically important institutions could fail and even many more of them would have failed if they had not been taken over by other financial institutions or supported by the government.³¹ So, financial markets froze,

³⁰ Pill and Reichlin (2014) describe the financial crisis response by the ECB in detail.

³¹ In other words, the devastating systemic nature of the crisis was caused by a mixture of contagion among financial intermediaries and, notably, the unwinding of the widespread imbalances that had built up in the

economic activity was disrupted, and many of the major economies were on the verge of collapse. Tensions spilled over from the financial sector into the real economy, leading to the Great Recession. The US economy, which had slowed considerably when the financial turmoil first began, entered a severe recession in December 2007 and exited it in June 2009.

Owing to strong economic and financial ties, the crisis spread to the main trade and financial partners of the United States, including the euro area. For example, a number of large euro area banks (compared to their home country) failed and/or were supported by their sovereigns, some more for their exposure to the collapse of the global credit trading system (triggered by the US sub-prime mortgage crisis and the revelation of many toxic ABS) and others more for their exposure to their tanking local economies and real estate markets.³² On the back of confidence effects and impaired trade finance, global trade plummeted by one-third in the fourth quarter of 2008, transmitting economic instability also to the countries whose financial intermediaries had not been engaged in the unsound international credit trading practices or toxic investments. The euro area experienced a “sudden stop” of capital flows across its member countries. Within a few months, it had entered its own severe recession, which lasted from the second quarter of 2008 until the second quarter of 2009. During this period year-on-year GDP growth fell by more than 5% (Figure 7), headline HICP inflation was briefly negative in the summer of 2009 (Figure 6) also on the back of falling oil prices (Figure 8). Money and credit growth dropped to 0% in the beginning of 2010 (Figure 9). The collapse in bank intermediation, which had gathered pace in the summer of 2008, amounted to a 13 percentage point reduction of credit to the private sector between December 2007 and January 2010.

In this period standard and non-standard monetary policy measures taken by the ECB worked in tandem, although the separation principle was maintained. Following the internationally coordinated interest rate cut of 8 October 2008 by 50 bps and in response to the collapse in output and inflation, the ECB decreased its key policy rates further in six steps by 275 bps, reaching a level of 1% for its main policy rate in May 2009, a new historical low (Figure 5).

At the same time, the ECB took a number of non-standard measures to satisfy the high demand for liquidity, foster an even transmission of monetary policy impulses across countries and banks and help fend off risks of an even more dramatic financial meltdown. These measures drew on its broad and flexible operational framework (see sub-section 2.1.1), which turned out to be more readily employable for meeting the challenges of the crisis than the case for some other major central banks. But they were still regarded as complements to interest rate decisions and not substitutes. From 15 October 2008 onwards the major refinancing operations (MROs and all longer-term refinancing operations) were carried out through a fixed rate tender procedure with full allotment at the interest rate on the main refinancing operation (MROR). In addition, the ECB expanded the list of marketable assets eligible as collateral in Eurosystem credit operations. Both measures stepped up significantly the ease with which counterparties could satisfy their liquidity demands. The ECB also

years before on financial institutions’ balance sheets, particularly from the combination of originate-to-distribute behaviour and the global trading of the resulting credit products (ABS, Collateralized Debt Obligations, Collateralized Loan Obligations etc.). See ECB (2009a) and de Bandt et al. (2015) for the different forms of systemic risk.

³² See Hartmann (2015) for a discussion of different euro area countries’ experiences with boom-bust cycles in residential real estate markets and problems with the associated prudential policies and frameworks.

reduced the minimum rating threshold for eligible collateral from A- to BBB-, adjusting to the fact that the crisis had lowered the average credit quality of assets in the market. Furthermore, the ECB enhanced the provision through longer-term refinancing (after having introduced 6-month operations already in March before) and provided US dollar liquidity through foreign exchange swaps (as already the case in December 2007, January 2008 and March 2008). The former gave greater planning certainty to counterparties and the latter helped manage dollar shortages in the euro area spilling over from instabilities in the US. Finally, the corridor of standing facilities was temporarily reduced from 200 bps to 100 bps from October 2008 to January 2009 to further contain the short-term money market rate volatility.

Additional non-standard measures were adopted in May 2009 – when the MRO rate reached the 1% level – to support the flow of credit to households and corporations.³³ These included announcements of the lengthening of the maximum maturity of refinancing operations to one year (one-year LTROs starting in June) and a Covered Bonds Purchase Programme (CBPP, starting in July), the first outright purchase programme carried out by the ECB with the aim of reviving the funding channel for banks and support their credit intermediation. Together with those adopted in October 2008, these measures configured the ECB’s policy of “enhanced credit support” in response to the financial crisis (Trichet, 2009). Interestingly, the press conference of the Governing Council meeting on 7 May 2009 was the first time that some of these non-standard measures were briefly included in the formal introductory statement by the President (and only detailed in separate press releases later).

The combination of these standard and non-standard monetary policy responses had a beneficial impact on interbank market spreads (Figure 13) and financing conditions more generally (Figures 14 and 15). They contributed, together with expansionary fiscal policies (Figure 12) and financial sector support measures, to the initial economic and financial recovery from the Great Recession.³⁴ For example, the cumulative government support to euro area financial institutions in the form of commitments for capital injections, liability guarantees or asset support between October 2008 and May 2010 has been estimated by Stolz and Wedow (2010) at around 28% of GDP (although the effective amounts were only about half of this). Already at that time, however, bank stress tests did not have all the desirable effects. For example, not long after the first European coordinated test of 22 major cross-border groups under the Committee of European Banking Supervisors (CEBS 2009), which was run however without a minimum capital threshold, further bank failures happened in the euro area.³⁵

[Insert Figure 14 around here]

³³ A comprehensive description of ECB market operations between the first quarter of 2009 and the second quarter of 2012 is provided in Eser et al. (2012).

³⁴ In line with an agreement for strengthening growth reached at the first G20 summit in Washington (DC) in November 2008, the European Commission combined national initiatives and a smaller share of EU funding to a 200bn concerted European Economic Recovery Plan to boost demand and stimulate confidence in the European Union (Commission, 2008). The total plan amounted to spending of about 1.5% of GDP, which was endorsed by the European Council in December 2008. For an analysis of the effects of this fiscal stimulus, see Coenen et al (2012).

³⁵ For a comprehensive overview of national financial sector policies during the crisis, including national stress tests, see Directorate-General for Financial Stability, Financial Services and Capital Markets Union (2017).

[Insert Figure 15 around here]

By the end of 2009, nevertheless, year-on-year real GDP growth turned again positive and continued to pick up in 2010 (Figure 7). The fall in underlying inflation stopped at around 1% late-2009/early-2010 and around the same time headline inflation rose quickly again reaching 1.7% in Q2 2010 and, ultimately, levels above 2% (Figure 6), as energy prices again soared (Figure 8). In addition, a modest recovery in money and credit growth set in mid-2010 (Figure 9). This led to an initial discussion about “phasing out” some of the exceptional monetary policies, which ex post proved to be premature.

The European sovereign debt crisis and the sovereign-bank nexus, re-denomination risk and the second recession (May 2010 – June 2013)

The financial crisis and the Great Recession had left its mark on public finances. Government bond yield spreads increased significantly in the euro area (Figure 13), in particular in those countries where deficits rose substantially owing to the impact of automatic stabilisers in the face of a deep recession, discretionary expansionary fiscal policy (Figure 12), and, importantly, interventions to shore up the banking sector (Stolz and Wedow, 2010 and Domingues Semeano and Ferdinandusse, 2018). For example, public debt in the euro area as a whole rose from about 65% of GDP in early 2008 to about 78% in early 2010 and above 90% in 2013. Particularly large increases occurred, notably, in Cyprus, Greece, Ireland, Portugal and Spain. At least to some extent risk was transferred from the financial sector onto the public sector balance sheets leading to a deterioration of fiscal positions.

Moreover, after the Greek public debt deceit started to be revealed as of October 2009 leading, inter alia, to a large revision of the reported government deficit for 2009, in April 2010 the Greek sovereign debt market seized up and markets lost confidence in the authorities’ ability and willingness to address the large rise in Greek government debt. Despite European governments putting together a rescue package and associated adjustment program for Greece and establishing the European Financial Stability Facility in June 2010 – a (temporary) backstop vehicle for future crisis incidents –, other “peripheral” countries faced their own crises in the following two years. Against the background of the discussion on countries with (private and public) debt overhang problems in sub-section 2.2.3 and the further public debt increases referred to above, it is instructive to note that the countries affected and that needed some form of adjustment program with financial assistance were precisely Ireland (2010), Portugal, Cyprus (both 2011) and Spain (2012). Over time Italy became also seriously distressed but never to the point that it had to take a rescue program.

The ECB’s policy response continued to abide by the separation principle. On the one hand, in order to ensure depth and liquidity in the sovereign bond markets of distressed countries and restore an appropriate functioning of the monetary policy transmission mechanism, in May 2010 the ECB introduced its first sovereign bond purchase programme, the Securities Markets Programme (SMP). To signal that the SMP was not designed to alter the stance of monetary policy, the SMP purchases of debt securities were sterilised.

On the other hand, as both GDP growth and headline inflation picked up, the ECB raised its key policy rates by 25 basis points in April 2011 and again in July 2011, following almost two years of no

change. The euro area economy had grown at a quarterly rate of 0.8% in the first quarter of 2011, and the economic analysis revealed some upside risks to price stability. In fact, inflation had risen to 2.6% in March 2011 (and actually reached 3% towards the end of 2011, way above the medium-term objective below but close to 2%). There were concerns about second-round effects in the setting of prices and wages, and a risk of inflation expectations becoming dis-anchored from the ECB's definition of price stability.

Although the econometric evidence reviewed in Section 3.3 finds that the SMP interventions did put downward pressures on and lowered the volatility of sovereign yields for most countries, they did not stop the rise in sovereign spreads. By mid-July 2011 financial tensions intensified again due to the worsening of public finances in several euro area countries and contagion from the agreement to restructure Greek sovereign debt (which was, however, not implemented before 2012).³⁶ After bank bailouts had weakened sovereigns, the sovereign-bank nexus closed because the weakened sovereigns implied mark-to-market losses on banks' government debt holdings and an erosion of public guarantees (e.g. Acharya et al. 2014). The sovereign debt crisis increasingly turned into a twin sovereign debt and banking crisis. Further negative feedback loops between vulnerable banks, indebted sovereigns and weak economies took hold in several countries and led to acute financial fragmentation along country borders (e.g. Shambaugh, 2012, ECB 2012a and 2013a). The most affected countries lost market access and entered adjustment programmes (see above), contributing to a period of (pro-cyclical) fiscal consolidation (Figure 12) and stabilisation slowdowns.

In addition to the fiscal woes and associated high and diverse sovereign yields across the euro area, monetary transmission remained severely hampered by lingering bank instabilities constraining the flow of credit to the economy and imposing significant obstacles to the ECB's enhanced credit support. The reason was that in many, particularly the fiscally weak countries bank re-capitalization or resolution processes progressed only very slowly. Cases in point are the two EU-wide coordinated stress testing exercises in 2010 and 2011. Although seven euro area banks out of 91 EU banks (a much larger set than in the first, 2009 CEBS exercise) failed the July 2010 tests and had to raise new capital (CEBS 2010), its potentially beneficial effect on confidence in European banks was soon undermined by the fact that the two largest Irish banks, which had passed the test like many others, needed to be bailed out only a few months later. Similarly, eight euro area banks out of 90 EU banks tested failed to meet the minimum threshold in the 2011 exercise, coordinated for the first time by the new European Banking Authority (EBA 2011), and were asked to replenish their capital. In October of the same year, however, the large Franco-Belgian group Dexia, which had passed the test by a wide margin, went in resolution.³⁷ At this point, the credibility of prudential and fiscal authorities' ability to solve Europe's banking problems was in a sorry state. Bank fragility and

³⁶ The restructuring of Greek debt reflected one aspect of the Deauville agreement between Chancellor Merkel and President Sarkozy in October 2010 to promote "private sector involvement" (PSI) in handling a public debt overhang. The lingering question about its application to the Greek case after October 2010, the decision in July 2011 to restructure the Greek debt and the delay in its implementation until spring 2012 implied an ongoing source of uncertainty and volatility over an extended period of time. It should not be forgotten, however, that the Franco-German Deauville agreement comprised a much more wide-ranging public debt crisis resolution framework for Europe, which included – inter alia – the establishment of a permanent rescue facility when the EFSF would expire in 2013. See Zettelmeyer et al. (2013) for a detailed history of the Greek debt restructuring and events around it.

³⁷ Spain's Bankia collapsed in April 2012.

fragmentation remained a serious impediment to an effective monetary policy for the whole of this period.

As the financial tensions intensified and fiscal consolidation took hold, economic confidence fell, the economy slowed down rapidly and the euro area entered a double-dip recession in the last quarter of 2011 (Figure 7). An important contributing factor was banks' deleveraging needs and the associated tightening of bank lending standards and further reductions in money and credit growth (Figures 14, 15 and 9).

In response the ECB entered a new monetary policy easing phase. On 7 August 2011, ECB President Trichet made a statement on Italy and Spain and announced that the ECB would reactivate its Securities Markets Programme. Towards the end of 2011, the ECB introduced several new non-standard measures. Two Long Term Refinancing Operations (LTROs) of twelve and thirteen months were announced on 6 October 2011, as well as a second covered bond purchase programme (CBPP2) for an intended amount of 40bn euro. Then, under the new President Mario Draghi, the ECB reversed the interest rate hikes of April and July 2011, by cutting key policy rates in November and December 2011 by a total of 50 bps. Moreover, in December 2011 and February 2012, two 3-year very long-term refinancing operations (VLTROs), with the option of early repayment after one year, were conducted with a combined gross amount of more than 1tr euros (Figure 16). These VLTROs gave banks funding certainty, eased redemption of maturing bonds and helped them sustain credit lines with private customers. Finally, on 8 December 2011, the ECB also decided to enlarge again the collateral list via a reduction of the rating threshold for certain asset-backed securities and reduce the minimum reserve ratio (see sub-section 2.1.1) from 2% to 1%.

[Insert Figure 16 around here]

These measures brought much needed relief for banks' funding, but – by definition of central bank liquidity operations – could not ensure the much needed balance sheet repair of many euro area banks. Also the need for fiscal consolidation lingered on. In early 2012, weak growth and news of fiscal slippages in several countries strained financial markets once more, and financial tensions rose again. Over the course of the sovereign debt crisis, a new phenomenon had slowly emerged, redenomination risk – the risk that euro assets could be redenominated in legacy currencies (De Santis forthcoming). In other words, some premiums priced into the government bond yields of a few countries reflected increasing market-derived probabilities that those countries could leave the euro. In 2011 and, particularly, in 2012 some of them reached new heights (De Santis forthcoming), increasing the cost of funding for several stressed euro area countries and seriously hampering the transmission of the ECB's policy stance to the real economy in those countries. Preserving the unity of the euro area became the defining challenge of the crisis.

This was the context in which, finally, also decisive steps were taken at the political level. For example, the "Fiscal Compact" was signed in March 2012, involving – inter alia – a balanced-budget rule. More importantly, at a key European summit on 28-29 June 2012 the President of the European Council proposed significant reforms to the financial, budget and economic policy frameworks of EMU, notably the establishment of the main elements of a European Banking Union –

single supervision, resolution and deposit insurance (European Council 2012a).³⁸ Making explicit reference to the need for breaking the sovereign-bank nexus, the euro area countries agreed to start with a Single Supervisory Mechanism (SSM) at the ECB (European Council 2012b). Already before, it had been agreed that the temporary EFSF would be replaced in October 2012 by the European Stability Mechanism (ESM), an intergovernmental organization to safeguard the financial stability of the euro area through financial assistance against strict conditionality to member states with severe financing problems. The ESM has a lending capacity of EUR 500 bn. and assumed later also the possibility of direct bank recapitalizations (European Council 2012b). Details of the reforms were worked out in the Four Presidents roadmap towards a genuine Economic and Monetary Union published in December 2012 (European Council 2012c) and subsequent legislation.³⁹

In this new context of a much clearer path for fixing some of the most important financial and fiscal weaknesses of EMU, on 11 July 2012 the ECB lowered rates by 25 basis points, bringing the Deposit Facility Rate (DFR) to 0% (which was then left unchanged for almost two years; Figure 5). More importantly, on 26 July 2012, ECB President Draghi (2012) delivered a speech in London in which he gave the assurance that: “Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough.” Several days later, on 2 August 2012, the ECB’s Governing Council announced it would introduce an outright monetary transactions (OMT) program. The OMT programme consists of purchasing sovereign bonds in secondary markets under strict conditions with the aim of “... safeguarding an appropriate monetary policy transmission and the singleness of monetary policy” in the face of potentially self-fulfilling redenomination risks. The technical framework of OMTs was announced on 6 September 2012 and, on the same day, the SMP was terminated. A necessary requirement for OMTs was strict and effective conditionality attached to an appropriate EFSF/ESM programme (including a precautionary programme). The OMT back-stop was seen as credible, supported by the political agreements at the June Summit,⁴⁰ and led to an immediate contraction of sovereign bond spreads, which rapidly declined to more sustainable levels (Figure 13).

On 8 May 2013 the ECB lowered the MRO rate by 25 basis points and the Marginal Lending Facility rate (MLFR) by 50 basis points, further narrowing the interest rate corridor (Figure 5). With the DFR at 0% already before the room for further cuts in interest rates was increasingly limited. In response to the partial normalisation of financial tensions, growth slowly picked up in the course of 2013.

2.3.3 Discussion

Overall, in the period between August 2007 and June 2013 the ECB entered the uncharted territory of non-standard monetary policy measures. At first, the ECB’s operational framework was well-suited to address impairments in the interbank market by providing ample liquidity to its wide set of counterparts and against a wide set of collateral (Cassola et al, 2011, and Eser et al, 2012). The ECB particularly “lent to the market” like a traditional lender of last resort for a banking system with

³⁸ In June 2012 the European Commission had also presented a first draft of a European Bank Recovery and Resolution Directive.

³⁹ Also the Greek debt restructuring had finally taken place in March and April 2012, although the agreed bond exchange had to be complemented with an EFSF buyback of newly issued debt already in December (e.g. Zettelmeyer et al. 2013).

⁴⁰ For example, the Commission tabled a proposal for the SSM in September 2012.

liquidity problems.⁴¹ In so doing, it relied on a separation principle to distinguish very generous liquidity provision from setting the monetary policy stance. One question in this regard is whether (with the benefit of hindsight) the ECB was too optimistic about its (or other policy branches') ability to contain those impairments – notably the later and more severe ones (see next paragraph) – and their macroeconomic effects. This question has become subject to debate in particular with respect to the short-lived tightening of standard monetary policy in 2008 and 2011 in parallel with continued easy liquidity provision. The reaction function analysis in section 3.2, which adopts the adequate real-time perspective, suggests that the July 2008 interest rate increase was not fully in line with the ECB's own falling growth and inflation forecasts. The interest rate increases in 2011 were more in line with the strong growth and inflation forecasts in early 2011, though somewhat delayed. As non-standard monetary policy measures became more forceful, the distinction between monetary policy stance and market operations started to soften. For example, with the introduction of the FRFA credit operations in October 2008 the excess liquidity that started to build up in the banking system (see Figure 16) pushed the overnight rate in the money market from the middle of the ECB's interest corridor to the bottom, making the DFR the effective policy rate. Also in communication, non-standard measures based on the ECB's market operations started sometimes to be mentioned in the introductory statement to the Governing Council press conference.

However, as first the financial crisis and then the sovereign debt crisis took hold and the underlying solvency problems of both banks and sovereigns lingered on and reinforced each other, the incompleteness of EMU in the banking and fiscal areas became increasingly obvious and undermined the effectiveness of the ECB's monetary policy. The imperfect ways in which major financial and fiscal instabilities were addressed by the competent authorities and the absence of sufficient institutions and tools for solving the related collective action problems in a highly integrated monetary union of sovereign states with primarily national fiscal and supervisory policies, posed formidable challenges for the ECB's monetary policy. An early indication of this was that in spite of very early generous liquidity provision the ECB did not succeed in pushing interbank market rates all the way back down close to pre-crisis levels, as shown in Figure 13. One plausible explanation is that these spreads contained a significant credit risk component and that credit risks and liquidity risks were strongly intertwined (e.g. Eisenschmidt and Tapking 2009 and Angelini et al. 2011). Relatedly, the pass-through of the lower policy rates to bank lending rates became very uneven across countries over time as financial fragmentation took hold, again undermining the effectiveness of monetary policy.

ECB monetary policy itself could not address the underlying solvency issues of either banks or governments. In fact, the prohibition of monetary financing laid down in the Treaty forbids the ECB to directly finance governments or government tasks such as the recapitalization of banks.⁴² It provides an important protection of the ECB from fiscal dominance over its monetary policy, thereby supporting the achievement of price stability in the medium- to long-term. Instead such solvency issues can only be effectively addressed by prudential and fiscal authorities. Unfortunately, major

⁴¹ Emergency liquidity assistance to individual banks was undertaken, where needed, by euro area national central banks outside their Eurosystem responsibilities. But banks with sufficient Eurosystem eligible collateral could also tap the ECB's marginal lending facility.

⁴² Article 123 of the Treaty on the Functioning of the European Union prohibits overdraft facilities or any other type of credit facility for governments or government institutions with the European Central Bank or the Eurosystem, as well as the direct purchase from them of debt instruments.

progress in addressing the institutional limitations in the field of supervision and resolution only happened towards the end of this period, as political agreements were reached to build a Banking Union – with the setting up of the Single Supervisory Mechanism (SSM) at the ECB and a Single Resolution Mechanism – and to strengthen the back-stop for governments through the permanent ESM.

Against this background the ECB's actions had to balance the need to address impairments in the transmission of monetary policy due to malfunctioning financial markets and self-fulfilling market dynamics with the prohibition of monetary financing. This partly explains what some observers regard as the initial timid interventions in the government bond market through the SMP based on implicit conditionality.⁴³ When the necessary institutions and reforms around the June 2012 European Summit to improve on the main weaknesses of EMU in the prudential and fiscal fields were put on a credible path, the ECB could confidently step up its non-standard toolkit to the next level. This led to the powerful OMT programme, based on explicit conditionality of an adequate EFSF/ESM programme.

