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Assessing the efficacy, efficiency and potential side effects of the ECB's monetary policy instruments since 2014

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Set of Occasional Papers related to the ECB's Strategy review 2020-21

No 263, "The implications of globalisation for the ECB monetary policy strategy".
No 264, "Inflation expectations and their role in Eurosystem forecasting".
No 265, "Inflation measurement and its assessment in the ECB's monetary policy strategy review".
No 266, "Digitalisation: channels, impacts and implications for monetary policy in the euro area".
No 267, "Review of macroeconomic modelling in the Eurosystem: current practices and scope for improvement".
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No 278, "Assessing the efficacy, efficiency and potential side effects of the ECB's monetary policy instruments since 2014".
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Contents

Abstract

This paper summarises the work done by Eurosystem staff in the context of the Strategy Review Seminar on Monetary Policy Instruments. More specifically, it focuses on the efficacy, efficiency and potential side effects of the key monetary policy instruments employed by the European Central Bank since 2014. The following main findings emerge from the analysis. First, instruments have been effective in easing financing conditions and supporting economic growth, employment and inflation. Second, considering the effective lower bound on policy rates, a combination of instruments is generally more efficient than relying on a single tool. Third, side effects have been generally contained so far, but they are found to vary over time and need to be closely monitored on an ongoing basis. Fourth, the monetary policy toolkit needs to remain innovative, diversified, and flexible, i.e. reviewed regularly to ensure that it remains fit for purpose against the backdrop of evolving financial and macroeconomic conditions.

JEL codes: E52, E58, E43, E44, E47.

Keywords: monetary policy instruments, standard and non-standard measures.

1 Introduction

The Eurosystem has significantly expanded its set of monetary policy instruments since the onset of the Great Financial Crisis, developing a diversified set of instruments to steer the monetary policy stance and ensure a smooth transmission of the stance through financial markets and the real economy. The toolkit has evolved from one in which the key ECB interest rates were the instrument for determining the stance of monetary policy to one in which policy rates, forward guidance as well as the size and composition of the balance sheet are being actively used and combined to compensate for the reduced scope of conventional policy action, enforce the appropriate stance of monetary policy and support market functioning in order to safeguard the transmission of monetary policy to the real economy.

This paper summarises the work done by Eurosystem staff in the context of the Strategy Review on efficacy, efficiency and potential side effects of standard and non-standard monetary policy instruments employed by the European Central Bank since 2014. The focus of this paper is on the unconventional measures adopted since mid-2014, i.e. the negative interest rate policy, asset purchases (under the asset purchase programme, APP, and the pandemic emergency purchase programme, PEPP), forward guidance on rates and purchases, and targeted longer-term refinancing operations (TLTROs). Thus, the emphasis is on the monetary tools that were introduced to achieve the ECB's price stability objective and it excludes policies aimed primarily at stabilising dysfunctional financial markets, such as the Securities Markets Programme (SMP) and Outright Monetary Transactions (OMT). The paper assesses the effectiveness and efficiency of the measures regarding their impact on financial conditions, the macroeconomy and inflation (Section 2). It assesses the side effects of the measures regarding financial market functioning, banks and other financial intermediaries, as well as side effects on productivity and distributional implications (Section 3). The concluding remarks (Section 4) summarise the main findings, draw key lessons learned and outline possible future challenges. While this paper summarises a large body of academic research and analyses carried out by Eurosystem staff, it does not claim to be a complete and up-to-date assessment of the ECB's policy instruments.[1]

The analysis finds the instruments to be effective, highlights the importance of instrument diversification and suggests that potential side effects have not harmed instrument effectiveness so far but warrant continued close monitoring. According to Eurosystem staff estimates, the instruments adopted since 2014 have helped to ease financing conditions at times when the standard policy instrument was constrained by the lower bound on policy rates. Improved financing conditions in turn supported economic growth and inflation which would have been markedly lower in the absence of such policy measures. A further finding is that a combination of instruments is generally more efficient than achieving the same

[1] Specifically, the paper and the documented charts and tables reflect data and other information available to staff up to mid-January 2021.

impact on inflation by relying on a single instrument: this would likely have triggered larger side effects. While side effects have generally been contained so far, they are found to vary over time and are likely to increase when unconventional monetary policy measures are used intensely over an extended period of time. Accordingly, they need to be closely monitored also in the future as part of the regular proportionality assessments. Looking ahead, as a general conclusion from the analysis, the monetary policy toolkit needs to be innovative, diversified and flexible, i.e. it has to be reviewed regularly to ensure that it remains fit for purpose against a backdrop of constantly evolving financial and macroeconomic conditions.

2 Effectiveness and efficiency of the monetary policy instruments adopted since 2014

The monetary policy instruments adopted since 2014 have provided monetary policy stimulus via financial markets and financial intermediaries, thus helping to ease financial conditions at times when the standard policy instrument was constrained and the equilibrium real interest rate was at historical lows. Financial conditions were made more supportive through a variety of channels that have strongly interacted with one another and that amplified and complemented one another's transmission through the financial system. Before inspecting the characteristic transmission of the various instruments in further detail in the following sections, Table 1 provides an overview. The cells on the diagonal summarise the impact channel of each measure as a standalone instrument, while the off-diagonal elements capture the channels through which each instrument has influenced the transmission of the others.

Table 1

Overview of ECB measures taken since 2014 – summary of their impact and interaction