2.4. Deflation risks and the low-inflation recovery (June 2013 – June 2018)

2.4.1 Addressing the lower bound on interest rates

The fourth and most recent episode was characterised by the ECB's actions to overcome the zero-lower bound on interest rates in its attempt to address deflation risks and bring inflation back to levels close to 2%. In doing so, the ECB turned to policies such as quantitative easing, funding for lending and explicit forward guidance that had been used before by other central banks such as the Fed and the Bank of England. The ECB was, however, the first major central bank to also go into negative interest rate territory. We review existing evidence on the effectiveness of these programmes in Section 3.3.

As monetary policy became much more complex, there was an increased need for communication. As part of the efforts of enhanced communication in a more complex environment, in January 2015 the Governing Council decided to release the accounts of the monetary policy Governing Council meetings, approximately four weeks after each meeting (Draghi, 2014a). At the same time, the frequency of these meetings was changed from monthly to eight times a year, in order to align it better with the arrival of enough new information and to reduce the number of instances when expectations could cause market volatility. Different from previous communication, in which the ECB had stated that it would not pre-commit on monetary policy decisions, it also turned to forward guidance in this period (Table 2). Following the taper tantrum in the US, which led to significant undesired interest rate spillovers to the euro area, the ECB introduced explicit forward guidance about the future path of key interest rates in July 2013. As in other central banks, the precise formulation of the forward guidance evolved over time, as we describe in section 2.4.3.

⁴³ As discussed in Section 3.3, the ECB characterised the SMP interventions as limited and temporary, leading markets to doubt that it was prepared to offer a full backstop.

2.4.2 Negative rates, targeted lending and quantitative easing

The sovereign debt crisis abated and the recovery started to take hold, as some of its underlying causes were addressed by the various country programmes, the creation of a banking union with common supervision and resolution and the establishment of a back-stop for governments via the European Stabilisation Mechanism (ESM) and the ECB's OMT programme. The damage of high unemployment and negative output gaps in 2012 and 2013 was however done (Figure 3). Towards the second half of 2013 both headline and core inflation dropped below 1%, with headline inflation becoming negative in the course of 2015 (minimum of -0.7% in January 2015) largely on account of falling energy prices (Figures 6 and 8). Inflation expectations, which up until then had remained well anchored, started to decline and to exhibit a significant downward skew (Section 3.1).⁴⁴ Concerns of deflation risks and a prolonged period of low inflation grew. Moreover, it became increasingly clear that the transmission of the easing of ECB key policy rates had remained impaired and uneven. In particular, the cumulative 125 bps reduction from September 2011 to June 2014 had not yet been transmitted to households and firms in the stressed euro area countries. At the same time, as the medium-term outlook for inflation continued worsening, the ECB's balance sheet shrank, credit growth remained negative reflecting ongoing deleveraging and (until March 2014) the exchange rate of the euro strengthened (Figures 16, 9 and 10).

To stave off emerging deflation risks and address the impairment of the bank lending channel, the ECB embarked on a three-pronged comprehensive monetary policy easing strategy as of June 2014. This strategy was foreshadowed in a speech by President Draghi (Draghi 2014a) in which each of the conditions for the three elements of the easing strategy were laid out. A first measure was to go into negative interest rate territory. In June 2014, and again in September 2014, the ECB lowered the DFR by 10 bps respectively to -0.2%. Second, in order to revive the provision of credit and address the fragmented policy transmission a renewed round of credit easing measures with a series of targeted longer-term refinancing operations fixed at the MRO rate plus 10 basis points were announced. The surcharge was abolished in January 2015. The maximum maturity for the TLTROs was set to September 2018, and the initial allowance amounted to 7% of outstanding loans to the euro area non-financial private sector. The maturity of the loans was conditional on banks achieving certain lending thresholds to the corporate sector. These credit easing measures were complemented by an asset-backed securities purchase programme (ABSPP) and a third covered bond purchase programme (CBPP3) in September 2014. Thirdly, in order to provide additional stimulus in an environment where further cuts in short-term rates were constrained, in January 2015 the ECB announced an expanded Asset Purchase Programme, with average monthly purchases of public and private sector securities of 60bn euro. Through the portfolio rebalancing and signalling channels this put further downward pressure on long-term interest rates and flattened the slope of the yield curve. At the same time, it led to a big expansion of the central bank's balance sheet (Figure 16). The combined impact of these measures was to lower market- and bank-based financing costs and ease financial conditions more broadly (Section 3.3). Figure 15 shows that the composite indicator of the cost of borrowing for NFCs and households fell from 3% to close to 2% at the end of 2015 and bank lending rates started to converge following the earlier fragmentation. At the same time, banks

⁴⁴ For example, in his speech at the Jackson Hole Symposium in August 2014, President Draghi (2014c) digressed from his main topic of euro area unemployment to point out that inflation expectations were declining significantly at all horizons (see e.g. Figures 18 and 20 below).

started easing lending standards and credit growth to the private sector gradually started recovering (Figures 9 and 14). By the summer of 2015 GDP growth had picked up to close to 2% and both headline and underlying inflation had stabilised, but at relatively low levels of 0 and 1%, respectively.

Against this background of still uneven and fragile growth and low inflation, the growth in global demand faltered in the summer of 2015 as a stock market collapse in China and an unexpected depreciation of the renminbi caused financial turbulence in emerging market economies. In order to avoid a renewed increase in deflation risk and to continue to support the gradual recovery in the euro area economy, the three-pronged package of measures was recalibrated again in December 2015 and March 2016 with a view of adding further monetary policy stimulus. On 9 December 2015, the ECB lowered interest rates further by 10bps and announced a recalibration of the APP, prolonging the programme until March 2017, or beyond if necessary to ensure a sustained adjustment of inflation towards the aim of below, but close to 2%. At the same time, the ECB announced that it would reinvest the principal repayments, keeping the stock of the APP portfolio constant after the end of the net purchases for as long as necessary, and extended the list of APP-eligible assets to include securities issued by regional and local governments. On 10 March 2016, the ECB lowered rates again, bringing the interest rate corridor down to 65 basis points and lowering the DFR by 10 bps to -0.4%. At the same time, a considerable expansion of the APP was announced, with average monthly purchases being increased to 80bn euros. The ECB also launched a corporate sector purchase programme (CSPP) as integral part of the APP. Finally, four new targeted longer-term refinancing operations (TLTRO-II), each with a maturity of four years, were announced, starting in June 2016 and running until March 2017. The rates on these operations could be as low as the negative DFR rate, if banks exceeded certain lending benchmarks. The combined effect of these additional easing measures was to further improve financing conditions. This stimulated domestic demand and turned a fragile and uneven recovery into a solid and broad-based expansion in spite of the temporary weakness of the international economy. Accordingly, but also partly due to rising commodity prices, inflation picked up as of Q3 2016 reaching 1.8% in January 2017 (Figures 6 and 8).

As the economy strengthened, but underlying inflation remained subdued, further monetary stimulus was deemed appropriate, but the intensity of the monetary stimulus was gradually adjusted. On 8 December 2016, the Governing Council decided to extend the net APP till the end of 2017, while at the same time reducing its monthly pace as of April 2017 to 60bn euros. As of Q2 2017 growth further increased, peaking at 2.8% in September (Figure 7). On 26 October 2017 a further recalibration of the APP was decided as the programme was extended until September 2018 with a reduced monthly pace of purchases of 30bn euros starting from January 2018. Finally, on 14 June 2018, the Governing Council announced an anticipated extension of the net APP till the end of 2018 at a reduced pace of 15bn euros followed by ending the net APP. At the same time, it enhanced its forward guidance on policy rates by stating that it expects policy rates to remain at their present levels at least through the summer of 2019 and, in any case, for as long as necessary to ensure the sustained convergence of inflation to levels that are below, but close to 2%. In fact, headline inflation stabilised around 2% during the summer of 2018, whereas core inflation continues to “creep up” only very slowly.

2.4.3 Discussion

Overall, the fourth episode was characterised by the ECB's actions to overcome the zero-lower bound on interest rates in its attempt to address deflation risks and bring inflation back to levels close to 2%. In doing so, the ECB turned to policies such as negative interest rates, quantitative easing, funding for lending and explicit forward guidance and in this respect started to resemble more closely many of its peers.

Most of the debates in this period related to the rationale, the sequencing and the cost and benefits of the new non-conventional measures. We review the rationale for the various measures and the evidence of their effectiveness and their potential side effects in Section 3.3. Here it is important to realise that, as the ECB ventured into uncharted territory, it learned from its own and other central banks' experience. A prominent example is the introduction of a negative deposit facility rate, which was introduced in small steps of 10 basis points and followed positive experience with negative rates in a number of smaller countries such as Denmark and Switzerland. Also the ECB's forward guidance evolved in this period (Table 2). Following the taper tantrum in the US, the ECB announced that the policy rates were expected "to remain at present or lower levels for an extended period of time" and that this expectation was "based on the overall subdued outlook for inflation extending into the medium term, given the broad-based weakness in the real economy and subdued monetary dynamics." The aim was to anchor policy expectations and maintain an accommodative level of long-term interest rates in the face of rising bond yields in the global market and a still very subdued and fragile euro area recovery. As explained by Praet (2013), the forward guidance on interest rates was meant to clarify the ECB's reaction function. As in other central banks, the ECB's forward guidance framework subsequently evolved. It took on a more complex and time and state-dependent form when the expanded APP was announced in January 2015. On this occasion, the ECB also gave forward guidance on the net asset purchases and announced that they "are intended to be carried out until end-September 2016 and in any case until it sees a sustained adjustment in the path of inflation which is consistent with its aim of achieving inflation rates below, but close to, 2% over the medium term." This forward guidance therefore had both date and state-dependent conditioning elements. The former underscored the commitment made by the Governing Council, whereas the latter made the state dependent nature of the forward guidance clear. A direct link with the ultimate objective was seen as more appropriate than alternative intermediate targets, also in the light of the mixed experience with conditioning variables such as unemployment in the United States and the United Kingdom. The APP was subsequently extended in December 2015, in December 2016 and in October 2017 maintaining a similar formulation.

In March 2015, when the APP monthly purchases were increased from 60 to 80bn per month, the ECB also for the first time linked the forward guidance on interest rates to that on the APP by stating that the "key interest rates would remain at present or lower levels for an extended period of time and well past the end of the net asset purchases". This helped to secure the credibility of the interest rate forward guidance (Coenen et al, 2017), thereby reinforcing both parts of the easing programme, and it also provided clarity on the sequencing in the normalisation of the various elements of the easing measures (Praet, 2018). In June 2017, the reference to lower interest rates (the "easing bias") was dropped. And, in June 2018, when the anticipation of the end of the net asset purchases by the end of 2018 was announced, the forward guidance on interest rates was delinked from the APP programme and now states that "The Governing Council expects key interest rates to

remain at the present level through the summer of 2019 and, in any case, as long as necessary to ensure the continued sustained convergence of inflation to levels that are below, but close to, 2% over the medium term". A date and state-based element is now attached to the lift-off of policy rates.

Controversy around the ECB's policy decisions in this period focused mostly on the Public Sector Securities Programme (PSPP) which constituted the largest part of the APP. Despite an observable slide in inflation, there was some opposition to a large-scale bond purchase programme because of monetary financing concerns (Article 123 of the Treaty on Monetary Union) and possible effects on governments' willingness to pursue debt consolidation and enact reforms (e.g. Weidmann, 2015). The fact that deploying asset purchases was fully in line with the ECB's mandate was confirmed by the European Court of Justice. In its judgement on the OMT programme, it ruled that purchases of government bonds are legal under the ECB's statute and a legitimate tool of monetary policy.⁴⁵ To ensure that secondary market purchases of government bonds cannot be assimilated to primary market purchases that are forbidden under the monetary financing prohibition, it is, however, also important to ensure that the programme is consistent with the ultimate objectives of Article 123, namely safeguarding (i) the primary objective of price stability, (ii) central bank independence, and (iii) fiscal discipline of a Member State. To that effect, the ECB built sufficient safeguards into the PSPP. First, PSPP purchases adhere to a black-out period, i.e. the Eurosystem does not buy around the date of a new issuance, which facilitates the formation of market prices for PSPP-eligible securities.⁴⁶ Furthermore, the relevant securities are subject to an issue share limit and an issuer limit, which preserve market functioning. Finally, in order to avoid free-riding by national governments, risk sharing of the PSPP was limited to 20% of the portfolio and the portfolio weights were guided by the capital key, i.e. the share of each national central bank in the ECB's capital. All these safeguards were designed to ensure that PSPP purchases cannot be perceived as a circumvention of the monetary financing prohibition.

3. Assessing the ECB's monetary policy

3.1. The objective of price stability: performance, credibility and challenges

In this section we analyse the performance and credibility regarding the ECB's primary mandate of medium-term price stability for the euro area. The key question is to what extent the ECB managed to anchor medium-term inflation expectations consistent with its mandate, in particular in the aftermath of the twin-crises.

3.1.1 How well anchored are inflation expectations in the euro area?

Figure 17 shows that over the past two decades average euro area inflation has been approximately 1.7 percent. This average outcome is consistent with, but on the low side of Issing's indication of an

⁴⁵ See Judgment of the Court of Justice of the European Union (Grand Chamber) of 16 June 2015, Peter Gauweiler and Others vs Deutscher Bundestag.

⁴⁶ See the decision of the ECB of 4 March 2015 on a secondary markets public sector asset purchase programme (ECB/2015/10) https://www.ecb.europa.eu/ecb/legal/pdf/en_dec_ecb_2015_10_f_sign.pdf.

inflation aim between 1.7 and 1.9%. Over this period annual HICP inflation has roughly fluctuated between 0 and 4%, mostly reflecting the impact of volatile energy and food price inflation. The range for core inflation (i.e. HICP inflation excluding energy and food) is smaller and lies between 0.7 and 2.5% reflecting its more sluggish nature (Figure 6). Figure 17 also depicts a five-year centred moving average of HICP inflation which may capture a more appropriate medium-term horizon for assessing the ECB's performance. This moving average has fluctuated closely around 2 percent till the sovereign debt crisis, but started to decline below its previous range in the second half of 2012 and fell to a historic low of approximately 0.7% at the beginning of 2016 and is expected to slowly recover since then.⁴⁷

[Insert Figure 17 around here]

Given the imperfect short-term control of inflation by the central bank, it is also useful to examine the stability of medium to long-term inflation expectations. The anchoring of longer-term inflation expectations to the ECB's inflation aim is a good measure of the ECB's credibility for maintaining price stability over the medium term. The empirical literature has shown that the degree to which inflation expectations are anchored has been dispersed across countries and time and appears to co-move with the degree of credibility of monetary policy. The tendency towards better anchored expectations was typically stronger in countries with official inflation targets, suggesting that agents use inflation targets as focal points when forming long-term inflation expectations (See, for example, Demertzis et al. (2009) and Gürkaynak et al. (2010)).

[Insert Figure 18 around here]

A study focusing on the earlier part of the EMU period (Beechey et al, 2011) showed that on average euro area long-run inflation expectations were more firmly anchored than those in the US. In this section we follow Dovern and Kenny (2017) and use the ECB's Survey of Professional Forecasters (SPF) to examine how the various moments of long-term inflation expectations in the euro area have evolved over the past two decades. Figure 18 shows the evolution of two measures of average 5-year ahead inflation expectations taken from the SPF (together with two measures of market-based inflation expectations derived from swap rates between inflation-adjusted and nominal government bonds). The average point forecast stayed close to 2.0% over the full EMU period, roughly fluctuating between 1.8 and 2.0%. The average mean of the individual forecasters' distributions has fluctuated a bit more and reached a minimum of 1.65% at the beginning of 2016. As shown in Lyziak and Paloviita (2016), there is some dependence of those average forecasts on a moving average of actual inflation, but overall these movements have been very contained. Using more formal tests for breaks in mean long-term inflation expectations, Dovern and Kenny (2017) find two significant breaks in 2005Q2 and then again in 2013Q2. In 2005Q2 the mean expectation shifted upward from an estimated 1.85% to 1.92%. Arguably this may be due to the clarification of the definition of price stability of below, but close to 2% in 2003. This upward movement in expectations was however more than reversed in 2013Q2 when the mean inflation expectation dropped back to 1.8%, partly in response to the persistently low level of inflation following the sovereign debt crisis in the euro area.

[Insert Figure 19 around here]

⁴⁷ The ECB/Eurosystem's inflation projections are used to calculate the 5-year moving average towards the end of the period.

It is also instructive to look at the second moment of the longer-term forecast distribution. Figure 19 shows three measures of longer-term inflation uncertainty based on the SPF. First, it shows a measure of disagreement amongst professional forecasters, i.e. the standard deviation of individual forecasters' point forecasts. Disagreement fell significantly in the first decade of EMU from 0.4pp to 0.1pp suggesting that the ECB's extensive communication about its stability-oriented monetary policy strategy and the quantitative definition as well as the consistent and transparent conduct of monetary policy were effective in aligning longer-term expectations across forecasters. While disagreement rose significantly after the start of the great recession, it has fallen back reaching levels close to 0.15pp since then. The other two measures take into account the individual forecast uncertainty. Following the financial crisis longer-term inflation forecast uncertainty has clearly increased, reflecting also the higher variance of actual HICP inflation after 2007 (Dovern and Kenny, 2017). There is no evidence that this measure of uncertainty has so far significantly reverted to its pre-crisis level.

[Insert Figure 20 around here]

Finally, one can also analyse the balance of longer-term inflation risks as captured by the professional forecasters expected distributions. Figure 20 gives the evolution of a number of such measures, as well as the median. It shows that before the financial crisis the risks around the longer term inflation forecast were roughly balanced. Interestingly, a slight negative skew emerged around 2003-2004, when as discussed before there was a debate about the impact of the zero-lower bound on optimal inflation targets and the ECB's inflation aim was clarified. However, the skew became persistently negative following the outbreak of the financial crisis and in particular after the sovereign debt crisis. Most recently there has been a return towards more balanced risks. This is consistent with recent evidence in Grishchenko et al (2017).

Figure 20 also shows that the negative skew is highly correlated with model-based estimates of the inflation risk premium in inflation indexed bonds and can explain why market-based 5-year ahead 5-year forward inflation rates have been more responsive to actual headline inflation than the average survey expectations (Figure 18). As the probability of getting trapped in a low inflation or deflation regime increases, the demand for deflation protection rises affecting inflation risk premia.

A second approach for analysing the anchoring of inflation expectations is to investigate the sensitivity of longer-term inflation expectations to short-term macro-economic news and inflation developments, as reviewed in Ciccarelli and Osbat (2017). While the reviewed studies differ in the details of their respective methodologies, there are some common findings which are consistent with the findings above. Before the crisis no significant pass-through effects were recorded. The overall picture is less clear after the start of the financial crisis.⁴⁸ However, after the negative oil price shock of mid-2014, three out of four pass-through measures identified increasing risks of a de-anchoring of longer-term inflation expectations. In 2015, the announcement and subsequent implementation of the APP seems to have softened these risks and some studies suggest that the pass-through signal has become insignificant.

⁴⁸ For the US a number of studies have shown that long-term mean inflation expectations started to react more strongly to macroeconomic news after the financial turmoil of 2008 (See, for example, Galati et al., (2011) and Autrup and Grothe (2014)).

Overall, this review of the evidence suggests that in contrast to some early fears the ECB was effective in anchoring medium to long-term inflation expectations to its inflation aim early on (Smets, 2010). Moreover, modal expectations remained anchored below, but close to 2% throughout the financial and sovereign debt crisis. However, the higher uncertainty around the expected longer-term inflation forecast and the emergence of a significant negative skew in the balance of risks after the beginning of the sovereign debt crisis in particular suggests that the ECB was not able to fully dispel the probability of ending up in a low inflation/deflation regime (as had happened in Japan). This may not necessarily be related to the credibility of the ECB's commitment to maintain price stability, but it may be due to doubts that the ECB had the necessary tools to fight deflation in a low interest rate environment. Not the willingness of the central bank, but its ability may have been put in doubt particularly as, compared to other major central banks such as the Federal Reserve System, the Bank of England and the Bank of Japan, the ECB was slow in applying large-scale purchases of government bonds as a monetary policy tool. This explanation is also borne out by some evidence of asymmetry between the response of long-term market inflation compensation measures to inflationary and deflationary shocks (Natoli and Sigalotti, 2018). While this may have been more important for the European Central Bank where a discussion on the use of QE was more intense and may explain its delayed implementation, the fact that this feature has to some extent also been observed in other jurisdictions with a single fiscal authority suggests that it may be a more general phenomenon related to the risk that one can get trapped in a deflation regime once inflation expectations adjust (Benhabib et al, 2001). As discussed above, the emergence of medium-term deflation risks eventually led the ECB to embark on a comprehensive unconventional easing programme which helped to remove the deflation risks (Andrade et al, 2016).

3.1.2 Possible implications for the definition of price stability

The review of the ECB's credibility highlights that over the past two decades the initial concerns that the ECB may not have had the same anti-inflation credibility as some of its predecessors such as the Bundesbank turned into the opposite concern that it may not be sufficiently equipped to avoid a low inflation or deflation equilibrium. In this light, it is worthwhile to review some of the elements of the ECB's definition of price stability.

One issue is whether the excess sensitivity of longer-term inflation expectations to low inflation is partly due to a persistent perception of a lack of *symmetry* in the ECB's inflation objective. Due to the formulation of the inflation aim ("below, but close to"), many observers continue to think that the ECB's tolerance for lower inflation is higher than its tolerance for higher inflation, although ECB policy makers have continuously stressed the importance of symmetry.⁴⁹ The question of symmetry can be addressed within the policy reaction function literature. Paloviita et al (2017) finds no evidence of asymmetry if the inflation target is assumed to be 1.7%, but some evidence of asymmetry if the target is assumed to be 2%.⁵⁰ In Section 3.2 we test for asymmetry in a simple policy reaction function set-up and find little evidence of a stronger response to positive deviations of inflation than to negative deviations from the ECB's inflation aim.

⁴⁹ For example, in a recent speech President Draghi (2016) emphasised the importance of pursuing the price stability objective symmetrically particularly in a zero-lower-bound and high debt environment. This criticism was around from day one, as discussed before.

⁵⁰ Examples of other earlier studies of possible asymmetries of the ECB's monetary policy include Aguiar and Martins (2008), who finds a "precautionary demand for price stability" and Surico (2007).

A related question is whether the *precision* of the medium-term inflation objective matters. As mentioned above, empirical evidence suggests that a point target helps agents to focus when forming inflation expectations and contributes to the anchoring of those expectations. This is why many academics were originally in favour of a point target (e.g. Bernanke et al, 1999). It also explains why most inflation targeting central banks have a clear focal point, even if this is often embedded within a target range to underline that a central bank cannot precisely pin down inflation at all times.⁵¹

But what is the optimal focal point for inflation? In the advanced economies there has been a convergence of inflation targets to 2% since the start of inflation targeting regimes in New Zealand in 1989. Recent examples are the Federal Reserve Board in 2012, the Bank of Japan in 2013 and the Norges Bank in 2018. One argument against being very precise is that there is uncertainty surrounding *the optimal medium-run inflation objective* and that it may change over time. In the academic literature estimates of the optimal inflation target vary from mild deflation to 4% and higher. The recent experience of a higher macroeconomic volatility and a lower equilibrium real interest rate lead some macroeconomists to argue for higher inflation targets of 4% (e.g. Blanchard et al, 2010, Ball, 2014 or Krugman 2014).⁵² The higher probability of hitting the zero lower bound in a low interest rate environment is also brought out in quantitative simulation studies like Kiley and Roberts (2017). At the same time, central banks, including the ECB, have gained a lot of positive experience with the use of unconventional policy measures to circumvent the effective lower bound on short-term interest rates. Recent empirical research suggests that these tools may have been equally effective as the more standard short-term interest rate tools in steering the economy, although they may come with some additional side effects, as discussed in sub-section 3.3 below (see, for example, Swanson (2018), but also Hamilton (2018) for an opposite view). And changing inflation objectives always runs the risk of undermining the central bank's credibility and increasing uncertainty and the inflation risk premium.⁵³

A suggested compromise has therefore been to keep the 2% focal point, but strengthen the role of inflation expectations as an automatic stabilisation mechanism to further alleviate the zero lower bound on interest rates. This can, for example, be done by average inflation targeting (e.g. Svensson (1999) and Nessen and Vestin (2005)). Gaspar et al (2010) show that those benefits continue to exist even in the absence of rational expectations, as long as the agents learn and adapt their expectation formation to changes in the regime.⁵⁴

⁵¹ A precise numerical target also helps in communication. In the words of Stephen Nickel, former Bank of England MPC member, in 2006: "In my own experience, I find being provided with a precise numerical inflation target enormously helpful, since I can then explain my own policy decisions very simply in terms of avoiding an undershoot or overshoot of this target".

⁵² Early on, Wyplosz (2001) argued for a higher inflation target of 4-10% for the euro area on the basis of the presence of more significant downward nominal wage rigidities.

⁵³ For example, raising an inflation objective could increase the risk that inflation expectations become unanchored (see e.g. Ascari et al. 2017 and Deutsche Bundesbank 2018) or be "too blunt an instrument" compared to alternative options (e.g. Coibion et al. 2012).

⁵⁴ An argument against average inflation targeting is that it may require short periods of deflation following periods of inflation. This is addressed in the proposal by Bernanke (2017) of installing a price level target only after periods in which the lower bound has been binding.

3.2. The conduct of monetary policy: The ECB's interest rate decisions

This section analyses the ECB's interest rate decisions through the lens of an empirical interest rate reaction function. This is particularly appropriate until the ECB hits the zero-lower bound in 2013. Figure 5 shows the developments of the main policy-controlled interest rates since the start of EMU. During the first decade of EMU, the overnight interest rate (EONIA) has fluctuated within a 200 basis point corridor given by the marginal lending facility rate (MLFR) and the deposit facility rate (DFR) (with the exception of the initial weeks in 1999). As discussed in section 2, until October 2008, the main objective of the ECB's operational framework was to steer very short-term interest rates in line with the decisions of the Governing Council. During that time, the main policy rate was the minimum bid rate (MBR) in the ECB's weekly main refinancing operations (MROs). These are liquidity-providing repo operations conducted as variable rate tenders, subject to the minimum bid rate, in which the ECB determines the total amount that is allotted to counterparties, while banks submit bid schedules expressing the price they are willing to pay for liquidity in these operations. As can be seen from Figure 5, over this period the EONIA, the overnight money market rate, stayed relatively close to the MBR, i.e. the midpoint of the corridor, with exceptions at the end of the maintenance period when unexpected liquidity shortages or surpluses can lead to sharp deviations within the corridor. Over this decade a number of refinements were made to the ECB's operational framework, but the big changes came with the outbreak of the financial crisis in October 2008 (ECB, 2011a).

As discussed above, following Lehman's failure the interbank market seized up both internationally and within the euro area, giving rise to large spreads between secured and unsecured money market rates and falling interbank transaction volumes. The ECB responded by adopting a fixed-rate/full-allotment (FRFA) tender procedure in all its regular monetary policy operations, expanded its list of eligible collateral (BBB or higher) and lengthened the average maturity of its outstanding operations. These measures led to a significant expansion of the ECB balance sheet as the ECB became the market maker in the money market and in this way avoided a more dramatic and costly financial collapse and promoted effective monetary policy transmission. As shown in Figure 16, excess liquidity increased and as a result the EONIA dropped below the MRO rate towards the bottom of the corridor given by the DFR, which became the main policy rate. The distance of the EONIA rate from the DFR is a function of the amount of excess liquidity in the banking system as illustrated in Figure 21. Two periods are characterised by a rising EONIA relative to the deposit rate. The first one is in 2011 when the macro-economic picture improved, the ECB raised rates twice and excess liquidity dropped to very low levels. The second period is towards the end of 2013 and 2014 when excess liquidity again fell to low levels as banks started repaying the VLTRO operations.

[Insert Figure 21 about here]

In the rest of this section we analyse the setting of the main policy rate through the lens of a simple, but robust first-difference policy rule originally proposed by Orphanides (2003). This rule links the change in the main policy rate of the ECB (the MBR before October 2008 and the DFR after October 2008) to deviations of the one-year ahead inflation forecast from the ECB's inflation aim and deviations of the one-year ahead real GDP growth forecast from potential output growth:

$$(1) \quad \Delta i = 0.5(E\pi_{t+1} - \bar{\pi}) + 0.5(E\Delta y_{t+1} - \Delta \bar{y})$$

Orphanides (2003) showed that this rule describes quite well the behaviour of US policy rates during the Volcker/Greenspan period. As discussed in Orphanides (2006), one of the advantages of this simple rule is that it avoids having to rely on unobservable concepts such as the output gap and the natural real interest rate, which are subject to considerable uncertainty. Moreover, the first-difference rule has been shown to be robust in a variety of models, reflecting a wide range of data, parameter and model uncertainty (Orphanides and Williams, 2008). Finally, because the rule can be implemented on the basis of short-term forecasts for growth and inflation that were available at the time of the policy decision, it is an easy way of constructing a real-time policy benchmark that is not contaminated by ex-post information. Smets (2010), Orphanides and Wieland (2013) and Bletzinger and Wieland (2016), amongst others, have applied this rule to the euro area.

[Insert Figure 22 about here]

Figure 22 replicates and extends the rule shown in Orphanides and Wieland (2013). The solid black line depicts the changes in the relevant policy-controlled interest rate.⁵⁵ The shaded area shows the predictions of the Orphanides rule where we use the one-year ahead forecasts for inflation and growth from the ECB's Survey of Professional Forecasters (SPF) and the European Commission's real-time estimate of the potential GDP growth as input variables. The upper and lower limits of the shaded area correspond to a range for the inflation aim between 1.5 and 2.0%. As also shown by Smets (2010) and Orphanides and Wieland (2013), it is remarkable how well this simple rule captures the changes in the ECB's policy rate. If we impose the condition that the average error between the actual and predicted interest rate changes is zero (as in a regression analysis), then we can use this rule to calculate the ECB's implied inflation aim which is 1.76%, very close to the midpoint between 1.5 and 2.0% and consistent with the range highlighted by Issing in 2003.

In the rest of this section we go beyond the previous papers by using the ECB's own growth and inflation projections to derive the rule. From the start in 1998, the ECB and the Eurosystem have produced quarterly macroeconomic projections, which typically are presented to the Governing Council in the first meeting of March, June, September and December of each year as part of the economic analysis.⁵⁶ Kontogeorgios and Lambrias (2018) recently investigated some of the properties of the ECB/Eurosystem staff projections for GDP growth and HICP inflation and they find that they satisfy the properties of optimal forecasts. They are generally unbiased; errors are not correlated beyond what one theoretically could expect; and the uncertainty in the forecast increases with the horizon. They outperform simple benchmarks such as the Random Walk and an AR(1) model, and, in the case of inflation, are rational (See also ECB, 2013b and Alessi et al, 2014). Unfortunately, a direct comparison with the SPF forecasts is difficult because the professional

⁵⁵ Note that the changes in the policy rate are quarterly changes to align it with the quarterly frequency of the SPF forecasts, whereas the policy decisions are monthly through most of the period. We take the policy rate set in the middle of the quarter to align it with the time when the SPF forecasts are first available to the Governing Council.

⁵⁶ The June and December projections are called the Broad Macroeconomic Projection Exercise (BMPE) because it is a Eurosystem exercise involving the contributions of all the national central banks of the euro area, whereas the March and September Macroeconomic Projection Exercise (MPE) is an intermediate update of the December and June BMPE produced by ECB staff. Note that the ECB/Eurosystem's projections were at first based on a constant interest rate assumption, but since the June 2006 projection exercise are based on market expectations of short and long term interest rates. Differences in technical assumptions for the oil prices or the exchange rate may explain part of the differences between SPF and ECB/Eurosystem projections.

forecasters use different information sets and different technical assumptions. Paloviita et al (2017) focus on the properties of the ECB/Eurosystem staff forecasts over the projection horizon. They find that the ECB/Eurosystem staff projections exhibit stronger and faster mean reversion than implied by the persistence in the actual data. After about six quarters the median inflation projections are already in the proximity of their levels at the end of the forecast horizon. They also find that inflation forecasts are too often close to the mean and that 3 to 4 quarters out the inflation and growth forecasts are not correlated with the actual outcomes. Figure 23 shows the mean, max/min, and 25/75 percentile of the ECB/Eurosystem staff projections of year-on-year inflation and GDP growth over the projections horizon.

[Insert Figure 23 about here]

Figure 24 shows the outcome of applying the Orphanides rule to the ECB/Eurosystem staff projections. In order to align the interest rate decisions with the ECB/Eurosystem projections, we take the policy rate set when the projections are presented (i.e. in the last month of the quarter). This explains the slightly different pattern of interest rate changes compared with Figure 22. The conclusions remain, however, roughly the same. The simple policy rule captures the ECB's policy decisions quite well. The increase in rates in 1999 and 2000 and the subsequent fall, the pause in 2004-2005, the rise starting in 2006, the sharp fall in 2008 and 2009 and the slight increase in 2011, as well as the fall in 2012 are all captured fairly well by a simple response to deviations of the one-year ahead inflation projection from the inflation aim and the deviations of the one-year ahead growth projection from estimated potential output growth. Not surprisingly, the correspondence is less striking as of 2013 when the deposit rate is constraint by the zero lower bound and only small further changes into negative territory were feasible.

[Insert Figure 24 about here]

Table 1 shows the results from estimating this rule.⁵⁷ The estimated coefficients are somewhat smaller than, but not significantly different from 0.5. The ECB's implicit inflation aim which can be deducted from the estimated constant is 1.81%. The R² is higher than 0.5, which is quite high given that the variable we are trying to explain is expressed in first differences. Shortening the sample till the second quarter of 2013, when the ECB reached the zero-lower bound on its deposit rate (second column of Table 1) does not significantly change these results. In these regressions we chose the horizon for year-on-year GDP growth to be t+3 Quarters, reflecting the fact that at the time of the interest rate decisions in the last month of the quarter, the current quarter is not yet known while the previous quarter is known, whereas for inflation we have t+11 Months, reflecting that inflation in the previous month is known. We tested for different forecast horizons and found that for both GDP growth and inflation the one-year ahead projections are the most informative for policy decisions (highest R²).

[Insert Figure 25 around here]

⁵⁷ Other studies that have estimated policy reaction functions for the ECB include Gerdesmeier and Roffia (2003), Gorter et al (2008), Gerlach and Lewis (2014), Paloviita et al (2017). Paloviita et al (2017) find support for monetary policy reaction functions with very short run (one quarter ahead) GDP growth projections, somewhat longer (one-year ahead) inflation projections and a proxy for the natural rate of interest.

Figure 25 shows the cumulated errors of both the calibrated and estimated rules. Using this set of benchmarks suggests that interest rate policy may have been somewhat too loose in 2002 and too tight in 2009 and 2013.⁵⁸ This finding is consistent with more elaborate thick-modelling exercises by ECB staff, which identify both 2009 and 2012/2013 as periods in which the actual interest rate is above what a range of Taylor rules estimated before 2008 would have suggested. Of course, the latter periods are also when the ECB implemented a range of unconventional measures as we will discuss below. The interest rate increase in July 2008 does not appear to be justified by the ECB's own outlook for growth and inflation, but was quickly reversed. The interest rate increases in 2011 do not show up as a major policy mistake, but seem delayed as the inflation and growth projections suggested an earlier tightening move. Of course, this does not exclude the possibility that the ECB underestimated the impact of the financial and sovereign debt crisis on economic activity and inflation, but similar results using SPF forecasts suggest that the ECB was not the only institution to do so. Finally, these benchmarks do not suggest that monetary policy was too loose during the run-up to the crisis, as suggested by Taylor (2007) for the United States.

[Insert Table 1 around here]

In Table 1 we also test a number of alternative specifications. First, the third column shows that the ECB/Eurosystem staff projections outperform the SPF forecasts in explaining the ECB's interest rate decisions. This is not surprising as the SPF forecasts are collected one to two months earlier than the ECB/Eurosystem staff projections and therefore do not incorporate the latest data available at the time of the interest rate decision. Second, we test whether the projection for HICP inflation excluding food and energy adds additional value in explaining the interest rate decisions (the fourth column). The estimated coefficient on the projection for core inflation is negative, but insignificant. This is consistent with empirical findings for the euro area that headline inflation leads core inflation and not the other way around and the descriptive analysis in section 2 which points to the fact that on a number of occasions the ECB was worried about second-round effects on wages and underlying inflation of changes in headline inflation driven by rising oil prices. This was, for example, the case for the interest rate increases in 2008 and 2011.

Next we test whether the ECB responded more aggressively to positive deviations of projected inflation from its inflation aim than to negative deviations. The fifth column of Table 1 shows that the relevant coefficient is not significantly different from zero. However, when we interact both inflation and output terms with a dummy when positive, we get the interesting finding that the coefficient is large, positive and significant when inflation is above target, but insignificant otherwise, whereas we have the opposite for growth: It is large and significant when growth is below potential and insignificant when growth is above potential. So, over the sample period the ECB seems to ease policy mainly in response to expected growth slowdowns and tighten policy mainly in response to expected inflation above its inflation aim.

⁵⁸ The finding of too tight policy in 2009 is somewhat at odds with the findings of Giannone et al (2012) and Pill and Smets (2013), which show that by the end of 2009 and until 2012 the actual path of 3-month Euribor was below the counterfactual one based on the historical ECB monetary policy rule. Pill and Reichlin (2014) argue that the euro area experience contrasts with evidence from the US, where the zero lower bound appears to have been a binding constraint on rate setting throughout the crisis period.

Finally, we also tested whether indicators coming from the ECB's *monetary analysis* have additional explanatory information value for the ECB's interest rate decisions. Fischer et al (2008) and Smets (2010) do not find additional explanatory power coming from the monetary analysis. This is consistent with the idea of monetary analysis being a cross-check. It is also consistent with the argument by Orphanides (2006) that the simple policy rule can also be derived from the combination of the quantity theory of money and a money demand function and therefore already embeds an implicit role for money. The last column of Table 1 includes changes in annual credit growth as an additional explanatory variable in the interest rate rule. The related coefficient is not significant and, if anything, negative. Similar results are obtained with M3 growth or other money and credit growth indicators. Of course, this does not exclude the usefulness of monetary analysis as a cross-checking device (see Beck and Wieland, 2008 and 2010).

3.3. Reviewing the ECB's non-standard monetary policy measures

3.3.1 Classifying the ECB's non-standard policy measures

Table 2 gives an overview of the non-standard monetary policy measures the ECB has taken since 2007.⁵⁹ These measures can be divided into four categories as shown in the four rows of Table 2: i) lending operations with the ECB's counterparties, i.e. euro area monetary and financial institutions; ii) outright asset purchases of both private and public sector securities; iii) negative interest rates; and iv) forward guidance, i.e. enhanced communication about future policy actions.⁶⁰

[Insert Table 2 around here]

Broadly speaking the use of the non-standard measures served two purposes. First, some of the measures complemented standard reductions in policy-controlled interest rates in the presence of impairments in the monetary policy transmission. In a financial crisis it may be optimal to address the rise in funding and financing costs arising from malfunctioning financial markets through direct market interventions or lending operations, rather than try to offset them through a reduction in policy-controlled interest rates. Second, other measures were substitutes for standard policy: they provided additional stimulus in the presence of limited room for further standard interest rate easing close to the zero lower bound.⁶¹

A number of observations are worth making regarding these two purposes. First, in the early stages of the financial crisis when short-term interest rates were not yet constrained by the zero lower bound, the ECB in its communication made a clear distinction - through the so-called separation principle - between standard policy which was geared at maintaining price stability and non-

⁵⁹ See Eser et al (2012), Alvarez et al (2017), Task Force on the Use of Monetary Policy Instruments (2018) and Bindseil et al. (2017) for detailed and comprehensive descriptions of the Eurosystem's operational framework and its monetary policy instruments since the start of the financial crisis.

⁶⁰ The extent to which these measures can be classified as non-standard is of course debatable. For example, in the early part of the financial crisis the ECB primarily adjusted the conditions and features of its lending operations which are standard instruments of the ECB's monetary policy operational framework. Similarly, negative interest rates and forward guidance can be seen as variants of the standard setting of policy-controlled interest rates and their communication.

⁶¹ See also Neri and Siviero (2018) for a discussion of the motivations, the effectiveness and risks of the ECB's unconventional measures.

standard measures that were focused on addressing malfunctioning financial markets and impairments in policy transmission. In practice the two policies of course interact and together determine the monetary policy stance, but arguably highlighting this distinction allowed the ECB to more easily take different directions in its standard and non-standard monetary policy. This was, for example, the case in 2008 and 2011, when the ECB tightened standard monetary policy while non-standard measures were still in place. One signal of the separation principle during the sovereign debt crisis was the decision to sterilise the SMP and OMT interventions.⁶²

Second, the nature of the non-standard measures depends on which impairments are being addressed. As discussed in section 2 and shown in Table 2, three stages can be distinguished. In the early stages of the financial crisis, the focus was primarily on banks' funding markets, in particular the money market and the covered bond market. In the second stage, the financial crisis turned into a sovereign debt crisis with repercussions for bank funding markets (the so-called sovereign-bank nexus) and the emergence of self-fulfilling redenomination risk. The last stage focused on the heterogeneous transmission in bank lending markets and involved funding for lending operations (TLTROs). An evaluation of those different non-standard measures therefore involves an assessment of whether the specific impairments were addressed.

Third, the non-standard measures geared at addressing impairments in the monetary transmission process are akin to classical lender of last resort policies whereby the central bank steps in to provide liquidity and avoid that market runs and self-fulfilling speculative attacks turn into solvency issues. One issue with those policies is that it is often not easy to distinguish between liquidity and solvency problems. In lending operations to MFIs this is solved by requiring collateral, often government bonds. However, in a monetary union with national fiscal policies sovereign risks may undermine the safety of such collateral and may make direct interventions in sovereign bond markets more problematic. This explains why non-standard measures to address illiquidity and self-fulfilling redenomination risks in sovereign bond markets (SMP and OMT) required conditionality ensuring the soundness and sustainability of the underlying fiscal policies.

Finally, from Table 2 it is also clear that over time, as the euro area economy fell in a double-dip recession, more of the measures, in particular the negative DFR, the large-scale asset purchase programme (APP) and the enhanced forward guidance, served the second purpose of easing policy close to the zero lower bound.

In line with this distinction, next we review the evidence on the effectiveness of the non-standard measures.

3.3.2 Addressing impairments in the monetary policy transmission process

During the early stages following the outbreak of the financial crisis the non-standard measures have mostly focused on bank funding markets. Due to the fixed rate full allotment procedure, liquidity provision was primarily demand-determined during that period. The “Enhanced Credit Support” programme helped ease tensions in the money market as indicated by the reduction in the Euribor-OIS spreads at various maturities (Figure 13). Reichlin (2014) and Pill and Reichlin (2014) describe

⁶² The ECB conducted regular one-week Fine Tuning Operations (FTO) between May 2010 and June 2014 to absorb the liquidity effect of the SMP initiated on 10 May 2010.

this period as the ECB taking a “market operation approach” to its role as lender of last resort and conclude that it contributed to the recovery of economic activity which started in the third quarter of 2009. Lenza et al (2010), Giannone et al (2012) and Peersman (2011) use a variety of counterfactual exercises to conclude that in this period the effectiveness of the ECB’s actions was not constrained by the zero lower bound and that these measures were supportive of economic activity, largely by preventing a more discontinuous and dramatic curtailment of credit provision to the real economy. See also Boeckx et al (2017). A model-based analysis is done in Cahn, Matheron and Sahuc (2017). Using an estimated DSGE model with a frictional banking sector, they find that liquidity injections have played a key role in averting a major credit crunch. A counterfactual analysis suggests that, absent these non-conventional measures, output, consumption, investment and the GDP deflator would have been 2.5%, 0.5%, 9.7% and 0.5% lower on average over 2009 respectively. See also Quint and Tristani (2007) for a similar analysis.