		TO			
		NIRP	FG	PSPP/ Public PEPP	TLTRO/CSPP
FROM	NIRP	1.1. Extends scope for rate action to below zero line.	1.2. Signals potential future rate cut, which generates curve inversion and downside pressure on lending rates and exchange rate.	1.3. Reinforces impact of APP on term premium through "Gesell tax" effect.	1.4. NIRP reinforces TLTRO incentive scheme: stronger loan origination entitles banks to negative borrowing rate. It also presses best-quality corporate bonds down to negative levels.
	FG	2.1. Contains potential term premium volatility created by larger future rate uncertainty (opens possibility to increase or cut rates in future).	2.2. Controls front end of forward curve by pricing out expected rate paths inconsistent with central bank's language.	2.3. Anchors short end of curve to ensure it doesn't back up prematurely as APP stimulates economy.	2.4 Together with NIRP, FG keeps intermediate segments of risk-free curve, used by banks and capital markets to price loans and corporate bonds, at low levels, thus stimulating credit demand.
	PSPP/ PEPP	3.1. Extra liquidity contributes to keeping overnight rate at DFR. Contains potential term premium volatility created by larger future rate uncertainty (opens possibility to increase or cut rates in future).	3.2. Extra liquidity makes overnight rate indirectly controllable even if FG applies to DFR. Strengthens signal of accommodative stance for long period of time.	3.3. PSPP reduces net supply of longer-term assets, which increases their prices and lowers their yields (extracts duration risk and compresses term premium directly). PEPP also leans against financial market dysfunctions/fragmentation via more flexible asset/country allocation.	3.4. PSPP favours decrease in banks' return on bond holdings relative to return on loan creation. Generates capital gains for banks and frees up balance sheet capacity that banks can redeploy to commercial loans under TLTROs. PSPP reinforces squeeze in corporate bond spreads by duration extraction.
	TLTRO/CSPP	4.1. TLTRO exempts borrowed funds from NIRP tax on reserves.	4.2. TLTRO strengthens signal of low rates for longer through fixed borrowing rate.	4.3. Favours increase in banks' return on loan creation relative to bond holdings.	4.4. Credit easing squeezes intermediation wedge: TLTRO, by compressing banks' funding costs while preserving lending margins; CSPP, by narrowing corporate bond spreads.

Source: Based on Rostagno et al. (2021b).
Notes: NIRP stands for negative interest rate policy, FG for forward guidance, PSPP for the public sector purchase programme (part of the expanded asset purchase programme, APP), PEPP for the pandemic emergency purchase programme, TLTRO for targeted longer-term refinancing operation, CSPP for the corporate sector purchase programme (part of the APP) and DFR for the deposit facility rate.

Besides extending the scope for conventional rate action below zero (cell 1.1), the ECB's negative interest rate policy has reinforced the signalling of forward guidance (cell 1.2) and has given a further impulse to the portfolio rebalancing spurred by asset purchases (cell 1.3), as investors were incentivised to purchase longer-term assets in a bid to avoid being "taxed" by the negative rate. The transmission of the negative interest rate policy was facilitated by the second and third series of targeted longer-term refinancing operations (TLTRO II and TLTRO III), which allowed banks to borrow at negative rates, thus alleviating the main adverse side effects of the

policy for financial intermediaries (cell 1.4). Forward guidance has helped control the front end of the yield curve by aligning financial market participants' expectations more tightly with the intentions of the ECB's Governing Council (cell 2.2), thereby also avoiding the creation of expectations of a premature policy rate lift-off due to the improvement in the macroeconomic outlook brought about by other instruments (cell 2.3). The sovereign bond legs of the asset purchase programme (APP) (public sector purchase programme, PSPP) and the pandemic emergency purchase programme (PEPP) have reduced the net supply of longer-term assets, which has increased their prices and lowered their yields (cell 3.3). They have also signalled the policymaker's intention to keep short rates low for an extended period and ensured that forward guidance on the deposit facility rate could influence the future expected path of the overnight interest rate, by creating the excess liquidity needed for the two interest rates to remain close to and shadow each other (cell 3.2). In addition, via a flexible asset and country allocation of purchases, the PEPP has also addressed threats to market stability and fragmentation, thereby ensuring a sound transmission of monetary policy (cell 3.3). The TLTROs (cell 4.4), together with the private sector legs of the APP – notably the corporate sector purchase programme (CSPP) – and of the PEPP, have operated as powerful credit easing measures. The TLTRO programme has compressed banks' funding costs while preserving lending margins, thereby reducing the cost of loan origination for banks and incentivising them to grant loans to the real economy at favourable conditions. The CSPP has narrowed corporate bond spreads, thereby providing a direct channel of transmission from monetary policy to the real economy.[2] In addition, by supporting the bond issuance of large firms, the CSPP has indirectly contributed to enhancing the access of small and medium-sized enterprises to bank finance, as it has freed up balance sheet capacity that banks can redeploy for creating loans to smaller businesses. While Table 1 provides a first qualitative overview of the instruments' own impacts and their mutual interactions, central bankers and academics have only started to systematically capture and quantify the various impact channels: the assessments in the subsequent sections are thus to be read as a snapshot of the understanding at the time of writing, but more analysis is certainly needed and forthcoming to better understand the instruments' transmission channels at work, and in particular their interaction.

2.1 Impact on financial conditions

Rate cuts (in positive and negative territory), rate forward guidance and asset purchases leave different "footprints" on the yield curve (Chart 1). The analysis assesses the response of financial variables to unexpected changes in the policy rate, rate forward guidance and the APP respectively, on the basis of a proxy structural vector autoregressive model, where identification is achieved by means of high frequency external instruments.[3] Results indicate that the impact of rate forward

2 For a classification of transmission channels (signalling channel, portfolio rebalancing channel and direct pass-through channel) see, for instance, Hammermann et al. (2019).

3 Specifically, the external instruments are the policy factors identified from the intraday response of financial market variables at the time of the Governing Council announcement on a policy-setting meeting day. Data are taken from the euro area monetary policy database. See Altavilla et al. (2019).

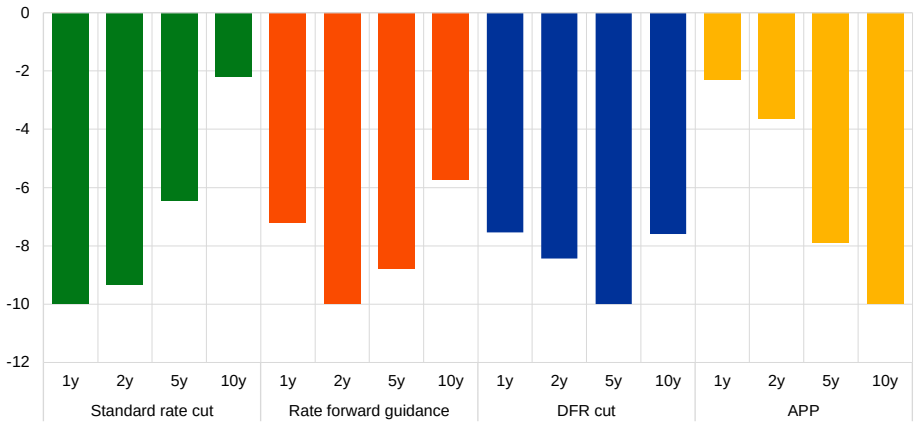
guidance tends to peak around mid-maturities, generating a hump-shaped response in the yield curve, as prevailing short-term rates remain unchanged. A standard rate cut in positive territory primarily affects the front-end of the curve, with the impact declining at longer maturities. The effect of a deposit facility rate cut in negative territory peaks around the five-year maturity and extends throughout the maturity spectrum. The APP largely impacts the long end of the curve.[4]