Part of the “Enhanced Credit Support” policy was the first Covered Bond Purchases Programme (CBPP1). Purchases of EUR 60 bn were made from July 2009 till June 2010, distributed across the euro area in both primary and secondary markets. Beirne et al (2011) discuss the modalities and the impact of the first CBPP and find that it has contributed to i) a decline in money market term rates, ii) an easing of funding conditions for credit institutions and enterprises, iii) encouraging credit institutions to maintain and expand their lending to clients, and iv) improving market liquidity. A second and a third instalment of the CBPP were decided respectively in October 2011 in the context of the intensification of the sovereign debt crisis which again impacted bank’s funding conditions and in September 2014 as part of the comprehensive easing package to fight risks of deflation starting in June 2014.

The Security Markets Programme (SMP) was introduced to address malfunctioning sovereign bond markets following the outbreak of the sovereign debt crisis, in particular in Greece, Portugal and Ireland, which suffered from illiquidity and which was deemed to threaten monetary policy transmission. Interventions faded out in the relatively stable first half of 2011, but as the sovereign debt crisis negatively affected Italy and Spain in July 2011 a reactivation of the SMP was announced on 7 August 2011. The SMP ran until the end of December 2012 and reached an outstanding nominal amount of around EUR 218bn, although the volumes were not announced ex ante. Various authors have assessed the impact of the SMP on sovereign bond yields. The SMP interventions succeeded in reducing yields and volatility of government bond segments of the countries under the programme. Using a counterfactual exercise, Ghysels et al (2017) find that purchases of Italian and Spanish bonds lowered two-year yields by 320 and 180 bps respectively, and ten-year yields by 230 bps for both countries. Similarly, Eser and Schwaab (2016) find a significant impact of the SMP on the yields of those securities purchased. Their baseline model suggests that, on average, a daily SMP intervention of EUR 100 million lowered yields by 0.1 to 2 bps. This impact is stronger in markets which are smaller, less liquid, and where risk premia are higher. See also Trebesch and Zettelmeyer (2016) and De Pooter et al (2018).

Nevertheless, the SMP was not able to stem the rising redenomination risk. Pill and Reichlin (2014) point to three reasons why the SMP did not succeed in stemming the rise in sovereign spreads. First, the SMP actions were characterised as limited and temporary, which undermined market confidence that the ECB was prepared to offer a full backstop. Second, the ECB had conditioned its provision to Italy and Spain on certain policy commitments which threatened the political feasibility of the

support. Third, there were concerns about the subordination of private sector bond holders. As discussed in Section 2.3.3, bolder ECB action became possible after European governments had started to strengthen fiscal governance, provided a back-stop for governments in the form of the ESM and decided to create a banking union with common supervision and resolution. Following the famous “whatever it takes” speech of President Draghi in July 2012, the ECB announced its readiness to undertake ex-ante unlimited Outright Monetary Transactions (OMTs) in euro area secondary sovereign bond markets, subject to countries complying with conditionality.⁶³ Although so far OMTs have not been activated, the announcement was instrumental in addressing excessive risk premia and improving financial market confidence as shown in Figure 13. The success of the OMT was dependent on a number of features: a strict and effective conditionality attached to an appropriate EFSF/ESM programme, a focus on the shorter segment of the yield curve, no ex-ante quantitative limits on size and *pari-passu* treatment. The conditionality was key for preserving the appropriate incentives for fiscal discipline and monetary dominance as well as to ensure proper risk management by the central bank. Using high-frequency data, Altavilla et al (2016) find that OMT announcements decreased the Italian and Spanish two-year government bond yields by about 2 pp, while leaving the bond yields in Germany and France unchanged. Using a multi-country VAR model, they also find that the reduction in bond yields due to the OMT was associated with a significant increase in real activity, credit and prices in Italy and Spain, with some positive spillovers in France and Germany. See also Krishnamurthy et al (2017), Szczerbowicz et al (2015) and De Santis (2018a,b) for additional evidence on the financial market effects. Aghion et al. (2017) find that growth effects worked particularly through highly indebted corporate sectors, notably via more easily adjustable short-term debt, but only if they were located in countries with relatively less regulated product markets. This bolsters the view that demand policies are more effective when accompanied by adequate supply policies. Using evidence from SAFE, Ferrando et al (2015) find that the ECB’s OMT announcement was followed by an immediate decline in the share of credit rationed firms and of firms discouraged from applying for loans. Firms with improved outlook and credit history were particularly likely to benefit from easier credit access. Acharya et al (2017) also find positive effects of the revaluation of sovereign bond portfolios due to OMT on bank lending. They argue though that a significant fraction of this lending went to “zombie firms”.

As part of the attempt to stop the doom loop, the ECB also conducted two 3-year Very Long Term Refinancing Operations (VLTROs) in December 2011 and February 2012. A combined gross amount of more than a trillion euros was allotted, giving banks funding uncertainty, easing redemption of maturing bonds and helping to sustain credit lines with households and firms. Darracq-Paries and De Santis (2015) show that the VLTROs increased real output and lending to NFCs over a two to three-year horizon (See also Garcia-Posada and Marchetti (2016) for evidence in Spain and Szczerbowicz (2015)). Jasova, Mendicino and Supera (2018) use micro-economic bank-firm level data for Portugal to show that the lengthening of bank debt maturity had a positive and economically sizable impact on bank lending. A one standard deviation increase in bank exposure to the reduction in roll-over risk is associated with a 5.3 percent increase in both existing and new lending. The effects are stronger on the supply of credit to smaller, younger and riskier firms. However, they also show that unrestricted liquidity provision provided incentives to banks to purchase more government securities, partly offsetting the positive effects on lending. Crosignani et al (2017) find that the VLTROs induced Portuguese banks to purchase short-term domestic government bonds and pledge

⁶³ The technical features of the OMTs are in ECB (2012b).

them to obtain central bank liquidity (See also Acharya and Steffen, 2015 and Van Bakkum et al, 2018)

Turning to the funding for lending policies, it is difficult to disentangle the effects of the TLTROs from the other measures that were part of the comprehensive easing package that started in June 2014 and which also included negative rates and asset purchases.⁶⁴ ECB (2015) shows that the rates on loans to NFCs declined markedly immediately after the announcement of the first series of TLTROs. The declines were sharper in countries where the composite lending rates to NFCs had been more elevated. Moreover, in vulnerable countries, banks that borrowed under TLTRO-I reduced their rates by more than banks that abstained from bidding. Altavilla et al (2016) explicitly analyse developments over time in the pass-through of monetary policy measures on bank lending rates and find that after 2014 the non-standard policy measures (including the TLTROs) significantly normalised the capacity of banks to grant loans and reduced the cross-sectional dispersion of interest rate pass-through.

3.3.3 Providing additional stimulus at the effective lower bound

As the policy controlled interest rates were increasingly constrained by the effective lower bound in 2013, the ECB took a number of additional non-standard measures such as the expanded Asset Purchase Program (APP) and forward guidance with the aim of further lowering medium to long-term interest rates through portfolio rebalancing and signalling channels (Table 2). One way of capturing the impact of these unconventional measures is to calculate a shadow short-term interest rate as proposed by Krippner (2015) and others. A shadow rate is the shortest maturity rate extracted from a term structure model that would generate the observed yield curve in the absence of a lower bound. It coincides with the policy rate in normal times and is free to go into negative territory when the policy rate is stuck at the lower bound.

Various authors have shown that the shadow rate captures the stance of monetary policy during lower bound periods in the same way the policy rate does in normal times (Claus, Claus and Krippner, 2014, Francis, Jackson and Owyang, 2014 and Van Zandweghe, 2015). They show that i) the shadow rate captures the impact of both conventional and non-conventional policy measures such as asset purchase programmes, forward guidance on interest rates and long-term refinancing operations; and ii) that the dynamic interactions between macro-economic activity and the short term rate is preserved through the shadow rate. The latter is consistent with the results in Debortoli, Gali and Gambetti (2018) that there has been no structural break in the macro-economic relations since the use of non-conventional measures. These authors conclude that the non-conventional tools must have had a similar impact on the macro-economy as conventional interest rate policy. Similarly, a number of VAR exercises, where unconventional monetary policy are identified through the term structure changes during a narrow window around monetary policy decisions, have shown that QE has very similar effects on the economy.⁶⁵ Finally, Wu and Zhang (2017) show that in a New Keynesian model for the United States the negative shadow rates are a useful summary statistic to capture the impact of unconventional policies, especially quantitative easing and lending facilities.

⁶⁴ ECB (2017a) explains the features of the two TLTRO programmes as well as their impact on bank lending. See also ECB (2017b).

⁶⁵ See Bundick and Smith (2016), Swanson (2016), Rossi and Inoue (2018).

[Insert Figure 26 around here]

At the same time, it is well-known that estimates of shadow rates are quite sensitive to differences in term structure models and in particular to the assumptions made about where the effective lower bound on interest rates lies. This may in particular be an issue for the euro area where the perceived effective lower bound has changed over time as interest rates went into negative territory. Figure 26 plots several shadow rate estimates for the euro area together with the EONIA. It shows generally speaking that the shadow rates are close to the EONIA before 2012 and that unconventional measures have had an easing impact on the yield curve after 2012. While there is considerable co-movement, the levels of the shadow rates are however very diverse. We therefore follow Mouabbi and Sahuc (2017) and use a common factor of the five alternative shadow rate models for the euro area as a summary statistic for the stance of monetary policy in the euro area after the second quarter of 2013. The results of this exercise are also shown in Figure 24, which after 2013 compares changes in the shadow rate (the dashed line) with the outcome of the Orphanides rule. Broadly speaking, changes in the shadow rate capture the two periods which correspond to a slowdown in expected growth and inflation and the resulting intensification of non-standard measures taken by the ECB as discussed in Section 2.4.2 and also reflected in Table 2. In contrast, as of the end of 2017 increases in the shadow rate reflect a relative tightening of monetary policy. However, movements in the shadow rate do not capture the need for additional easing in 2013.

Mouabbi and Sahuc (2017) use the shadow rates to capture monetary policy after 2013 in an estimated DSGE model for the euro area and find that without the implemented non-conventional measures year-on-year inflation and GDP growth would have been lower by 0.66% and 0.99% respectively over the period 2014Q1 to 2017Q2.

Overall, these estimates are in the same ball park of estimates by the ECB that are based on a variety of methods (Draghi, 2017; Praet, 2017 and Hutchinson and Smets, 2017).⁶⁶ ECB staff estimates that the monetary policy contribution of the easing package since 2014 to euro area GDP is around 1.9%, cumulatively over the period 2016-2019. About one third of the 5 percentage points increase in the employment rate observed in the euro area as a whole since mid-2014 is estimated to be due to the ECB's measures. This is the equivalent of 2 to 3 million jobs. Absent the ECB's policy package, inflation would on average be almost half a percentage point lower than currently projected in each year over the 2016-2019 period.

The main transmission channel is through the easing of financial conditions and financing costs. Counterfactual simulations by ECB staff estimate that the 2014 policy package has had a considerable impact on euro area financing conditions. Figure 27 shows some of the results. For example, without the ECB's measures the 10-year sovereign yield for a euro area GDP-weighted aggregate would be about 150 basis points higher and lending rates to euro area non-financial corporations (NFCs) approximately 70bps higher. The ECB's measures have also had a sizeable

⁶⁶ The approaches can be categorised into two groups: a "direct" and an indirect or "two-step" approach. In the "direct approach", models tend to be fully specified structural models such as DSGE models which incorporate mechanisms to directly allow for asset purchases to affect economic activity and inflation. Typically, these models extend the workhorse New-Keynesian model by including financial frictions so that central bank asset purchases impact on the economy. In the "two-step" approach, the first-step involves estimating off-model the impact of asset purchases on long-term yields and other financial prices. In the second-step, this is fed into a macro model which then estimates the impact on activity and inflation.

impact on nominal euro effective exchange rate, which would have been about 13% higher than without the measures (Altavilla, Carboni and Motto, 2015; Ambler and Rumler, 2017; De Santis, 2016). There is also emerging evidence of the portfolio rebalancing effects of the APP (Paludkiewicz, 2018).

[Insert Figure 27 around here]

To put all this in perspective, we compare in Figure 28 estimates of GDP and inflation effects of central bank asset purchases from a selection of studies for the US and UK with those for the euro area in a standardised format. Median ECB staff euro area estimates (red horizontal dashed line) are based on a suite of models (encompassing both direct and two-step approaches). While the euro area estimates are in the lower mid-range of the US estimates, they are below the estimates for UK GDP and are in the lower part of the range for inflation. See also Andrade et al (2016) and ECB (2017a).

[Insert Figure 28 around here]

Finally, as part of the comprehensive easing programme the ECB also lowered the deposit facility rate into negative territory, a move that before the ECB only central banks of smaller jurisdictions had dared. Rostagno et al. (2016) and Hartmann (2018) show that this shifted the yield curve down and twisted it (long rates coming down more), as one would expect from term structure models allowing for negative rates (Lemke and Vladu 2017). In other words, the interest rate channel of monetary policy was extended. Moreover, contrary to the concerns of some sceptics, in the euro area case it did not seem to hinder the bank lending channel, quite the contrary. Heider et al. (2018) find enhanced lending of banks with small retail depositor bases relative to banks with large retail deposits (which would suffer more from not being able to pass negative rates on liabilities on to households). Demiralp et al. (in progress) find evidence that this also amounted to an aggregate lending effect. Eisenschmidt and Smets (2018) review the euro area experience with negative rates and the related literature further. They document the pass-through of negative policy rates on bank deposit and lending rates as well as on loan volumes in the euro area. They confirm that the zero lower bound constraint is binding for interest rates on household deposits held at banks. Nevertheless, the pass-through on loan rates is broadly unchanged, in their analysis even for banks with high reliance on household deposit funding. The negative effect on the interest rate margin and profitability is generally offset by the positive impact of lower market rates on asset values and loan loss provisions (see Altavilla et al, 2018). Or, in other words, the “reversal rate” below which bank lending could be hurt (Brunnermeier and Koebe 2018) does not seem to have been reached so far. At the same time, it needs to be acknowledged that the effects of negative policy rates cannot be perfectly disentangled from other unconventional monetary policy measures active at the time. For example, the Targeted Long-Term Refinancing Operations (TLTROs) in April 2014 and March 2016 helped reducing funding rates into negative territory for banks that exceeded certain lending targets (e.g. Rostagno et al. 2016).

Overall, the research evidence on the effectiveness of the ECB’s non-standard measures in easing financial conditions, stimulating the economy and bringing inflation back to the ECB’s inflation aim is quite encouraging and suggests that concerns that central banks may be powerless when interest rates hit the zero lower bound may be overdone (Swanson, 2016).

4. Conclusions

In this paper we have reviewed the ECB's monetary policy during its first twenty years of existence. Overall, the ECB has delivered on its price stability mandate despite the very challenging crisis times of the last decade. Average inflation over this period has been 1.7 percent, which is in line with the ECB's aim of maintaining inflation below but close to 2 percent over the medium term. However, this average number masks quite stable inflation around 2 percent before the outbreak of the financial and sovereign debt crisis and a much more volatile and on average lower inflation rate around 1.5 percent thereafter. Throughout the whole twenty years, average five-year ahead inflation expectations, as captured by the Survey of Professional Forecasters, have remained stable within a narrow range between 1.8 and 2.0 percent, underlining the ECB's credibility. But following the sovereign debt crisis when headline inflation and various core inflation measures declined significantly below 1 percent, a series of indicators pointed to the emergence of tangible deflation risks. They only disappeared after the ECB initiated a comprehensive easing package starting in June 2014 – including quantitative easing, targeted credit operations and negative policy rates – and thereby dispelled doubts about whether it had an effective tool kit to address risks of deflation in a close-to-zero interest rate environment. Headline inflation is currently 2 percent (August 2018) and underlying inflation, while still subdued, is slowly converging back to close to 2 percent.

One issue debated regarding this price stability track record is whether the ECB could have been more proactive in responding to the fall-out from the sovereign debt crisis in the period from mid-2010 to mid-2012. A fair assessment requires a real-time and not an ex-post perspective. The simple real-time policy reaction function used in the paper arguably suggests that both the policy rate tightening in 2011 and the subsequent easing were broadly in line with the ECB's own and other professional forecasters' growth and inflation projections at the time. Moreover, this period was increasingly characterized by solvency issues in both banking and government finances, which lingered on for too long and reinforced each other in the absence of sufficient institutions and tools for solving the related collective action problems in a highly integrated monetary union of sovereign states with primarily national fiscal and supervisory policies. The unresolved public and private balance-sheet problems and the resulting financial fragmentation in the euro area provided tremendous obstacles to the effectiveness of the ECB's monetary policy. At the same time, monetary policy cannot directly address such solvency issues. In fact, the prohibition of monetary financing (art123 of the Treaty on the Functioning of the European Union) forbids the ECB to directly finance governments or government tasks such as the recapitalization of banks. Against this background, the ECB's actions had to balance the need to address impairments in the transmission of monetary policy due to malfunctioning financial markets and self-fulfilling market dynamics with the prohibition of monetary financing. This may explain, in part, what some observers regard as initially timid interventions in the government bond market through the Securities Markets Programme in 2010 and 2011. Only when solutions to the main weaknesses of EMU in the prudential and fiscal fields were put on a credible path around the key European Summit in June 2012, the ECB could confidently step up its non-standard toolkit to the next level. This led to the powerful Outright Monetary Transactions programme in August 2012 and to the comprehensive easing package mentioned above.

Overall, the main building blocks of the ECB's original monetary policy strategy and framework, its quantitative definition of price stability, the two pillars of economic and monetary analysis, the

communication and accountability framework and the broad-based and flexible operational framework have served the ECB well over the past twenty years. But, as described in the paper, it was important that they evolved in response to the challenges of the time.

For example, as initial doubts by some observers about the ECB's anti-inflation credibility during the early years turned into concerns about the ability to address downward risks to price stability in a low-rate environment, the quantitative inflation aim was clarified as being close to 2 percent, providing a buffer against the zero-lower bound. Our analysis of the ECB's interest rate reaction function in section 3.2 suggests that the ECB pursued this inflation aim symmetrically. Moreover, this analysis indicates that the economic analysis and the quarterly macro-economic projections formed the main basis for the monthly monetary policy decisions. At the same time, the monetary analysis provided a cross-check. It evolved from a narrower focus with emphasis on a reference value for M3 growth based on the quantity theory of money, which was useful in the first years to borrow the Bundesbank's credibility, to a broad-based assessment of monetary developments and the state of financial intermediation and bank lending in the euro area economy. Before the crisis, this broad-based analysis was useful for considering the build-up of financial imbalances, though our interest-rate analysis does not show evidence that the ECB pursued a leaning-against-the-wind monetary policy approach. At the time the ECB did have neither a microprudential nor a macroprudential policy mandate and the related tools to address the financial imbalances at the source. Only with the advent of Banking Union, did the ECB acquire an important banking supervisory role as of November 2014, which implied comprehensive microprudential and some limited macroprudential responsibilities. Following the outbreak of the financial crisis, the broadened monetary analysis was increasingly helpful in assessing fragilities in the banking sector and how they influence bank lending and the monetary policy transmission mechanism, as well as the effectiveness of some of the non-standard measures.

Also the communication and accountability framework adjusted, as the need for additional communication in a complex (non-standard) policy environment rose and forward guidance became an essential tool for easing policy in a low interest rate context. Finally, the ECB's operational framework was well suited to provide ample liquidity to the ECB's wide set of counterparties and against a wide set of collateral quickly when the money market froze. This helped addressing impairments in the early steps of the monetary transmission mechanism and also contributed to financial stability. Moreover, when the zero-lower bound became more and more a constraint after the sovereign debt crisis, the operational framework proved broad and flexible enough to allow the ECB to expand its tool set with other non-standard policy measures. A review of available research on the effectiveness of the ECB's non-standard measures in easing financial conditions, stimulating the economy and bringing inflation back to the ECB's inflation aim – also in comparison to the evidence from other constituencies having used similar instruments, such as the US or the UK – is quite encouraging and suggests that concerns that central banks may be powerless when interest rates hit the zero lower bound may be overdone.

All in all, the ECB has adjusted its monetary policy to the changing and challenging circumstances over time, making effective use of its strategy and framework and maintaining a clear focus on its primary mandate of price stability in the medium term. Broadening its tools over time it has become more similar to many of its peers as well. At the same time, some elements of its policy framework seem to have inspired changes in other central banks' frameworks, including the medium-term

orientation of its price-stability objective, the transparency and accountability associated with a press conference of the President and Vice-President soon after the formal monetary policy meetings and the broad and flexible operational framework.

A series of important reforms following the crises – in particular the establishment of the European Stability Mechanism, the implementation of the first two legs of the Banking Union – the Single Supervisory and Resolution Mechanisms –, the signing of the Fiscal Compact and the introduction of a European Semester with a Macroeconomic Imbalance Procedure – have addressed some of the incompleteness of EMU that complicated the ECB’s mission to maintain price stability over the past decade. Looking forward, the ECB’s monetary policy will benefit tremendously from a thorough implementation of these reforms, compliance with their objectives and rules and further progress with completing European Economic and Monetary Union along the lines of the 2015 Five Presidents report (European Commission, 2015).

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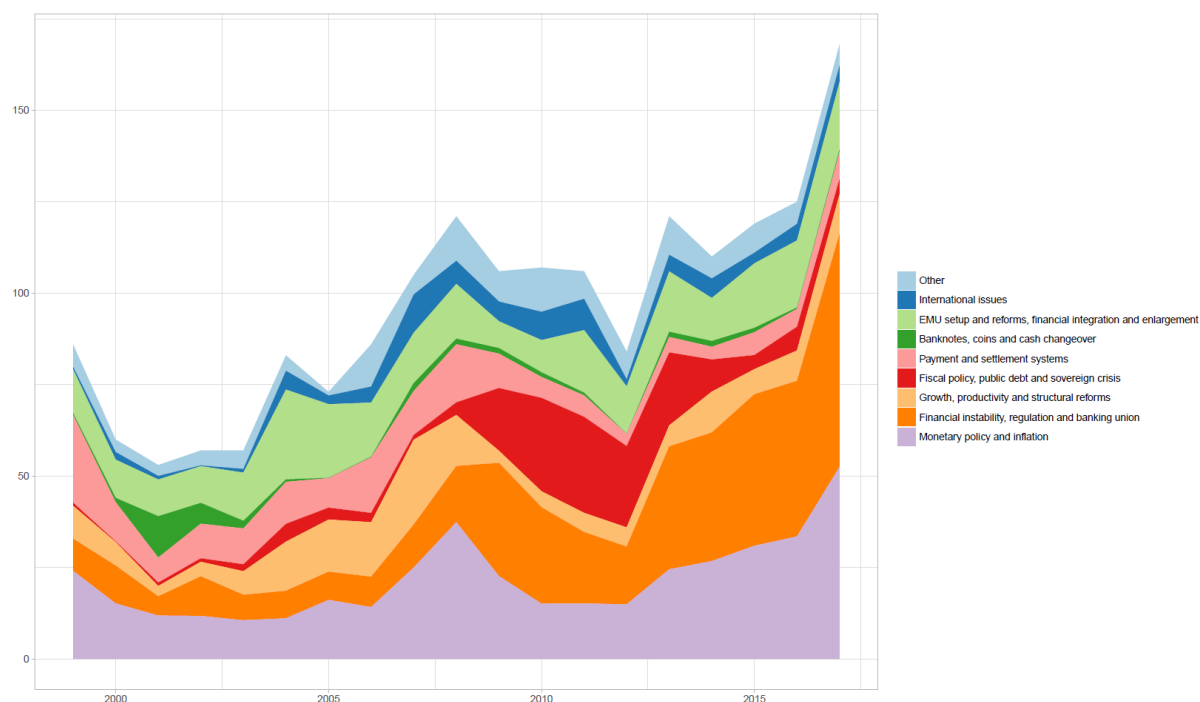
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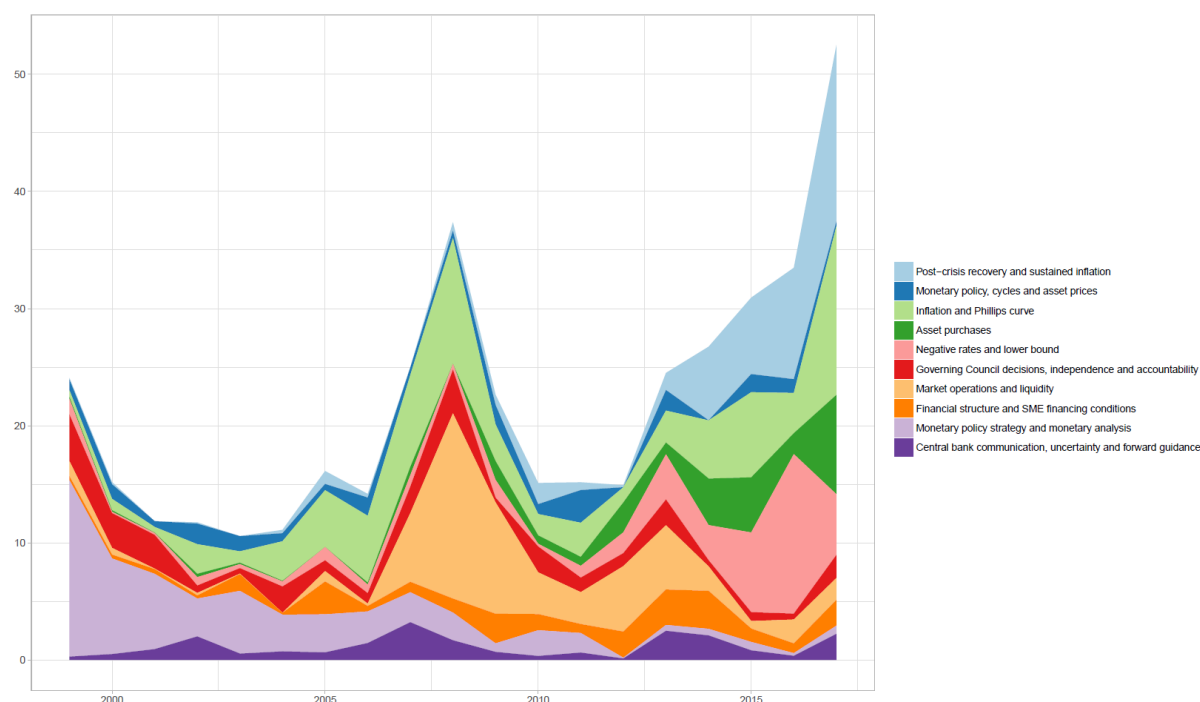
Figure 1: Speeches by ECB Executive and Supervisory Board members and their decomposition in general themes (number of speeches per annum)



Sources: Authors and ECB.

Notes: The figure is based on an application of the Latent Dirichlet Allocation methodology (LDA; Blei et al. 2003) to identify the topics addressed in the public speeches held by Executive Board members of the European Central Bank between May 1998 and April 2018. All speeches on the ECB website section (<https://www.ecb.europa.eu/press/key/date/2017/html/index.en.html>) have been considered as documents. Since 2014 also the speeches by the Chair, Vice-Chair and ECB Supervisory Board Members of the Single Supervisory Mechanism have been included (<https://www.bankingsupervision.europa.eu/press/speeches/date/2017/html/index.en.html>). Overall, the document set comprises 1,892 speeches. The figure shows results only for full years, i.e. 1999 to 2017 (1,829 speeches). The upper line shows the total number of speeches per year. The coloured areas underneath describe for a given year the shares of these speeches addressing nine general themes (see legend). The themes have been derived by the authors grouping the topics found by the LDA machine learning algorithm. The algorithm defines a topic as a set of words that occur together within documents and derives the probability that a given document addresses this topic. Applying Cao et al. (2009), the total number of topics has been set to 50. A speech can address more than one topic. The full list of topics and their grouping in themes is available from the authors upon request.

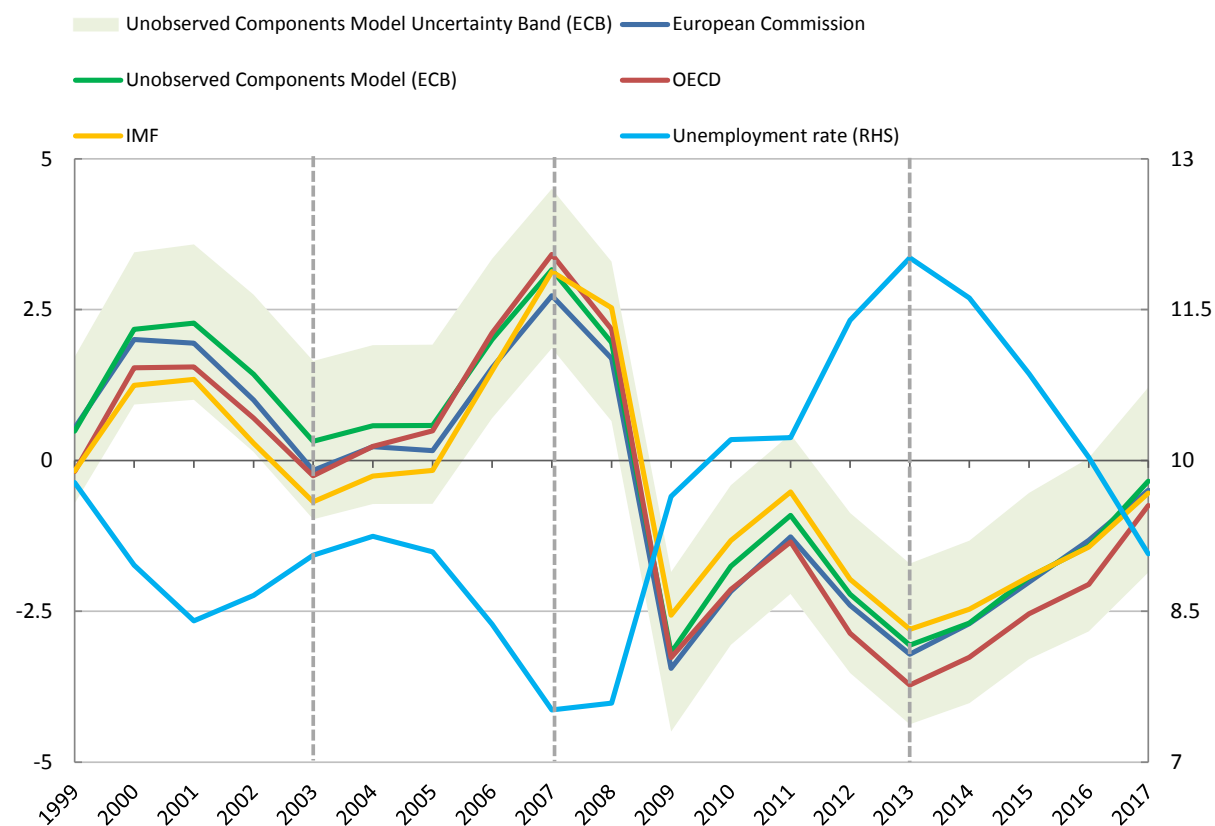
Figure 2: Speeches by ECB Executive Board members on monetary policy and inflation and their decomposition in topics (number of speeches per annum)



Sources: Authors and ECB.

Notes: The figure is based on an application of the Latent Dirichlet Allocation methodology (LDA; Blei et al. 2003) to identify the topics addressed in the public speeches held by Executive Board members of the European Central Bank between May 1998 and April 2018. All speeches on the ECB website section (<https://www.ecb.europa.eu/press/key/date/2017/html/index.en.html>) have been considered as documents. Since 2014 also the speeches by the Chair, Vice-Chair and ECB Supervisory Board Members of the Single Supervisory Mechanism have been included (<https://www.bankingsupervision.europa.eu/press/speeches/date/2017/html/index.en.html>). Overall, the document set comprises 1,892 speeches. The figure shows results only for full years, i.e. 1999 to 2017 (1,829 speeches). Applying Cao et al. (2009), the total number of topics has been set to 50. The figure only refers to the 10 topics (see legend) that can be grouped to a general theme denoted as “monetary policy and inflation” (see also Figure 1). The upper line refers to the number of speeches per year addressing these 10 topics. The coloured areas underneath describe the shares of these speeches addressing each topic for a given year. A speech can address more than one topic. The LDA machine learning algorithm defines a topic as a set of words that occur together within documents and derives the probability that a given document addresses this topic. The descriptions of the topics shown in the legend have been formulated by the authors, based on the words included in the different topics and their reading of the speeches that addressed the topics with high likelihood.

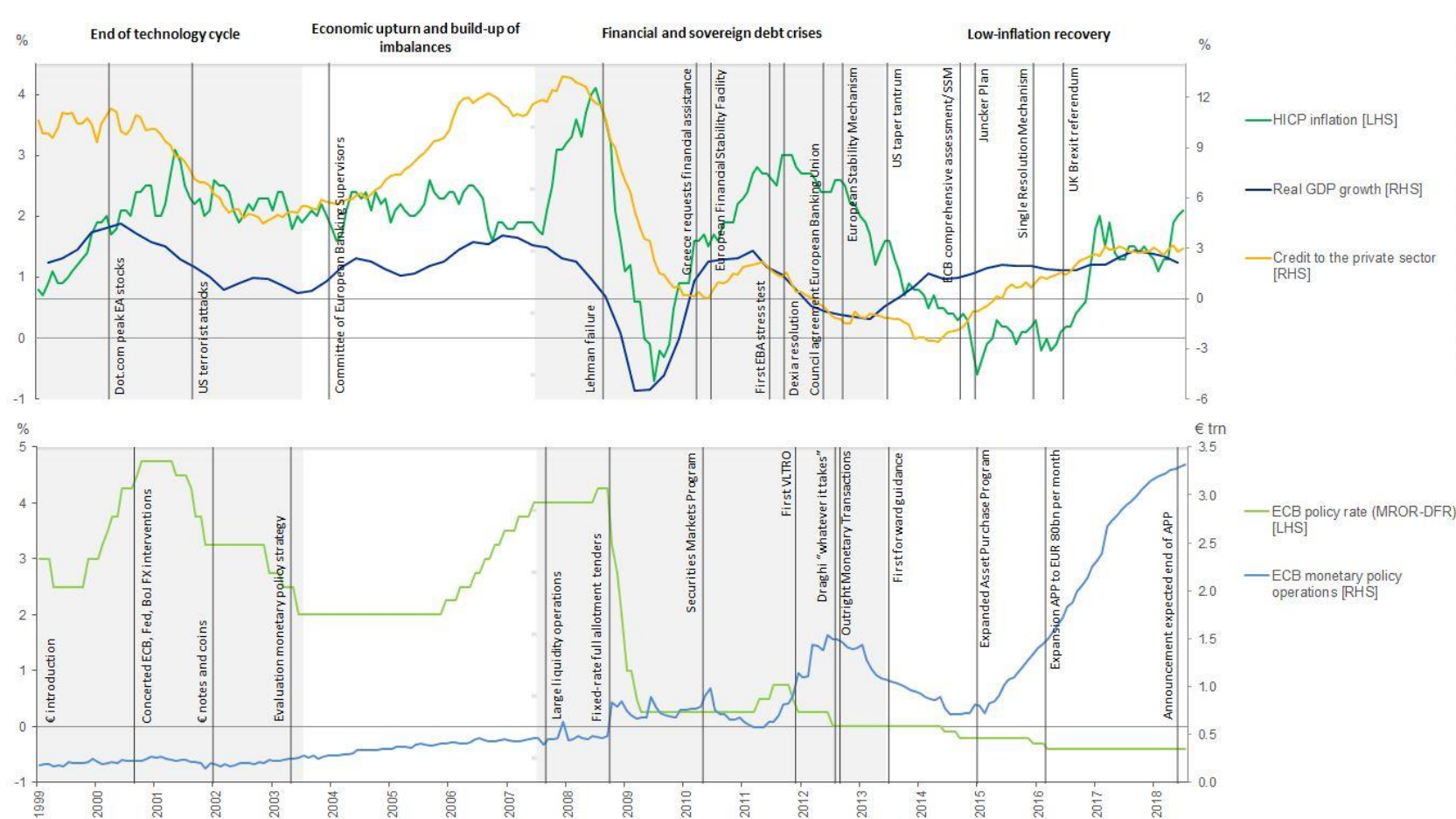
Figure 3: Euro area output gap estimates and unemployment rate (LHS: percentage points, RHS: percent of labour force)



Sources: European Commission spring 2018 forecast; International Monetary Fund (IMF) World Economic Outlook April 2018; Organisation for Economic Co-operation and Development (OECD) Economic Outlook May 2018; and ECB.

Notes: Yearly data and estimations are the latest available and therefore not in real time. The Unobserved Components Model (ECB) has been run following Szörfi and Tóth (2018) and the output gap estimates from it should not be regarded as official ECB output gaps. The uncertainty bands refer only to the Unobserved Components Model (ECB) output gap. Vertical dashed lines are indicative of business cycle troughs and peaks (see also Figure 4 below). Latest observation is 2017.

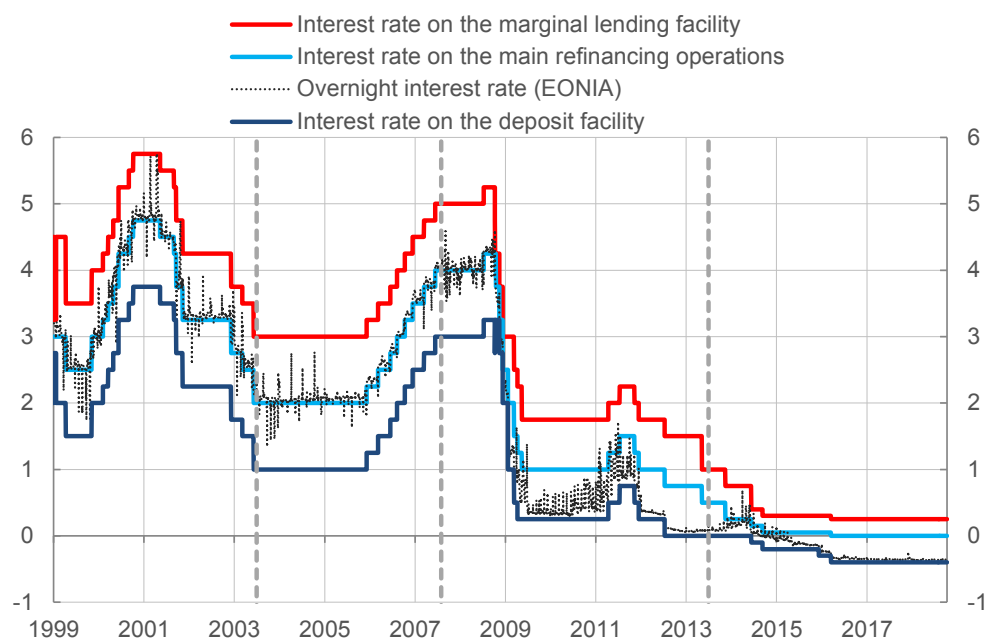
Figure 4: Four cyclical phases during the first twenty years of the euro – key macroeconomic and monetary policy variables and major events



Sources: Authors and ECB.

Notes: Grey areas (downturns) and white areas (upturns) reflect four cyclical periods with troughs around June/July 2003 and June/July 2013 and a peak around July/August 2007 dated on the basis of a large number of indicators (see also Figure 3). The lower panel shows ECB monetary policy variables and events and the upper panel other euro area macroeconomic variables and events. ECB interest rate policy is proxied by the main refinancing operations rate before October 2008 and by the deposit facility rate thereafter. The total amount of ECB monetary policy operations is indicative of non-standard monetary policy as of October 2008 and particularly when policy rates approached 0 or declined below. HICP inflation is the annual growth rate of the Harmonised Index of Consumer Prices. Credit to the private sector is total loans and securities by Monetary Financial Institutions vis-à-vis euro area non-MFIs excluding general government, i.e. vis-à-vis non-MFI firms and households. EBA stands for 'European Banking Authority'; SSM stands for 'Single Supervisory Mechanism'; BoJ stands for 'Bank of Japan'; VLTRO stands for 'Very long term refinancing operations'; TLTRO stands for 'Targeted long-term refinancing operations'; MROR stands for 'Main refinancing operations rate' and DFR stands for 'Deposit facility rate'.

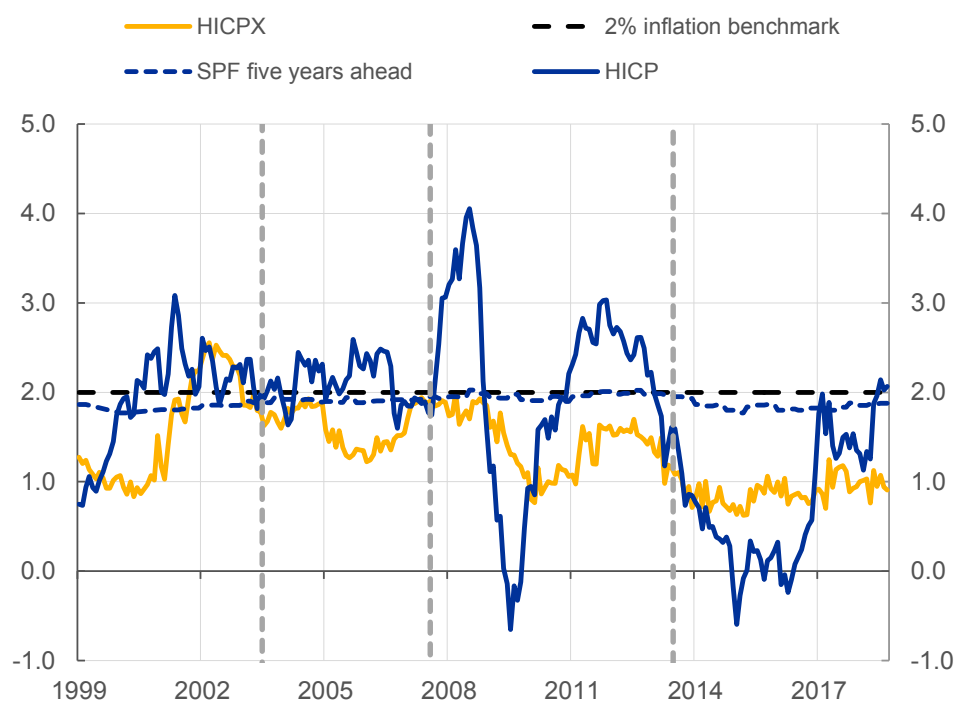
Figure 5: ECB policy rates and overnight money market rate (percentages per annum)



Source: ECB.