Apart from its impact on yield levels, forward guidance is found to have shielded rates from an excessive reaction to positive macroeconomic news while reacting marginally more to negative news (Chart 2), suggesting that rate forward guidance has played a stabilising role. The sensitivity of changes in the short-term forward rate 18 months ahead to macroeconomic news is estimated to be significantly lower since the adoption of the rate forward guidance in July 2013. This effectiveness holds equally during periods of market stress, even though more volatile conditions are, in principle, conducive to overreaction to news. In addition, through its state contingent leg, the prevailing rate forward guidance, as adopted since September 2019, appears to cap, in particular, the sensitivity to positive news, and this property has been preserved in current conditions.[5]

Chart 1

Impact of policy measures on the yield curve at different maturities

(basis points)



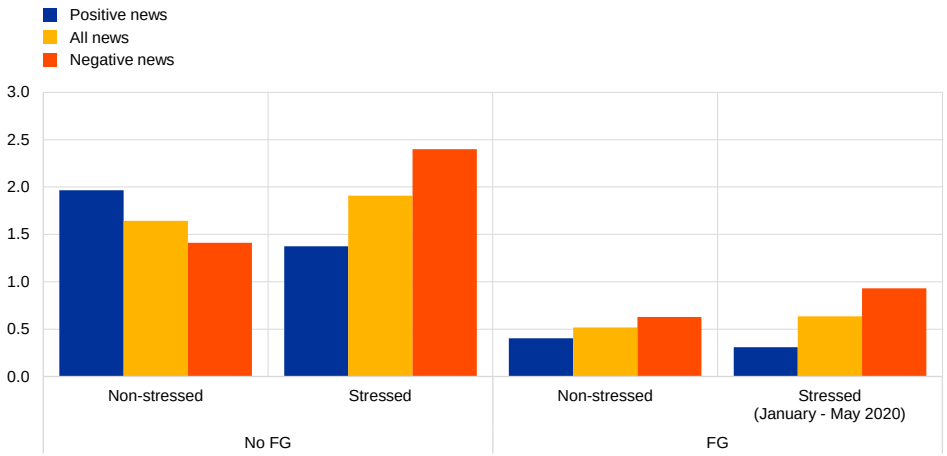
Source: Based on Altavilla, Brugnolini, Gürkaynak, Motto and Ragusa (2019).
Notes: The changes are normalised to a 10-basis point decline in the overnight index swap (OIS) rate at the maturity where the policy measure exerts the maximum impact, namely 1 year for the standard rate cut, 2 years for the rate forward guidance, 5 years for the deposit facility rate cut, and 10 years for the APP.

4 Similar results on the yield curve footprint of monetary policy measures are derived from high frequency movements around policy events (see Altavilla et al. (2019), Rostagno et al. (2021b)) and security level data (see Altavilla, Carboni, Motto (2015)).

5 According to the forward guidance formulation adopted by the Governing Council in September 2019 and reconfirmed thereafter, interest rates were expected "to remain at their present or lower levels until we have seen the inflation outlook robustly converge to a level sufficiently close to, but below, 2% within our projection horizon, and such convergence has been consistently reflected in underlying inflation dynamics".

Chart 2

Sensitivity of 3m-in-18m OIS forward rates to macroeconomic news



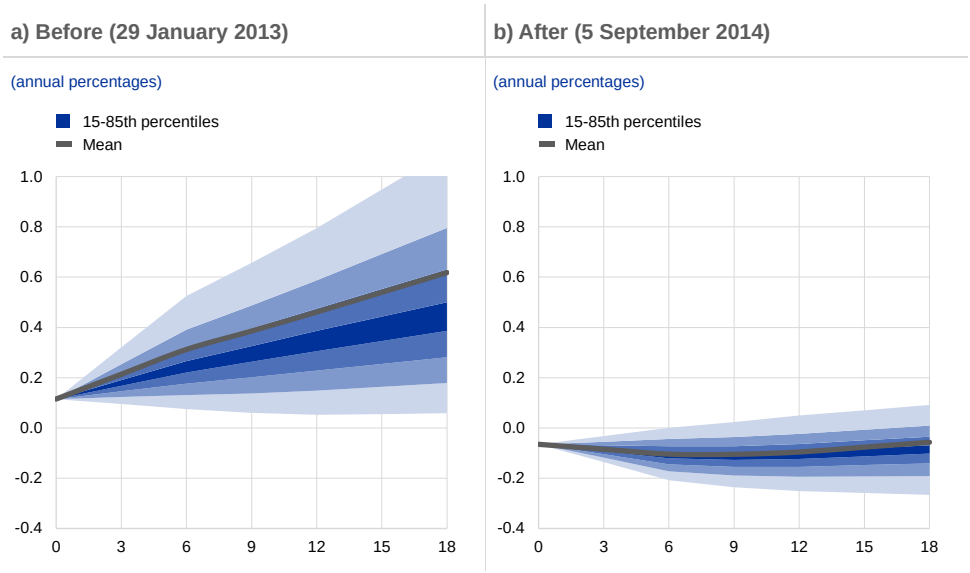
Source: ECB calculations.
Notes: Sensitivity is derived from separate regressions of changes in the 3-month in 18-month Euribor forward rate on an index based on macroeconomic surprises, considering alternative sub-periods and partitioning the news into positive and negative news. The periods under consideration are: No FG non-stressed: Jan-2000 to Jun-2008; No FG stressed: Apr-2010 to Jul-2013; FG non-stressed: Jul-2013 to Jan-2020; FG stressed: Jan-2020 to May-2020.