Notes: EONIA is the Euro OverNight Index Average rate. Latest observation is 10 October 2018

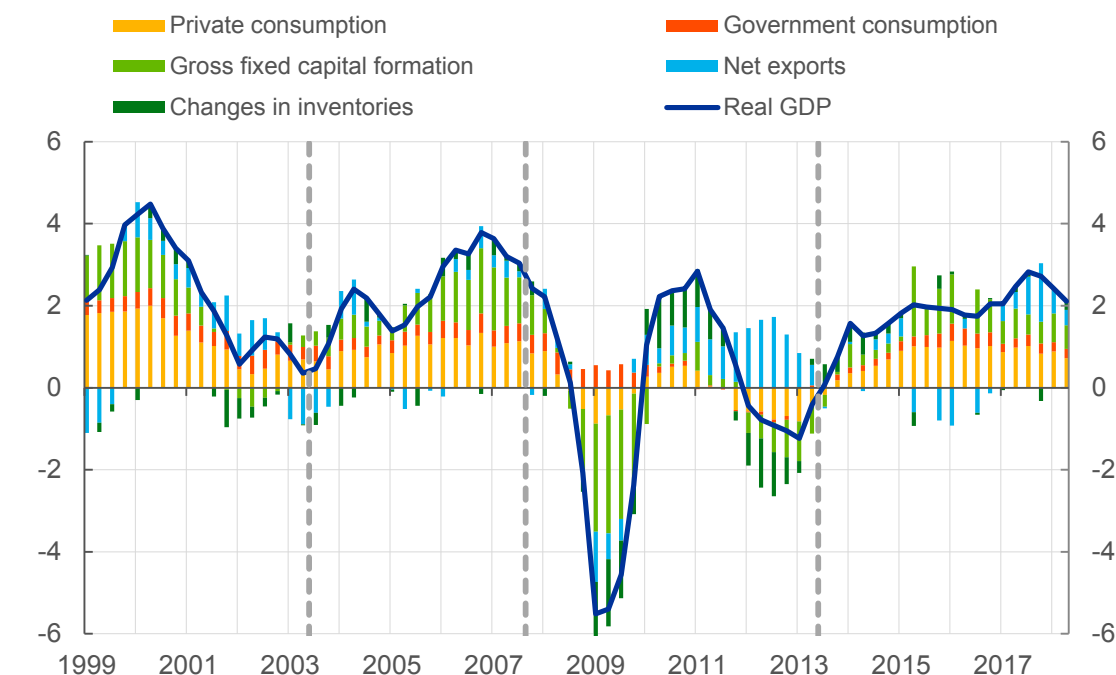
Figure 6: Euro area headline inflation, core inflation and longer-term inflation expectations (year on year percentage change)



Sources: ECB and survey of professional forecasters (SPF).

Notes: HICP refers to Harmonised Index of Consumer Prices (HICP) inflation and HICPX refers to HICP inflation excluding energy and food. SPF 5 years ahead refers to the average HICP inflation rate expected by the respondents to the Survey of Professional Forecasters. Latest observation is September 2018.

Figure 7: Euro area real GDP growth and its components (annual percentage changes and percentage point contributions)



Source: ECB

Note: Euro Area 19 (fixed composition). Latest observation is Q2 2018.

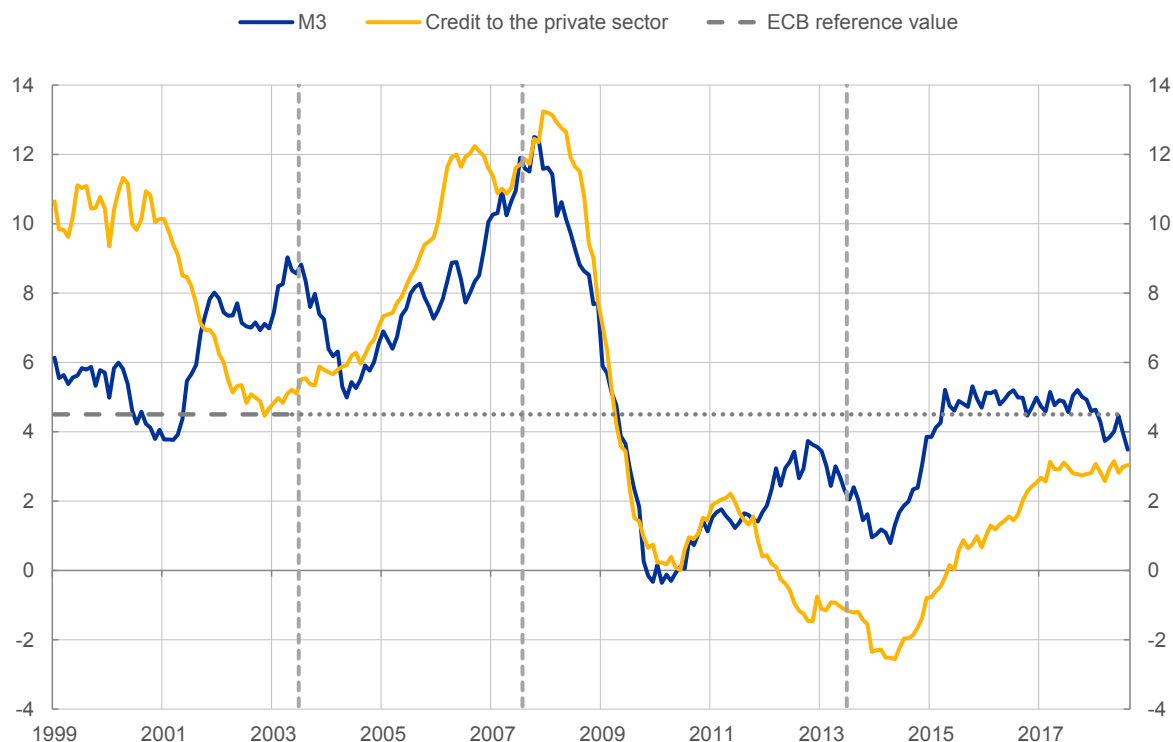
Figure 8: Global oil, metals and food prices



Sources: Bloomberg, HWWI and ECB staff calculations.

Notes: Oil prices refer to the Daily Brent Oil spot prices per barrel in US dollars. Food and metal prices are the respective sub-indices of the HWWI total commodity price index, which are normalized to 100 in 2015. Latest observation is 7 September 2018.

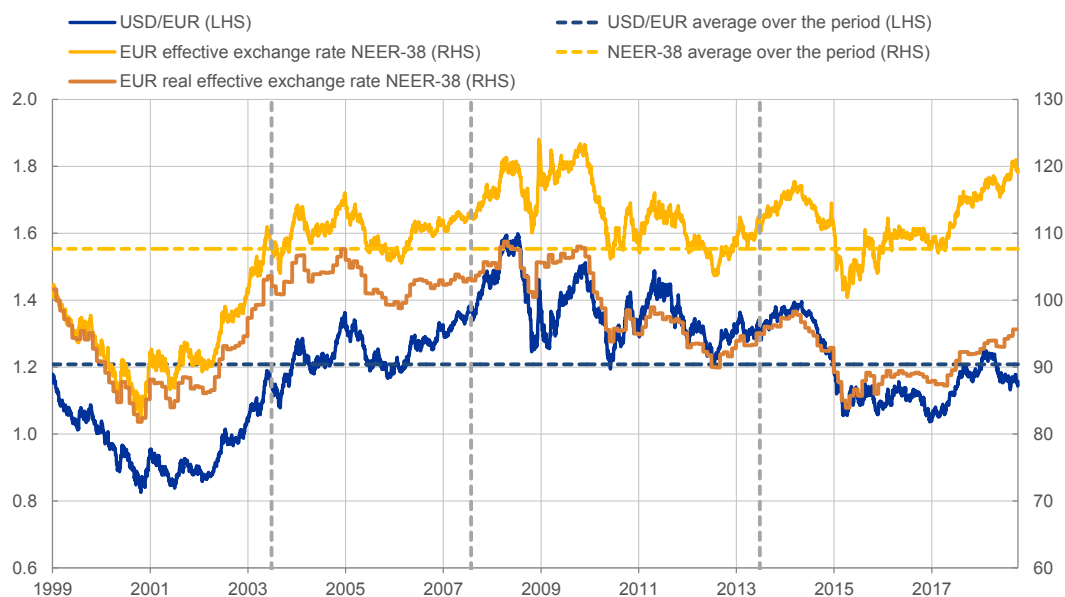
Figure 9: Growth of M3 and Monetary Financial Institutions' credit to the private sector for the euro area (annual percentage changes)



Source: ECB

Notes: Monetary Financial Institutions' credit to the private sector refers to total loans and securities vis-à-vis euro area non-MFIs excluding general government, i.e. vis-à-vis non-MFI firms and households. The horizontal dashed line refers to the ECB's reference value of 4.5% for M3 growth, signalling a particularly prominent role of money until the ECB reviewed its monetary policy strategy in May 2003. The line is dotted after the review, indicating that the annual review of the reference value was discontinued and the role of money diminished. Latest observation is August 2018.

Figure 10: Euro exchange rate against US dollar and in effective terms (LHS: US dollar, RHS: indexed at 1999Q1=100)

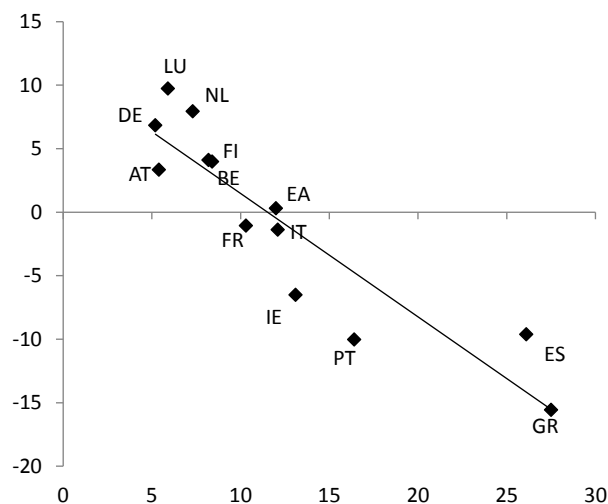


Source: ECB

Notes: ECB Real effective exchange rate CPI deflated of the Euro against EER-38 group of trading partners: AU, CA, DK, HK, JP, NO, SG, KR, SE, CH, GB, US and BG, CZ, HU, PL, RO, CN and HR, DZ, AR, BR, CL, IS, IN, ID, IL, MY, MX, MA, NZ, PH, RU, ZA, TW, TH, TR, VE. Latest observation is 5 April 2018.

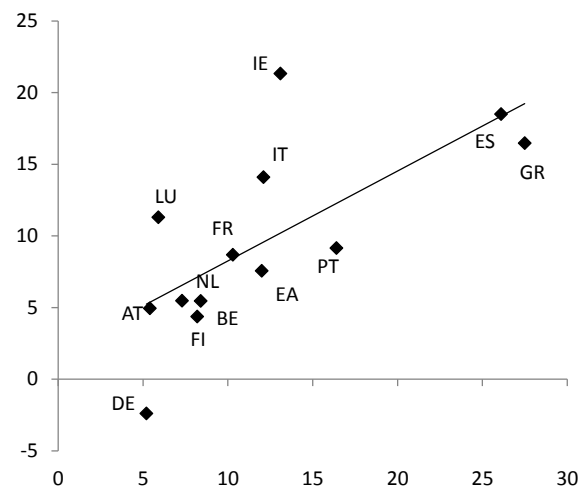
Figure 11: Euro area countries' economic and financial imbalances before the European twin crises and unemployment thereafter

Panel a – Current account balance (2007, in % of GDP, y-axis) and **unemployment rate** (2013, in % of labour force, x-axis)



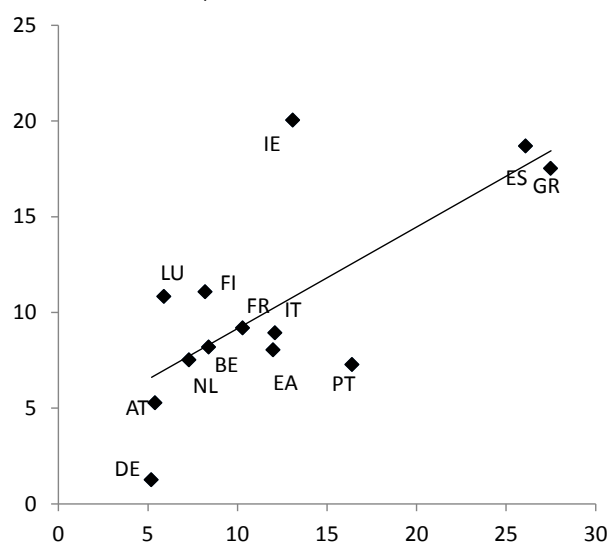
Source: Eurostat and authors' calculations

Panel b – Unit labour cost (cumulated growth 2002-2007 in %, y-axis) and **unemployment rate** (2013, in % of labour force, x-axis)



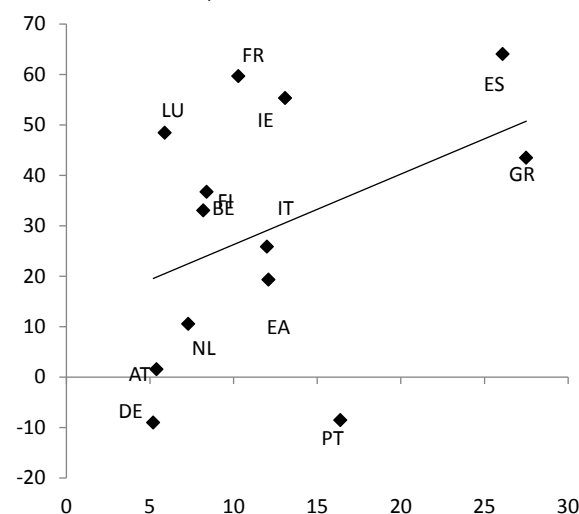
Source: Eurostat and authors' calculations

Panel c – Credit growth (average per annum 2002-2007 in %, y-axis) and **unemployment rate** (2013, in % of labour force, x-axis)



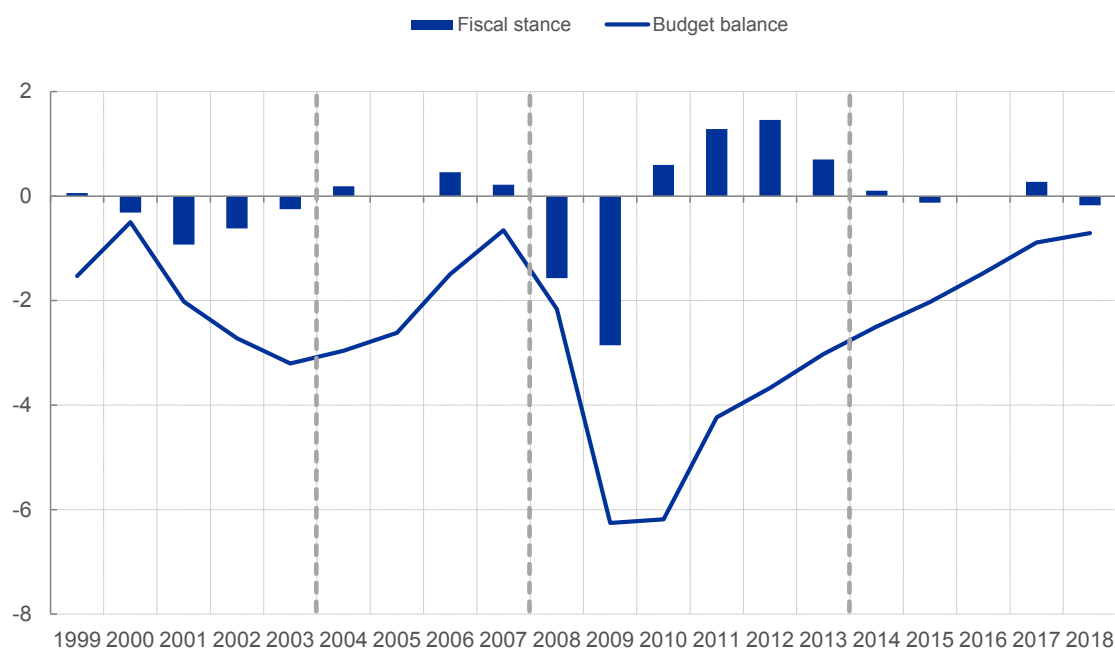
Source: Eurostat and authors' calculations

Panel d – House prices (cumulated growth 2002-2007 in %, y-axis) and **unemployment rate** (2013, in % of labour force, x-axis)



Source: Eurostat and authors' calculations

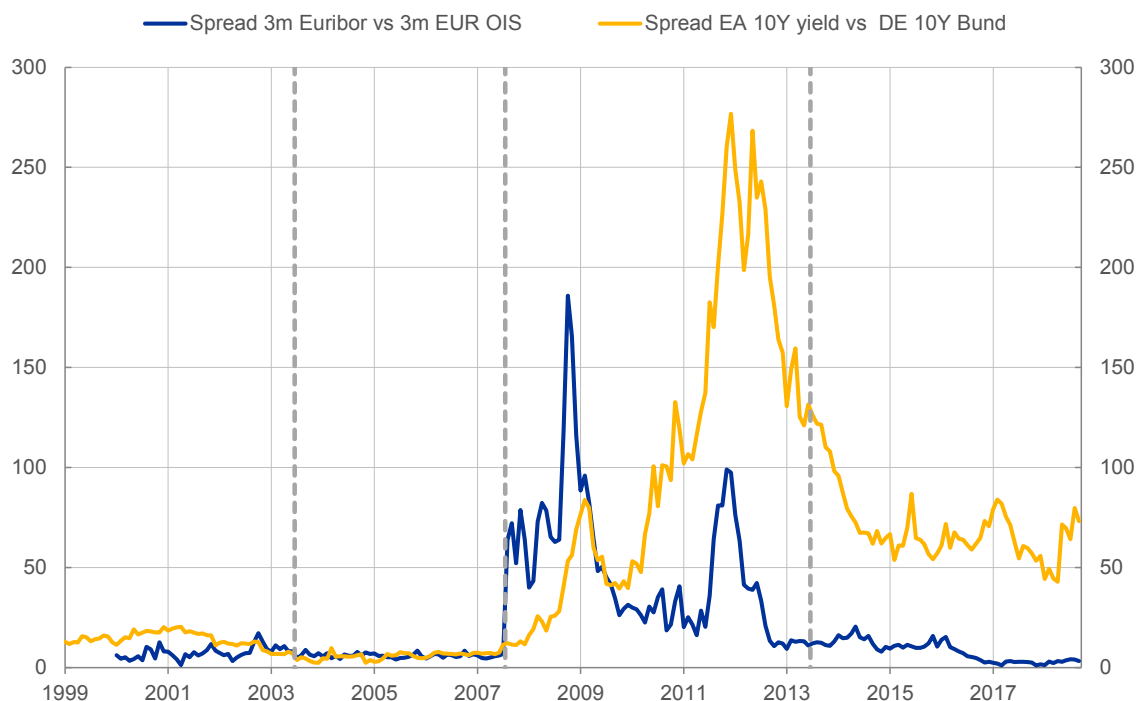
Figure 12: Aggregate of euro area member countries' fiscal policies (percent of GDP)



Source: ECB

Notes: The euro area fiscal stance is computed as the aggregate change in the cyclically adjusted primary balances of all member countries' governments. The cyclically adjusted primary balance corresponds to the budget balance minus interest payments and adjusted for cyclical factors. The budget balance refers to the difference between total government revenues and expenditures. Latest observation is 2018, taken from the ECB's June 2018 Broad Macroeconomic Projection Exercise.

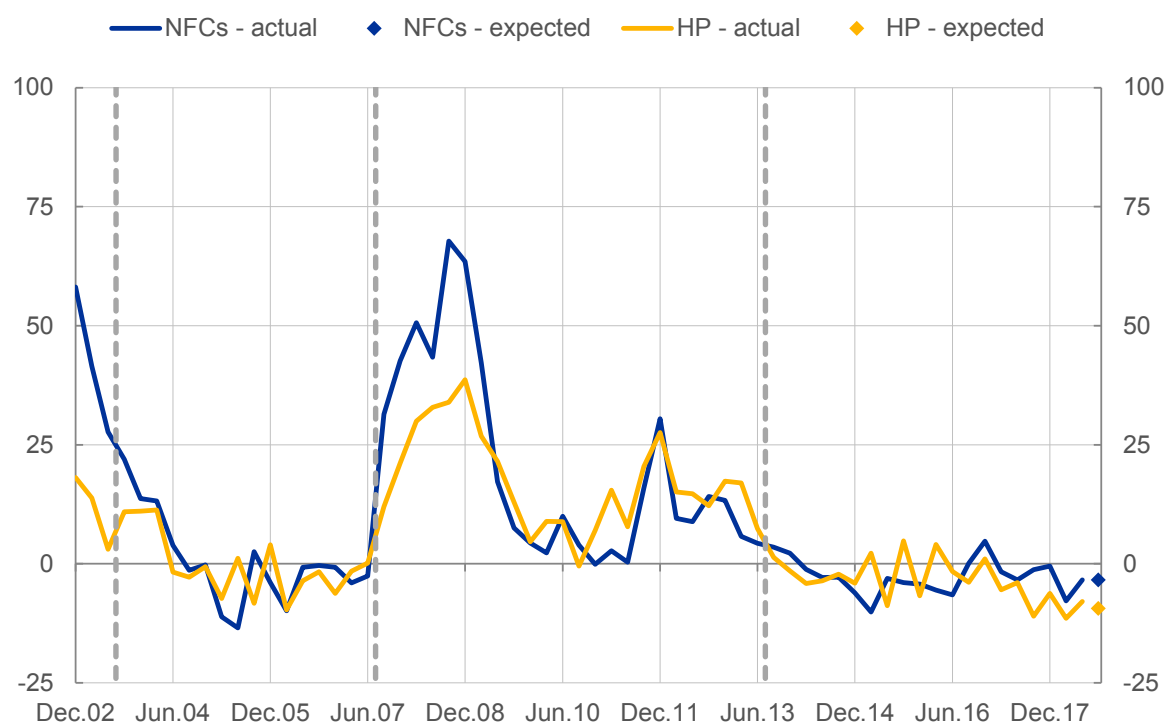
Figure 13: Euro area money and government bond market spreads (basis points)



Source: ECB

Notes: Euribor refers to the Euro Interbank Offered Rate and EUR OIS to the Euro Overnight Index Swap rate. The euro area (EA) 10-year (10Y) yield is a GDP-weighted average of euro area member countries' government bond yields. DE 10Y Bund is the yield on German 10-year government bonds. Latest observation is September 2018.

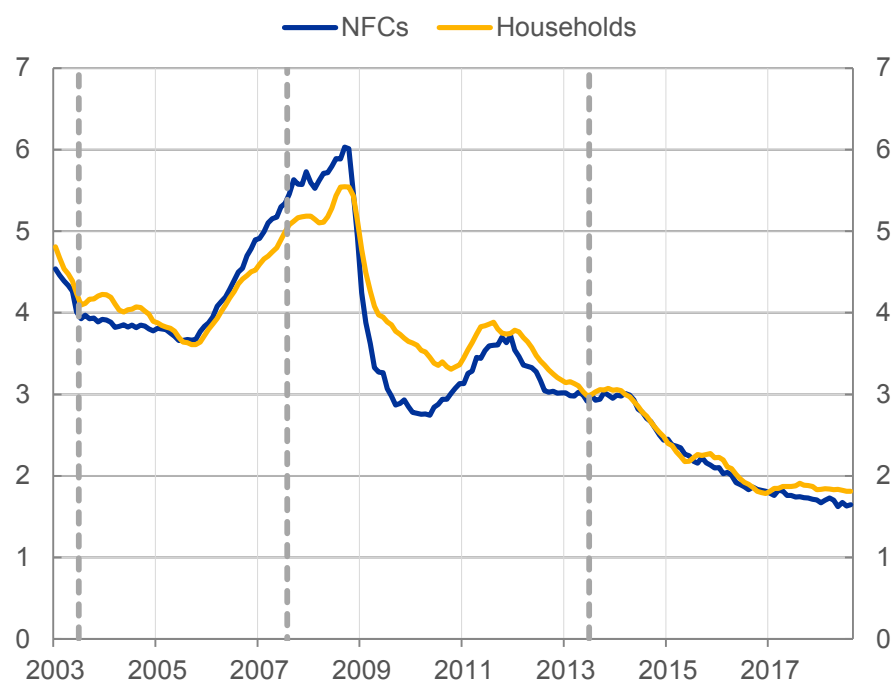
Figure 14: Changes in euro area bank credit standards (net percentage of banks reporting tightening credit standards)



Source: July 2018 ECB Bank Lending Survey.

Notes: Blue entries refer to changes in standards applied to the approval of loans or credit lines to non-financial corporations (NFCs) and yellow entries to the standards applied to loans to households for house purchases (HP). Net percentages are defined as the difference between the sum of the percentages of banks responding “tightened considerably” and “tightened somewhat” and the sum of the percentages of banks responding “eased somewhat” and “eased considerably”. Actual values are changes that the bank respondents to the survey report to have occurred, while “expected” values are changes anticipated by banks. Latest observations are Q2 2018 for actual changes and Q3 2018 for expected changes.

Figure 15: Euro area bank lending rates (percentages per annum)

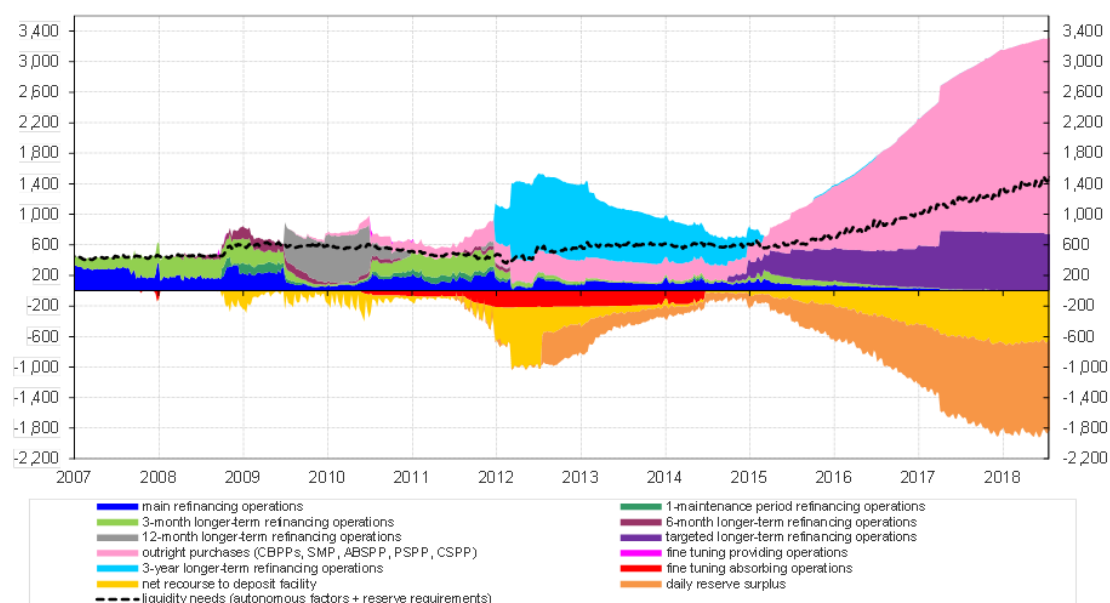


Source: ECB

Notes: The two indicators show the total cost of bank borrowing for non-financial corporations (blue line) and for households financing house purchases (yellow line). They are calculated by aggregating short and long-term rates using a 24-month moving average of new business volumes.

Latest observation: August 2018

Figure 16: Quantities of ECB market operations from a balance-sheet perspective (€ bn)

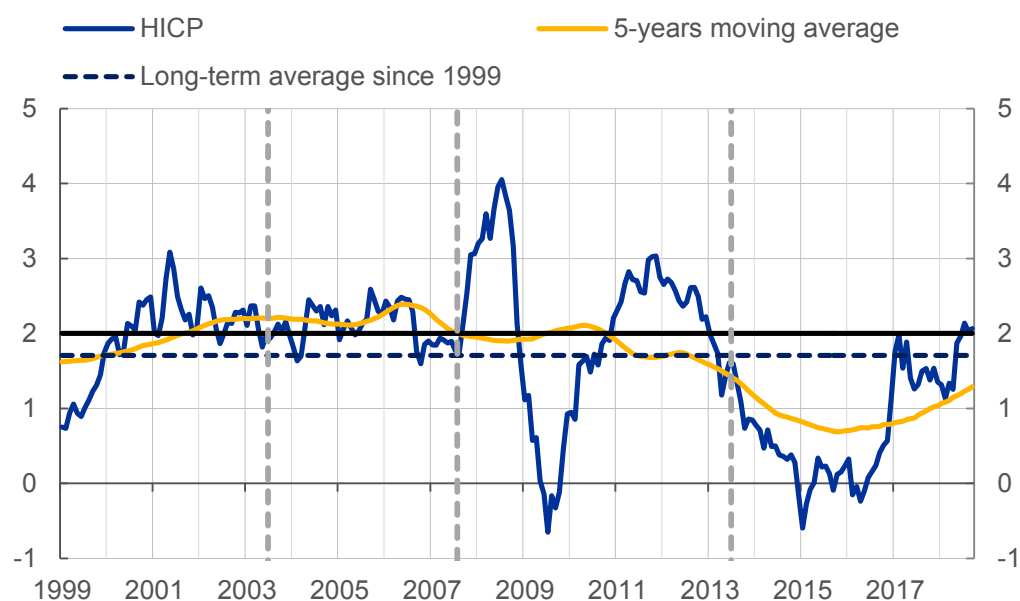


Source: ECB

Notes: The figure shows monetary policy items on the Eurosystem's balance sheet. Daily reserve surplus refers to the difference between Monetary Financial Institutions (MFIs') current account balances held with the central bank and banks' minimum reserve requirements. Liquidity needs are the sum of autonomous factors and minimum reserve requirements. Autonomous factors are factors, like banknotes in circulation and government deposits, that affect the liquidity needs of the banking system but are outside of the control of the central bank. Excess liquidity can be approximated by adding daily reserve surplus and net recourse to deposit facility. Net recourse to deposit facility is the difference between the marginal lending facility and deposit facility. Total ECB monetary policy operations are equal to the sum of MROs, LTROs and outright purchase programmes (CBPP, SMP, ABSPP, PSPP and CSPP).

Latest observation: 17 July 2018

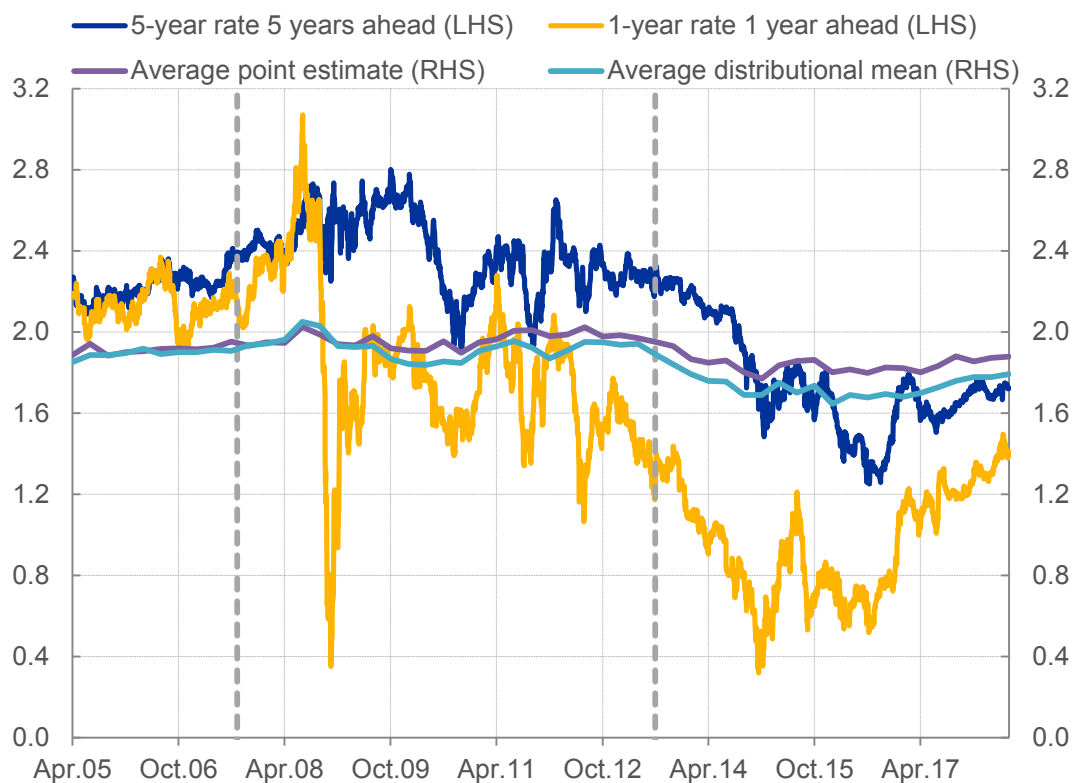
Figure 17: Euro area headline inflation and a 5-year moving average (year on year percentage change)



Source: ECB

Notes: Latest observation is September 2018.

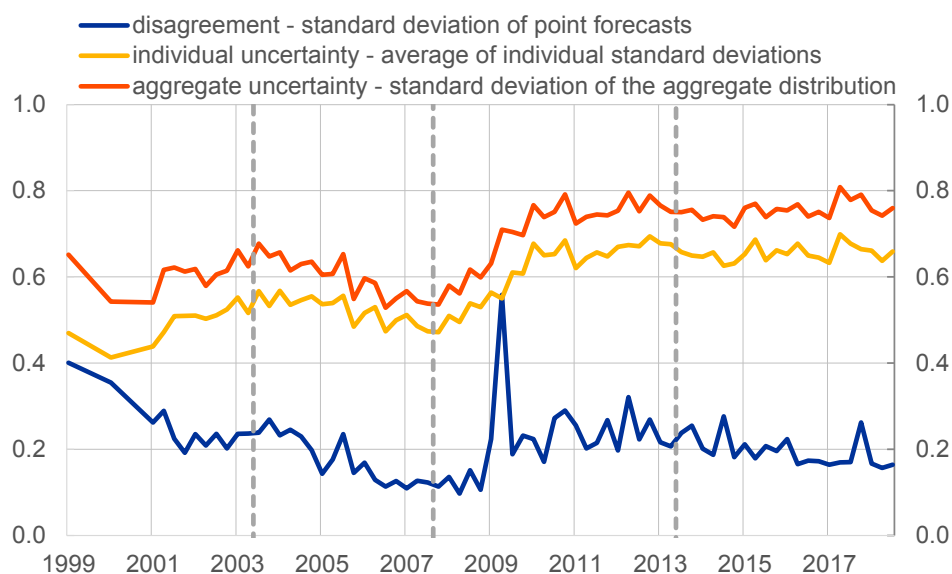
Figure 18: Survey and market-based inflation expectations in the euro area (LHS: percentages per annum, RHS: year on year percentage change)



Sources: ECB and survey of professional forecasters (SPF).

Notes: 1st moment – inflation expectations. Further explanations in Box 4 of ECB Economic Bulletin, Issue 5 / 2017 “How do professional forecasters assess the risks to inflation?”. Latest observations are 1 July 2018 and 10 September 2018.

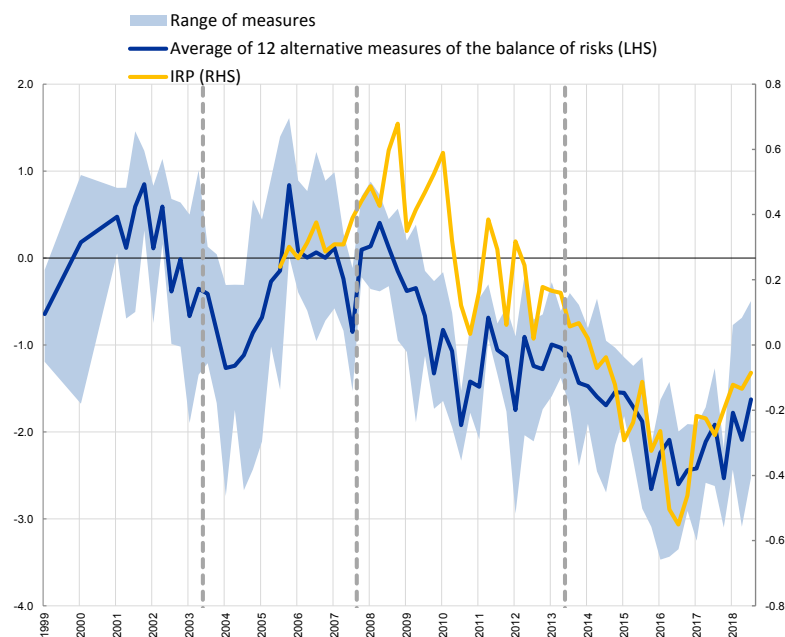
Figure 19: Survey-based longer-term inflation uncertainty in the euro area (standard deviations)



Source: ECB.

Notes: 2nd moment – inflation uncertainty. Further explanations in Box 4 of ECB Economic Bulletin, Issue 5 / 2017 “How do professional forecasters assess the risks to inflation?”. Latest observation is 1 July 2018.

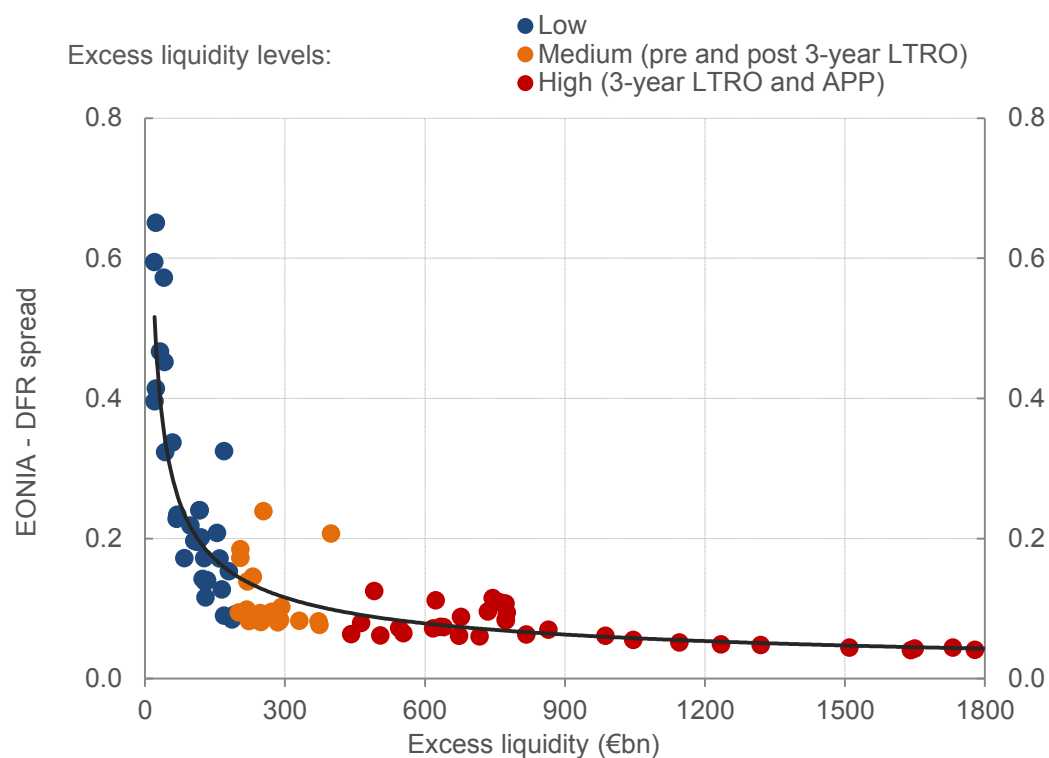
Figure 20: Survey-based balance of longer-term inflation risks and inflation risk premium in the euro area (LHS: number of standard deviations from zero, RHS: percentage points)



Source: ECB

Notes: IRP refers to inflation risk premium. The IRP decomposition is based on an affine term structure model and fitted to the euro area zero-coupon inflation-linked swap curve. The estimation method follows Joslin, Singleton and Zhu (2011). For details see Camba-Méndez, G. and T. Werner, ECB Working Paper 2033 (2017). Further information in Box 4 of ECB Economic Bulletin, Issue 5 / 2017 “How do professional forecasters assess the risks to inflation?”. Latest observation is 1 August 2018.

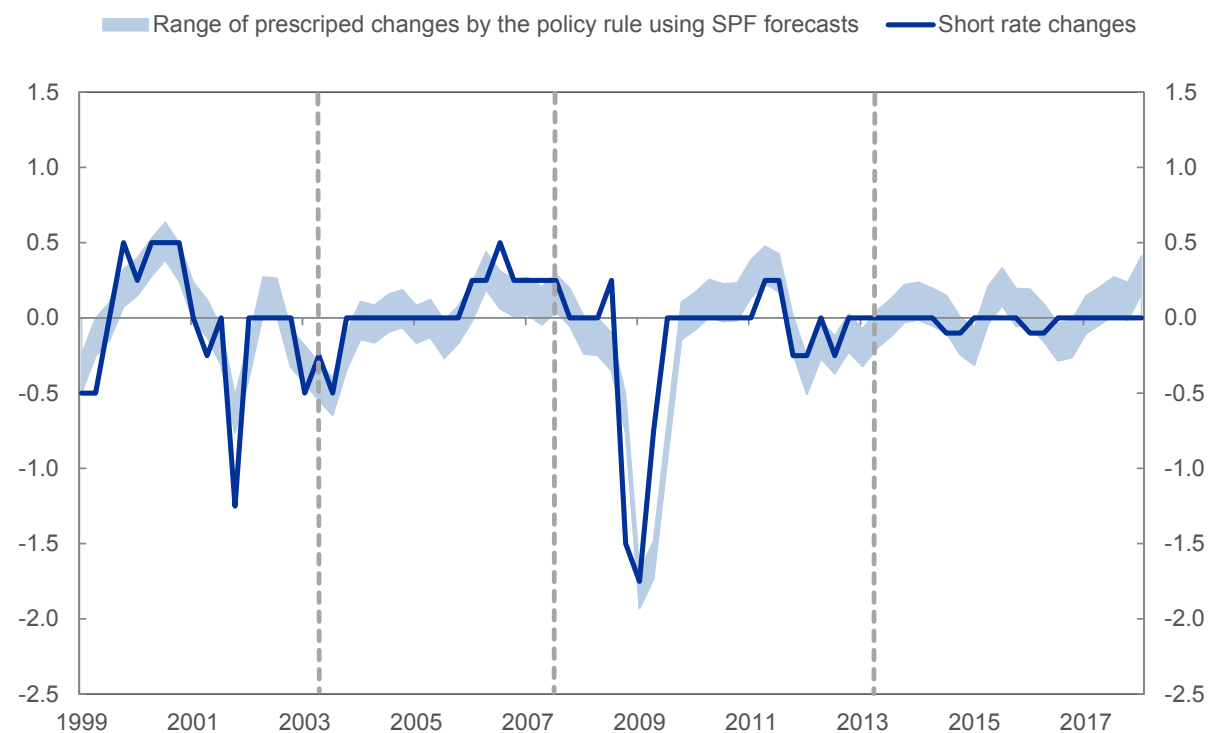
Figure 21: Euro area excess liquidity and EONIA-DFR differential (percentage points)



Source: ECB

Notes: Each dot corresponds to the average spread between the EONIA and the DFR over each maintenance period. Low excess liquidity levels refer to excess liquidity below €bn 200 and correspond to the period before December 2011 and between the end of 3-year LTRO and the start of APP. Medium levels refer to excess liquidity between €bn 200 and €bn 400 and high levels refer to excess liquidity above €bn 400. Latest observation is May 2018.