By relaxing the lower bound constraint, the introduction of negative rates has reduced current and expected future short-term rates in ways that are qualitatively different from and more powerful than traditional interest rate cuts in positive territory, leading to the different yield curve imprint shown in Chart 1. The introduction of negative rates alters market expectations that current and future short-term rates cannot be negative, softening the lower bound constraint and hence allowing the monetary accommodation to propagate through the entire yield curve. The primary mechanism works via market interest rates that reflect expectations about the future path of monetary policy. To illustrate this mechanism, Chart 3 contrasts the euro overnight index average (EONIA) forward curve and the predictive distribution around it at the beginning of 2013, i.e. before the introduction of negative interest rates (panel a), with the curve prevailing in September 2014 right after the introduction of the negative interest rate policy (panel b).[6] Once negative interest rates were introduced in June 2014, the forward curve became markedly flatter and the distribution around it more symmetric (forward rates closer to the median), with a mild inversion over short to medium-term maturities and some probability mass in negative territory.

6 See Rostagno, Altavilla, Carboni, Lemke, Motto, Saint-Guilhem and Yiangou (2021b).

Chart 3

EONIA forward curve and its risk-neutral density: before and after the introduction of the negative interest rate policy



Sources: Bloomberg and ECB, and Rostagno, Altavilla, Carboni, Lemke, Motto, Saint-Guilhem and Yiangou (2021b).
Notes: Risk-neutral densities are derived from options on euro interbank offered rate (EURIBOR) futures. The mean and the percentiles are expressed in terms of EONIA by subtracting the EURIBOR3M-OIS3M spot spread.

ECB asset purchases have compressed risk premia across a wide range of asset classes via portfolio rebalancing, particularly for longer-dated and lower-rated bonds through the extraction of duration and other risks. While rate cuts and forward guidance primarily affect shorter-term interest rates, asset purchases exert a relatively larger impact at the back end of the curve, leading to a decline in term and credit risk premia and a flattening of the yield curve. By the end of 2019, the ECB's net asset purchases and reinvestment policy had extracted 19% of the duration-equivalent stock[7] of outstanding public debt in the four largest euro area economies (Chart 4).[8] Model-based estimates find that these purchase volumes have led to a reduction in the ten-year sovereign term premium[9] of nearly 100 basis points (Chart 5).[10] Larger estimates emerge when also taking into account reductions in long-term yields emanating via the signalling channel, i.e. the transmission channel capturing the effect of purchases on future policy rate expectations. As part of the measures relating to the coronavirus (COVID-19) pandemic, the ECB's Governing Council decided in March 2020 to expand the APP

7 The duration-equivalent stock adjusts for the different maturities of the bonds included. Broadly speaking, the "ten-year equivalent" approach used in the chart gives a weight of one to a ten-year bond, while n-year bonds enter with a weight of n/10, reflecting their lower maturity, which is in turn a proxy for duration (interest rates sensitivity) risk.

8 At the same time, there is some evidence that asset purchases supported higher maturities at issuance, see, e.g., Plessen-Mátyás, Kaufmann and von Landesberger (2021).

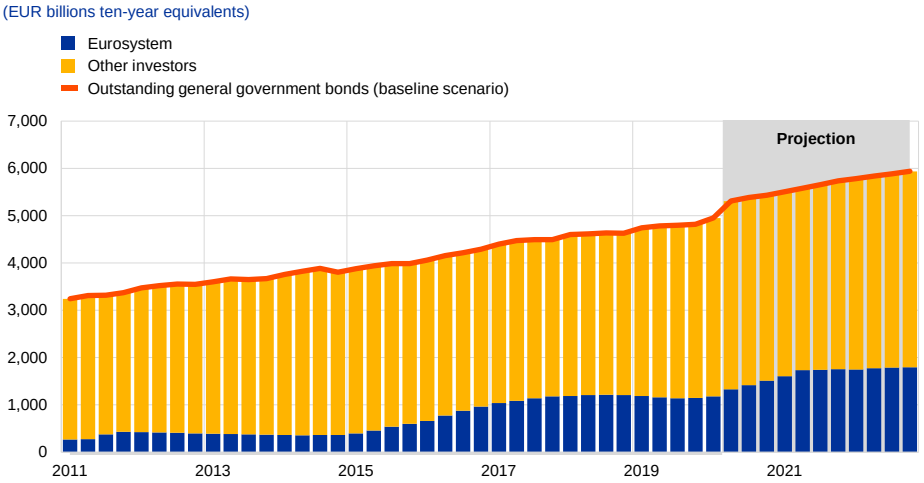
9 "Term premium" can be understood here as that portion of the considered sovereign bond yields (weighted average across Germany, Spain, France and Italy) that is not related to current or expected short-term rate expectations. For an explicit decomposition of the effect of bond purchases on rate expectations, term premia (in the narrow sense of just capturing duration risk), expected default compensation and credit risk premia, see Costain, Nuno and Thomas (2021).

10 The underlying econometric model by Eser et al. (2019) quantifies the yield impact of the Eurosystem's asset purchases via the duration extraction channel, which in turn is based on the theoretical framework by Vayanos and Vila (2021) and similar to the econometric model by Li and Wei (2013).

envelope by an additional €120 billion and to launch the PEPP with an initial overall envelope of €750 billion, with purchases to be conducted until the end of 2020. In June 2020, the Governing Council expanded the PEPP envelope by an additional €600 billion and extended the net purchase period to at least mid-2021. Against this backdrop, looking ahead from the vantage point of mid-2020 (i.e. taking into account the June 2020 increase in the PEPP envelope but not the further increase announced in December 2020), the extraction of duration risk was foreseen to increase to 27% of the overall projected supply by mid-2021. The additional duration extraction was estimated to further compress ten-year sovereign term premia by around 45 basis points (Chart 5). This estimate is conservative, as it is based on model elasticities[11] that are inferred from the experiences with the PSPP. As discussed further below, the specific features of PEPP may have given rise to a larger yield impact.

Chart 4

Outstanding quantity of duration: holdings of Eurosystem (PSPP and PEPP) and other investors

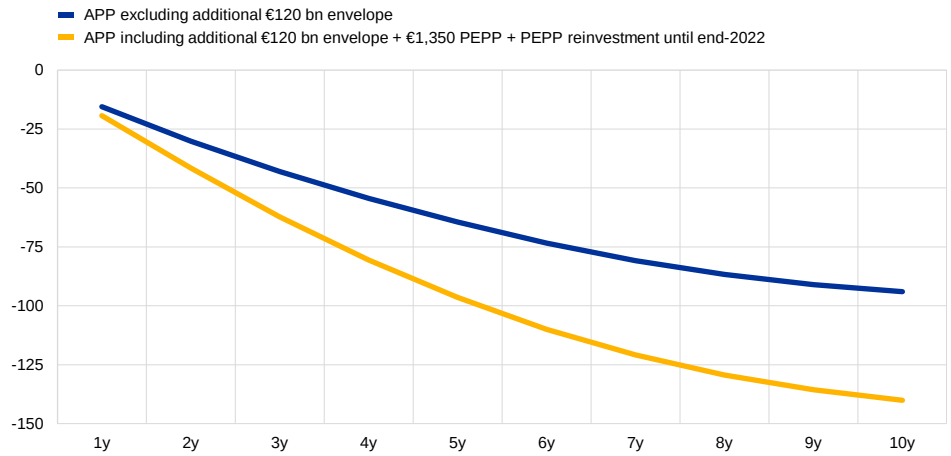


Sources: SHS, government finance statistics and ECB calculations.
Notes: The chart shows the stock of debt securities issued by each general government of the four largest euro area jurisdictions and the stock held by the Eurosystem (under the PSPP and PEPP) and other investors in ten-year equivalents. "Other investors" comprise all other financial and non-financial investors. The latest observations are for the first quarter of 2020 (historical data) and the fourth quarter of 2022 (projected data) excluding the Governing Council's policy decision of December 2020.

[11] The term "elasticities" is essentially a short-hand for the translation of asset purchases into yield effects. The model by Eser et al. (2019) deployed here maps the full trajectory of expected duration extraction implied by contemporaneous and expected future central bank bond holdings into the yield impact across maturities. The model is estimated based on time series and event information, and resulting elasticities are subject to several margins of uncertainty. See, e.g., Vlieghe (2018), challenging the use of event-study information for inferring the size of QE effects and the references given therein.

Chart 5

Estimated impact of asset purchases on sovereign term premia



Sources: SHS, government finance statistics and ECB calculations.
Notes: Impact estimates on zero-coupon GDP-weighted sovereign yields of Germany, Spain, France and Italy are based on the model by Eser, Lemke, Nyholm, Radde and Vladu (2019). The estimates are based on the current and future duration extraction implied by the Eurosystem's APP and PEPP as anticipated in mid-2020, using SHS data for the first quarter of 2020. The blue line excludes the PEPP and additional APP purchases following the Governing Council's decision of March 2020, while the yellow line incorporates them and the additional PEPP purchases announced at the June 2020 Governing Council meeting.

The private sector leg of the asset purchase programmes has directly contributed to improved credit conditions for the private non-financial sector. Corporate bond spreads over the risk-free rate are estimated to have declined in response to unconventional monetary policy action.[12] Moreover, announcement effects, such as the launch of the APP, have had spillovers to assets that were not initially targeted by the programme. Finally, corporate spreads have narrowed also for bonds that are not eligible under the CSPP.

Moreover, the CSPP is found to have spurred bond issuance, with overall beneficial effects for primary markets. Todorov (2020), for instance, finds that, as a result of the CSPP, firms issued €2.19 billion (25%) more of CSPP-eligible debt after the CSPP announcement than of other types of debt. Arce et al. (2021b) furthermore demonstrate that the effect of the CSPP programme did not remain confined to CSPP-eligible securities but it also supported bond issuance for firms with non-eligible bonds.[13] Finally, De Santis et al. (2018) and De Santis and Zaghini (2019) also find that the CSPP led to a significant increase in bonds issuance by eligible firms and improved supply conditions in primary markets. In addition, they

12 Specifically, bond yields dropped, on average, by 30 basis points (8%) after the CSPP announcement. Tri-party repo turnover rose by 29% and bilateral turnover increased by 72%. Bid-ask spreads also showed significant liquidity improvement in eligible bonds. See Todorov (2020). Mota and Papoutsi (2020) analyse credit spreads of CSPP-eligible bonds, documenting that they dropped by 0.23% and that the impact on credit spreads is almost fully explained by the non-default component.

13 Firms with non-eligible bonds are shown to have increased issuances by 6% in the quarter following the date of announcement. The authors also provide evidence consistent with a substitution of bank loans by bonds after the announcement of the CSPP, documenting the impact of monetary policy on firms' decision-making with regard to capital structure. Grosse-Rueschkamp et al. (2019) also document that firms whose bonds were eligible for central bank purchases faced a decline in yields, and that these firms substituted bank term loans with bond debt. Banks thus experienced a decline in loan demand, which reduced their regulatory or economic constraints and allowed them to increase lending to other firms. Galema and Lugo (2021) also find that the CSPP has favoured the substitution of bonds for other forms of debt capital. See also Abidi et al. (2018) and Zaghini (2019).

highlight that the CSPP has eventually led to increased bank lending to non-financial corporations (NFCs) that do not have access to bond-based financing.

Looking specifically at the PEPP, besides compressing average long-term bond yields the programme also defused the risk of bond market fragmentation, thereby safeguarding the transmission of monetary policy.[14] Sovereign bond spreads widened significantly relative to OIS rates when the pandemic reached Europe in early 2020 and threatened the homogeneous transmission of monetary policy. With the introduction of the PEPP in March, spreads narrowed markedly and displayed considerably less volatility thereafter. Moreover, the PEPP contributed to preventing undue disruptions in sovereign debt markets even as the second wave of the pandemic was causing a deep contraction in economic activity.

Event-study evidence indicates that the impact of the PEPP on yields may be stronger than that of the APP, which might reflect greater market distress and/or the greater flexibility embedded in the PEPP. As illustrated in Chart 6, a standardised increase in sovereign bond purchases of €500 billion in the euro area is associated with a decline of slightly less than 20 basis points for the ten-year GDP-weighted yield under the PSPP[15], while the decline associated with that volume based on the PEPP announcement is larger, at about 25 basis points. Both the PSPP and the PEPP elasticities provide an estimate of the induced bond yield compression but do not, on account of the design of the underlying econometric model, capture signalling effects regarding expected policy rates embedded in sovereign bond yields.[16] The higher estimated effectiveness of the PEPP, as opposed to the PSPP, can be explained by the greater flexibility of the PEPP as well as the higher sensitivity of bond yields in times of financial distress.