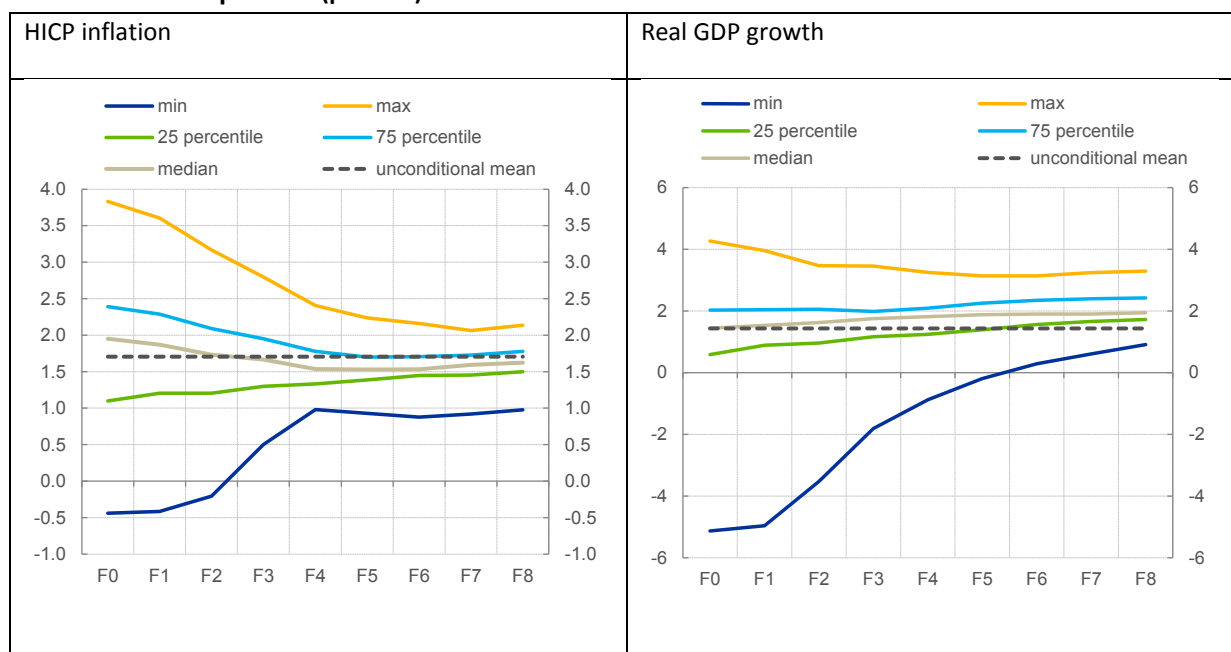
Figure 22: Orphanides rule for the euro area (with SPF as in Orphanides and Wieland, 2013)
(percent)



Sources: ECB, ECB Survey of Professional Forecasters and European Commission.

Notes: The short rate combines the time series of the changes in the main refinancing operations rate up to 2008Q3 with the changes in the deposit facility rate from 2008Q4 onwards. Changes are mid quarter-on-quarter changes. Latest observation is 2018Q1.

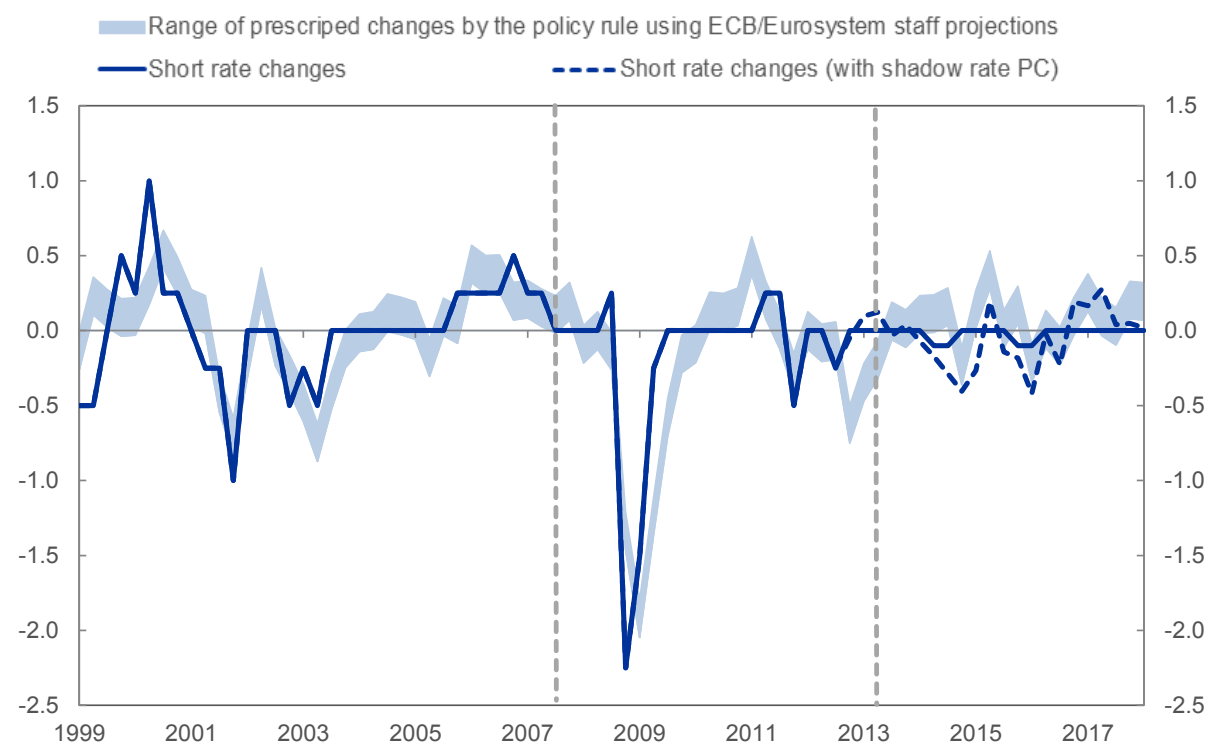
Figure 23: ECB/Eurosystem staff projections for year-on-year HICP inflation and real GDP growth - horizons 0 to 8 quarters (percent)



Sources: ECB, ECB staff projections.

Notes: F0 to F8 refer to the zero to eight quarters' ahead forecast horizons, where zero quarter is the forecast for the current quarter. For each forecast horizon we show the minimum, maximum, 25th percentile, 75th percentile, median and unconditional mean of forecasts for that horizon over a period of time. The period of time considered goes from 1999Q1 to 2018Q1 for HICP inflation and from 2000Q1 to 2018Q1 for real GDP growth.

Figure 24: Orphanides rule for the euro area with ECB/Eurosystem staff projections forecasts (percent)

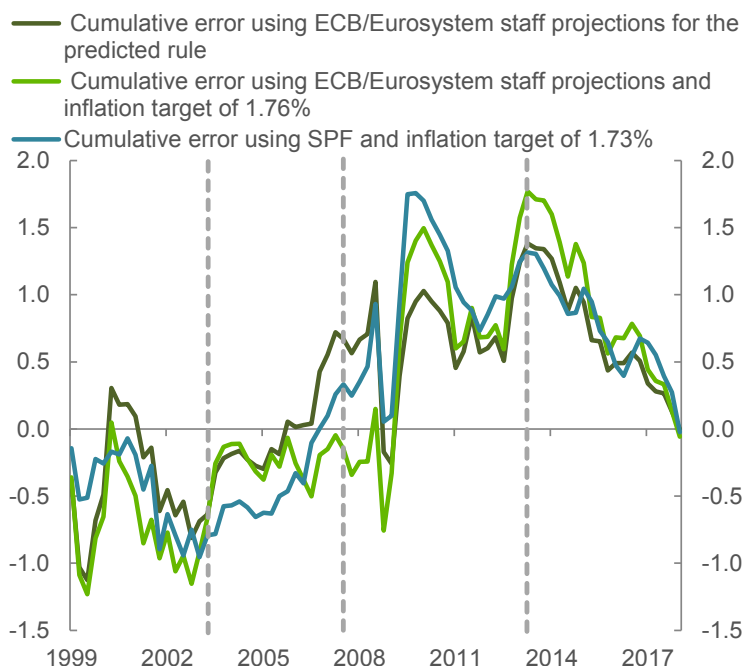


Sources: ECB, ECB staff projections and European Commission. The shadow rates come from Krippner (2015), Kortela (2016), Lemke and Vladu (2017) and Wu and Xia (2017).

Notes: The short rate combines the time series of the changes in the main refinancing operations rate up to 2008Q3 with the time series of the changes in the deposit facility rate from 2008Q4 onwards. Changes are end of quarter-on-quarter changes. The shadow rate refers to a shadow short-term interest rate, for which the zero lower bound is not binding and thereafter captures also the impact of unconventional monetary policy tools (see references in the sources). The short rate combines the time series of the changes in the main refinancing operations rate up to 2008Q3, the changes in the deposit facility rate from 2008Q4 and the changes of the principal component of five shadow rates from 2013Q3 onwards. Changes are end of quarter-on-quarter changes.

Latest observation: 2018Q1

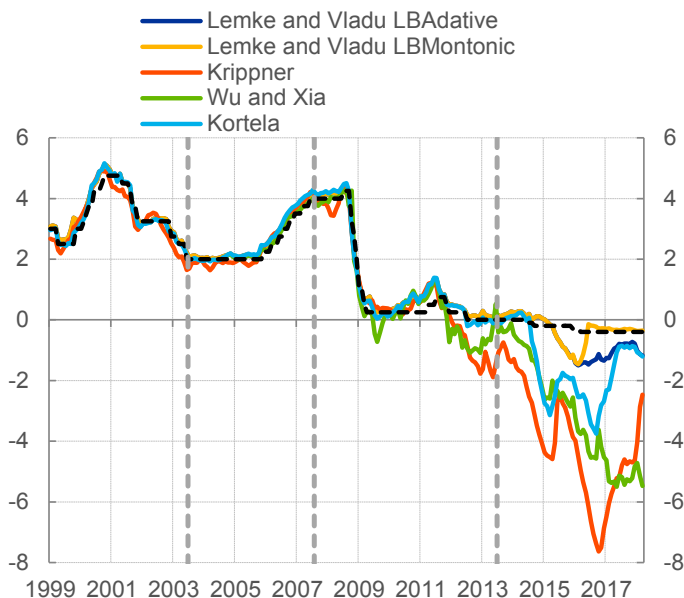
Figure 25: Cumulative errors from the Orphanides rule for the euro area (percent)



Sources: ECB, ECB staff projections, ECB Survey of Professional Forecasters and European Commission. Notes: The cumulated error is calculated as the cumulated difference between the Orphanides rule, using the corresponding inflation targets - e.g. 1.78%, 1.73% and 1.81% (for predicted rule) -, and the short rate. The short rate combines the time series of the changes in the main refinancing operations rate up to 2008Q3 with the time series of the changes in the deposit facility rate from 2008Q4 onwards.

Latest observation: 2018Q1

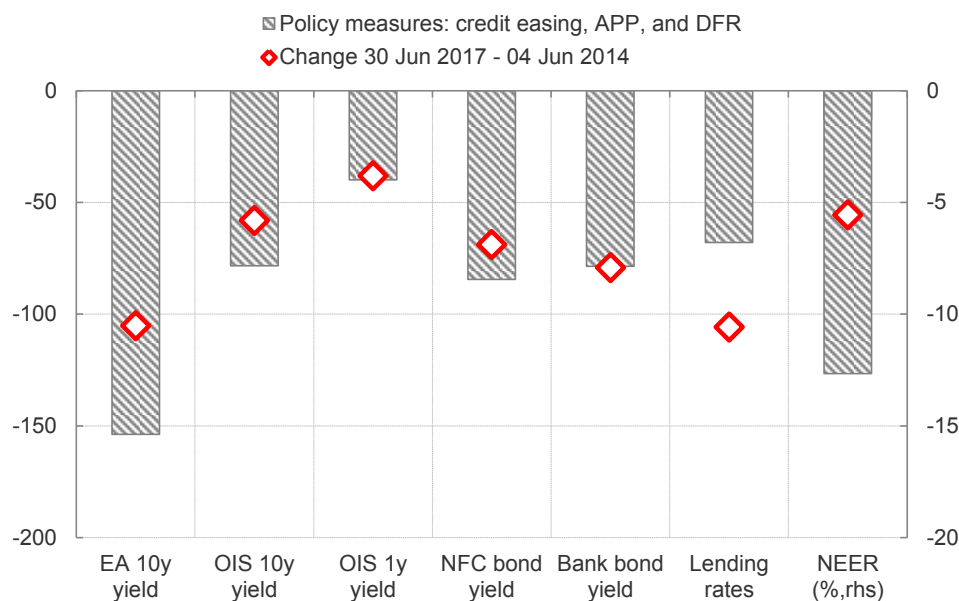
Figure 26: Estimated shadow rates for the euro area (percent)



Sources: ECB; Kortela, T. (2016). "A shadow rate model with time-varying lower bound of interest rates". Research Discussion Papers 19/2016; Bank of Finland; Krippner, L. (2015), "Zero Lower Bound Term Structure Modeling: A Practitioner's Guide", Palgrave-Macmillan; Lemke, W. and A. Vladu (2017), "Below the zero lower bound: a shadow-rate term structure model for the euro area", ECB Working Paper No 1991; Wu JC, Xia FD. (2017), "Time-Varying Lower Bound of Interests in Europe." Chicago Booth Research Paper 17-06, Chicago Booth. Notes: The shadow rate refers to a shadow short-term interest rate, for which the zero lower bound is not binding and thereafter captures also the impact of unconventional monetary policy tools (see references in the sources). MROR refers to the main refinancing operations rate and the DFR to the deposit facility rate.

Latest observation: March 2018

Figure 27: Changes in key euro area financial indicators since June 2014 and impact of ECB policy measures (basis points unless indicated)

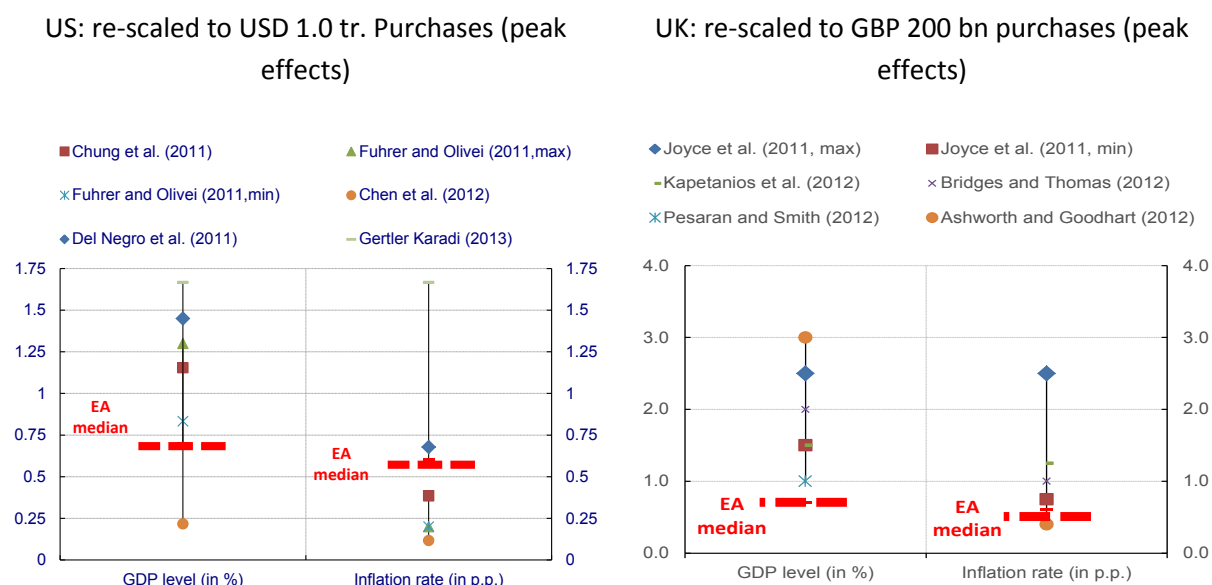


Source: Bloomberg, ECB, ECB calculations.

*Note: The impact of credit easing is estimated on the basis of an event-study methodology which focuses on the announcement effects of the June-September package; see the Economic Bulletin article “The transmission of the ECB’s recent non-standard monetary policy measures” (Issue 7 / 2015). The impact of the DFR cut rests on the announcement effects of the September 2014 DFR cut. APP encompasses the effects of January 2015, December 2015, March 2016, and December 2016 measures. The January 2015 APP impact is estimated on the basis of two event-studies exercises by considering a broad set of events that, starting from September 2014, have affected market expectations about the programme; see Altavilla, Carboni, and Motto (2015) “Asset purchase programmes and financial markets: lessons from the euro area” ECB WP No 1864, and De Santis (2015), “Impact of the asset purchase programme on euro area government bond yields using market news”, ECB WP No. 1939. The quantification of the impact of the December 2015 policy package on asset prices rests on a broad-based assessment comprising event studies and model-based counterfactual exercises. The impact of the March 2016 measures and the impact of the December 2016 measures are assessed via model-based counterfactual exercises. *Changes in lending rates are based on monthly data, the reference period for which is June 2014 to April 2017.*

Last observation: 30 June 2017.

Figure 28: Comparison of the effectiveness of asset purchases in the euro area, the US and the UK



Sources: ECB calculations, Ashworth and Goodhart (2012) Bridges and Thomas (2012), Chen et al. (2012), Chung et al. (2011), Del Negro et al. (2011), Fuhrer and Olivier (2011), Gertler Karadi (2013), Joyce et al. (2012), Kapetanios et al. (2012) and Pesaran and Smith (2012).

Notes: For the US, the macroeconomic impact is scaled to USD 1 tr. of asset purchases to allow for comparison across studies. Some of the studies provide the impact only for real GDP. The EA median for GDP refers to the median of the cumulated impact over 2015, 2016 and 2017 of a range of models (VAR, NiGEM, CMR, DKR and DSGE). The EA median for the inflation rate refers to the median of the peak impact of 2015 to 2017 for the same models.

Table 1: Regression results Orphanides Rule

<i>Y = Short rate</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Inf_BMPE	0.34*** (0.09)	0.30** (0.13)	0.20 (0.19)	0.37*** (0.14)	0.33** (0.14)	0.17 (0.13)	0.36*** (0.09)
GDP_BMPE	0.37*** (0.08)	0.43*** (0.09)	0.54*** (0.20)	0.36*** (0.08)	0.37*** (0.08)	0.52*** (0.14)	0.40*** (0.09)
Inf_SPF			0.27 (0.22)				
GDP_SPF			-0.17 (0.19)				
Core_Inf_BMPE				-0.073 (0.16)			
Pos_Inf_Dev					0.27 (0.17)	0.50*** (0.18)	
Pos_GDP_Dev						-0.46*** (0.17)	
Change_in_cred it_to_HH&NFC							-0.07 (0.07)
Inf_dev_dum					-0.10 (0.08)	-0.15** (0.07)	
GDP_dev_dum						0.02 (0.08)	
Constant	-0.62*** (0.164)	-0.52** (0.26)	-0.85*** (0.14)	-0.56*** (0.16)	-0.60** (0.22)	-0.22 (0.20)	-0.65*** (0.16)
Inf_target	1.81	1.75	1.78	1.85			1.82
Observations	77	54	77	77	77	77	77
Adjusted R-squared	0.52	0.58	0.54	0.52	0.53	0.57	0.53

Notes: Robust standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels. Coefficients are rounded to the second decimal. The dependent variable, short rate, combines the time series of the changes in the MRO up to 2008Q3 with the changes in the DFR from 2008Q4 onwards. Changes are end of quarter-on-quarter changes. The variable *Inf_target* is equal to minus the constant over the estimated inflation coefficient(s). The variables *Inf_BMPE*, *Core_Inf_BMPE* and *GDP_BMPE* refer to 1-year ahead HICP inflation projection, 1-year ahead HICP inflation excluding food and energy projections and 1-year ahead GDP growth projections of the ECB/Eurosystem staff projections, respectively. The variables *Inf_SPF* and *GDP_SPF* refer to 1-year ahead HICP inflation projections and 1-year ahead GDP growth projections of the ECB Survey of Professional Forecasters, respectively. *Inf_dev_dum* and *GDP_dev_dum* refer to dummies equal to 1 if the deviation of projected inflation is greater than the predicted inflation target of 1.81, and if the deviation of projected GDP growth is greater than potential output, respectively. *Pos_Inf_Dev* and *Pos_GDP_Dev* are the interaction terms for inflation deviation and for GDP growth deviation. *Change_in_credit_to_HH&NFC* is the change in the y-o-y growth rate of credit to households and non-financial corporations demeaned by 4.5 %.

Table 2: Timeline of ECB monetary policy measures since the breakout of the financial crisis (August 2007 to June 2018)

	Financial crisis		Sovereign debt crisis		Low-inflation recovery (with lower bound constraint)			
Interest rate policy	+25bps MRO:4.25%	-325bps DFR:0.25%	+50bps DFR:0.75%	-75bps DFR:0%	-20bps DFR:-0.20%	-20bps DFR:-0.40%		
Credit operations	Overnight FTOs "Front-loading" Maturity extension Dec07 \$ swaps	Oct08 FRFA Expand. collateral LTROs (6m) \$ swaps May09 LTROs (1y)		Oct11 LTROs Dec11 VLTRO I (3y) Feb12 VLTRO II (3y)	Jun14 TLTRO I	Mar16 TLTRO II		
Asset purchases		May09 CBPP I	May10 SMP I	Aug11 SMP II Oct11 CBPP II Sep12 OMT	Jun14 ABSPP CBPP III Jan15 PSPP	Dec15 APP I Mar 16 CSPP APP II (80bn)	Dec16 APP III (60bn) Oct17 APP IV (30bn) Jun18 APP V (15bn)	
Forward guidance					Jul13 FG I: Policy rate extended period Jan15 FG II: APP date and SAPI	Mar16 FG III: Policy rate well past APP	Jun18 FG IV: Exp. APP end date and SAPI	
	08/2007	09/2008	05/2010	08/2011	06/2013	08/2015	12/2016	today

● Standard interest rate policies

● Negative Deposit Facility Rate

● Non-standard policies to address lower bound of rates

● Impaired interbank and bank funding markets and later also bank lending channel

● Sovereign-bank nexus and re-denomination risk

● Heterogeneous pass-through in bank lending markets

Sources: Authors and ECB.

Notes: MRO stands for 'main refinancing operations'; DFR stands for 'Deposit facility rate'; FTOs are 'fine-tuning operations'; FRFA are 'Fixed-rate full allotment'; LTROs are 'long-term refinancing operations'; VLTROs are 'very long-term refinancing operations'; TLTROs are 'targeted long-term refinancing operations'; CBPP stands for 'Covered bond purchasing program'; SMPs are 'Securities Markets Programs'; OMTs are 'outright monetary transactions'; ABSPP stands for 'asset-backed securities purchase program'; PSPP is the 'Public sector purchase program'; APPs are simply 'Asset purchase programs'; FG stands for 'forward guidance'; SAPI stands for 'sustained adjustment in the path of inflation'.

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