Complementary evidence points to stronger "flow effects" during the stressed market conditions that characterised the initial phase of the PEPP. Estimates suggest that flow effects are concentrated primarily in more stressed countries and are more potent in supporting bond prices in stressed than in non-stressed conditions (Chart 7).[17] Specifically, a 1-percentage point increase in the purchases of central government securities relative to their outstanding amounts in stressed countries leads to a 1.8% increase in their daily returns in non-stressed conditions. In the stressed conditions prevailing from March to June 2020, this coefficient rose

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14 By contributing to lower (marginal) sovereign financing costs, the PEPP is likely to have also affected fiscal decisions. This dimension is discussed in Work stream on monetary-fiscal policy interactions (2021).

15 Note that "elasticity" is a simplification in that it ignores the time profile of central bank purchases and holdings, which matters in the econometric model based on which the elasticities are derived. The GDP-weighted yield is a weighted average across the four largest euro area jurisdictions, i.e. Germany, Spain, France and Italy.

16 Once accounting for signalling effects on the expectations component, the above-mentioned event-study analysis that accounts for market expectations formed prior to the policy announcement finds that bond purchases of €500 billion are associated with a decline of up to 30 basis points on ten-year euro area sovereign bond yields, for both the PSPP and the PEPP policy recalibration. See Rostagno et al. (2021a).

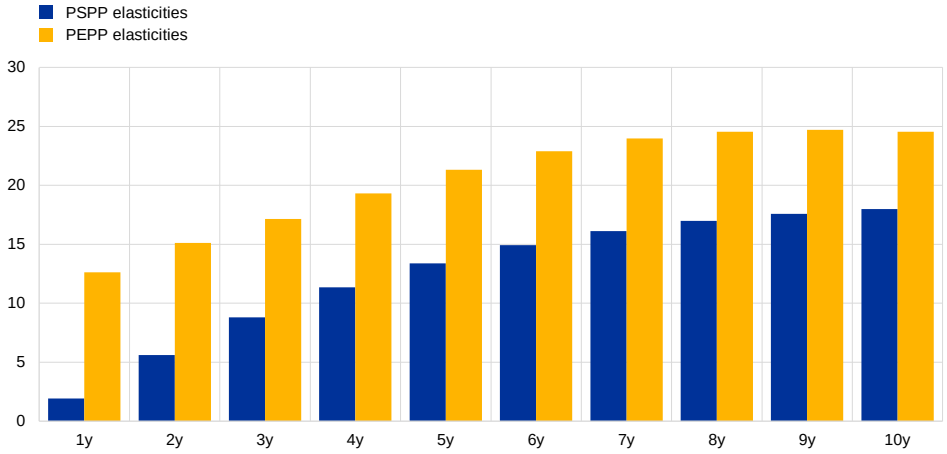
17 The analysis draws from De Santis and Holm-Hadulla (2020). The period of stressed conditions is assumed to start on 21 February and end on 30 June 2020. Bernardini and De Nicola (2020) use high frequency data on Banca d'Italia purchases of sovereign bonds and find that they exerted a downward pressure on long-term yields and contributed to improving market liquidity. These effects have been larger during periods of market stress.

markedly, standing at roughly one and a half times its level during the non-stressed period for stressed countries. Further ECB staff analysis based on high-frequency data confirms that outright purchases become significantly more effective in lowering yields under distressed conditions and, in particular, when market liquidity is low. From a policy perspective, these findings suggest that operational flexibility can strengthen the effectiveness of a purchase programme: for a given overall envelope, flexibility allows reallocation of purchase flows over time, with the possibility of stepping up their pace when they are needed but also more likely to be effective.

Chart 6

PSPP and PEPP yield elasticities to sovereign bond purchases

(basis points per €500 billion of sovereign bond purchases in the euro area)

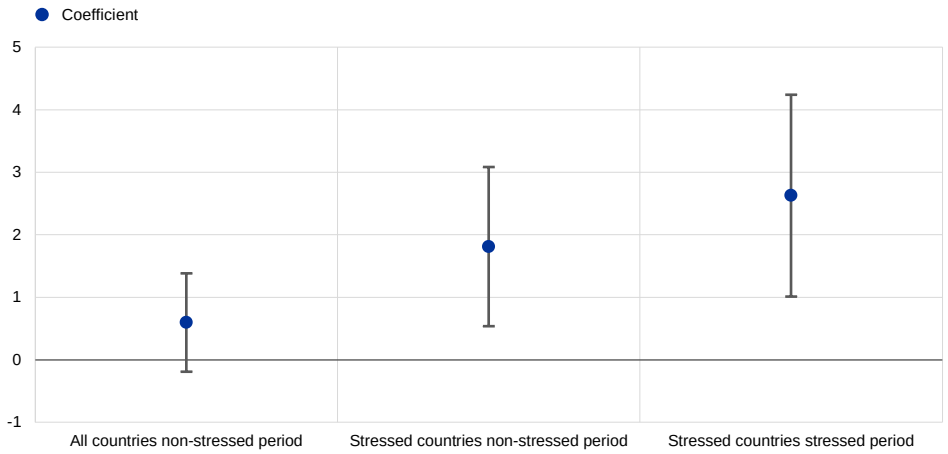


Source: ECB calculations.
Notes: PSPP elasticities are based on Eser et al. (2019) informed by the March-2020 PEPP envelope. PEPP elasticities are derived from a recalibrated version of Eser et al. (2019) so that the model-implied yield reactions to the March PEPP announcement match two-day yield changes observed after 18 March. Elasticities refer to GDP-weighted zero-coupon yields of the four largest euro area jurisdictions (i.e. Germany, Spain, France and Italy) in response to €500 billion of sovereign bond purchases in the euro area. No reinvestment assumed.

Chart 7

"Flow effects" on daily bond returns

(impact of 1 percentage point increase in purchases of security relative to the outstanding amount, as a percentage)



Source: ECB calculations.
Notes: The impact estimates derive from regressions of daily bond returns of individual central government securities on ECB purchases of these securities, scaled by their outstanding amounts, and a full set of security and day-fixed effects. Purchase volumes are instrumented via the blackout periods embedded in the PSPP and PEPP design, as detailed in De Santis and Holm-Hadulla (2020). The blue diamonds are point estimates and the whiskers are 95% confidence intervals.

2.2 Impact on bank funding and credit conditions

The TLTROs have provided a sizeable funding cost relief to euro area banks, and their built-in mechanisms have incentivised an effective transmission of favourable funding costs to the ultimate borrowers. For each participating bank, the relief stems from the direct substitution of more expensive funds and is a function of the bank's take-up and pricing scheme in the operations.[18] For banks not directly participating in the programme, the relief is indirect since banks participating in TLTROs are likely to cancel or postpone their market bond issuance. The resulting "bond scarcity" generates a reduction in the external funding cost even for those banks that do not directly participate in the operations.[19]

Besides preserving a smooth credit intermediation channel, the TLTROs have displayed their potential to ease broader credit conditions as well as the overall monetary policy stance. By lowering the minimum achievable rate to well below the deposit facility rate (Chart 8a), there has been a broad-based and deep participation across banks in many euro area jurisdictions (Chart 8b). The recalibration of TLTRO conditions, and notably the pricing feature, has been instrumental in compressing wholesale funding costs and injecting a substantial easing of lending conditions within the euro area.[20] Even if, in principle, repeated interventions in longer-term borrowing markets might alter the longer-term capital allocation in the banking system, so far the availability of TLTROs has not resulted in

18 See Barbiero and Burlon (2020).

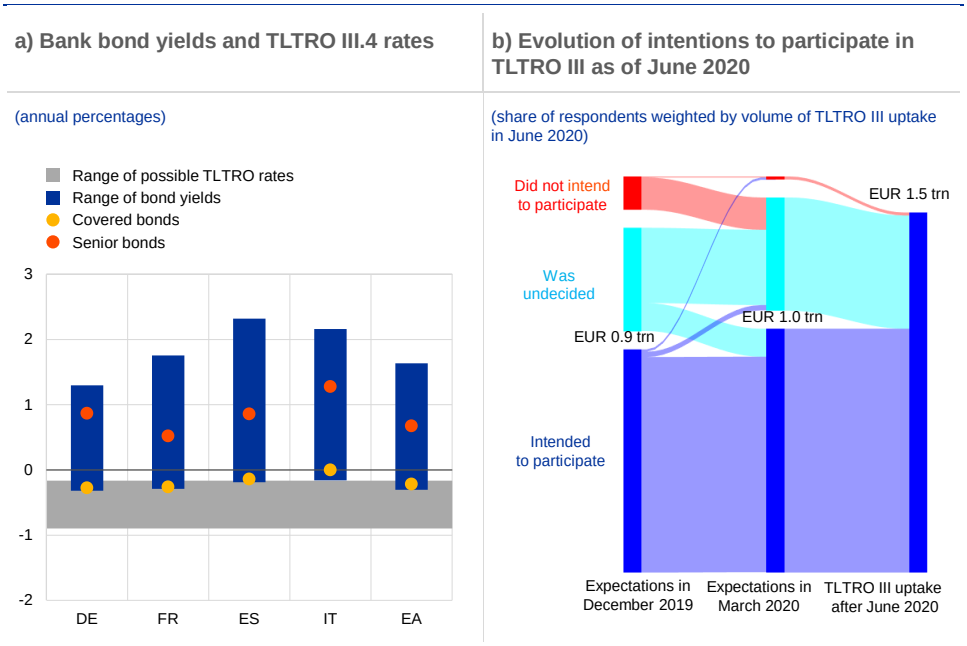
19 See Andreeva and Garcia-Posada (2019) and Rostagno et al. (2021b).

20 See Altavilla et al. (2020c). Kwapil and Rieder (2021) also provide evidence of an unambiguously positive effect on loan supply of TLTRO participation in Austria.

an impairment of private bond issuance nor in a deceleration of the pace at which banks have improved their capitalisation.[21]

Chart 8

TLTRO III pricing and participation



Sources: Panel a) – Markit iBoxx and ECB calculations; Panel b) – ECB, ECB's euro area bank lending survey (BLS).
Notes: Panel a) – TLTRO III.4 stands for the fourth in a series of ten operations during the third TLTRO programme. Bond yields are average yields on investment grade bonds in the week 15-19 June, with a maturity between one and five years. The range of bond yields covers the 5th to 95th percentile of bond yields for each jurisdiction. The minimum value in the range of possible TLTRO rates corresponds to a bank that reaches the lending threshold required to attain the minimum rate and uses the early repayment option. The maximum value in this range corresponds to a bank not reaching the (pandemic or modified) threshold and not repaying early; Panel b) – The blue bar on the right column measures the €1.5 trillion of participation in TLTRO III as of June 2020 (participation by BLS respondents exceeds €1 trillion, so figures have been scaled up accordingly to match the aggregate numbers reported in the chart). The three bars on the left column measure the eventual participation in the June operation by banks that, in December 2019 (January 2020 BLS), reported that they intended to participate (blue bar), were undecided (cyan bar) or did not intend to participate (red bar). The three bars on the central column measure the same participation in the June operation but based on responses given in March 2020 (April 2020 BLS). The shaded areas between the left and central columns measure transitions from one response to the other between survey waves. The latest observations are, for Panel a), for 15-19 June 2020, around the time of TLTRO III.4 bidding; and, for Panel b), for June 2020.

Euro area banks have consistently indicated a positive impact of the ECB's measures on bank lending in the euro area bank lending survey. According to the banks, the ECB's asset purchase programmes (the APP and the PEPP), the liquidity injection from the TLTROs and the low interest rate environment are all reported to have a positive impact on bank lending volumes. Additionally, a widespread easing of terms and conditions has been reported. The soft data was confirmed by ECB internal estimates based on a variety of models and has amounted to around 2 percentage points of additional loan growth each year since 2015.[22] According to a wide range of studies available in the literature, around half

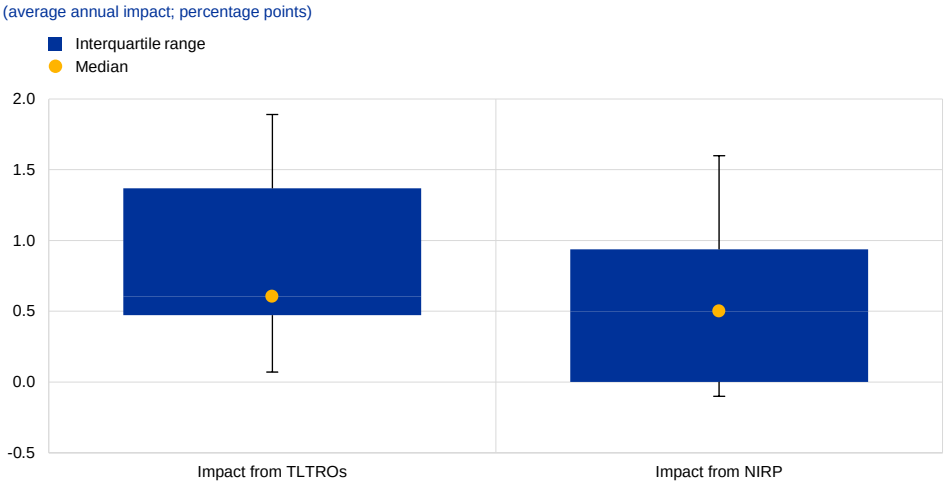
[21] The design of TLTROs also allowed for banks subject to a deleveraging process to continue consolidating their balance sheet without detriment to the terms and conditions offered by the operations, thus allowing for a smooth shedding of legacy assets from participants' balance sheets.

[22] See Adalid et al. (2020). Note, however, that Arce et al. (2021b) find that the announcement of the CSPP in March 2016 significantly raised (large) firms' propensity to issue CSPP-eligible bonds, with the flipside of a drop in the demand for bank loans from these firms. That said, this drop in demand for credit by bond issuers triggered a positive and significant side effect on the flow of new loans extended to firms that do not issue bonds. See Bartocci et al. (2021) for a macroeconomic assessment of this channel.

of that contribution was attributable directly to the TLTROs and the negative interest rate policy (Chart 9).

Chart 9

Meta-analysis of the impact of TLTROs and the negative interest rate policy on loan growth to non-financial corporations since the start of each policy measure



Sources: For the TLTROs, Afonso and Sousa-Leite (2019), Altavilla et al. (2020a), Altavilla et al. (2020b), Andreeva and García-Posada (2019), Arce et al. (2021b), Balfoussia and Gibson (2016), Bats and Hudepohl (2019), Benetton and Fantino (2018), Boeckx et al. (2020), Cravo Ferreira (2019), Esposito et al. (2020), Flanagan (2020), Gibson et al. (2020), Laine (2021), Blaes et al. (2019), Rostagno et al. (2021b) and van Dijk. and Dubovik (2018). For the negative interest rate policy, Altavilla et al. (2021a), Arce et al. (2021a), Boucinha and Burlon (2020), Bubeck et al. (2019), Bottero et al. (2019), Demiralp et al. (2021), Grandi and Guille (2021), Heider et al. (2019) and Tan (2019).
Notes: Chart displays the average annual impact of the TLTROs (left-hand scale) and the negative interest rate policy (right-hand scale) on loan growth to NFCs since the start of each policy measure. Estimates of each study are rescaled to take into account differences in data, samples and methodologies. The yellow bars report the median impact across studies, 18 percentage points for TLTROs and 9 percentage points for the deposit facility rate cuts. The dark blue areas correspond to the interquartile range and the whiskers represent the range between the 10th and 90th percentiles. The latest observation is for September 2020.

At the same time, the precise patterns of the resulting improvements in credit conditions have varied across different types of banks and/or across countries. Asset purchases have led to an active rebalancing of financial intermediaries' portfolios towards assets with higher expected returns, such as loans to households and firms, especially in countries where constraints on loan demand and supply were less significant. For banks with greater recourse to the first two series of TLTROs and tighter balance sheet constraints, the transmission has worked mainly via a reduction in lending rates.[23] For banks holding higher amounts of excess liquidity and facing significant demand for credit, the stimulus has resulted in an improvement in credit volumes, although large heterogeneity across banks surrounds these central tendencies.[24]

The pandemic has recently highlighted the role of attractive TLTROs and bridge facilities as a backstop against the escalation of funding tensions. The spike in wholesale funding strains and precautionary motives experienced in the first half of 2020 was partially reversed as the broad-based participation in the TLTROs

[23] See ECB (2017). See also Benetton and Fantino (2018) and Esposito et al. (2020), who provide evidence of a decrease in lending rates for Italian banks participating in TLTRO I and TLTRO II respectively.

[24] See Albertazzi, Becker and Boucinha (2020).

was made possible by the recalibrations of March and April 2020.[25] Moreover, the extraordinary level of uncertainty brought about by the pandemic has induced marked precautionary behaviour by both households and firms, leading to a large increase in retail and corporate deposits that contributed to containing overall bank funding costs. Without attractive and affordable terms and conditions, participation in the TLTROs would have been hampered by the potential stigma attached to banks relying on an otherwise unattractive operation in a situation of heightened financial tensions and uncertainty. Banks tapped the favourably priced TLTRO III and bridge facilities partly to cover their liquidity needs in response to a massive drawdown of credit by firms.[26]

2.3 Impact on real economic activity and efficiency

Beyond the impact on financial conditions, empirical analysis tends to support the conclusion that the package of measures has been effective in providing accommodation and in supporting the macroeconomic outlook in the euro area. Eurosystem staff estimates generally suggest that the average growth and inflation rate would have been markedly lower in the absence of these measures. Regarding the effectiveness of asset purchases, a host of academic and Eurosystem quantitative studies finds a distinctly positive impact on growth, with a median impact estimate (computed over all studies considered in the meta-analysis) of around 0.75 percentage points, cumulatively over a horizon of up to three years, when asset purchases are increased by 10 percentage points of GDP (Chart 10, panel a)). The median impact on inflation is at around 0.5 percentage points in cumulated terms.[27] Similarly, a forward guidance shock reducing the short-term forward rate one year ahead by 10 basis points tends to lift growth by between 0.1 and 0.2 percentage points, cumulatively, and inflation by a bit less (Chart 10, panel b)).

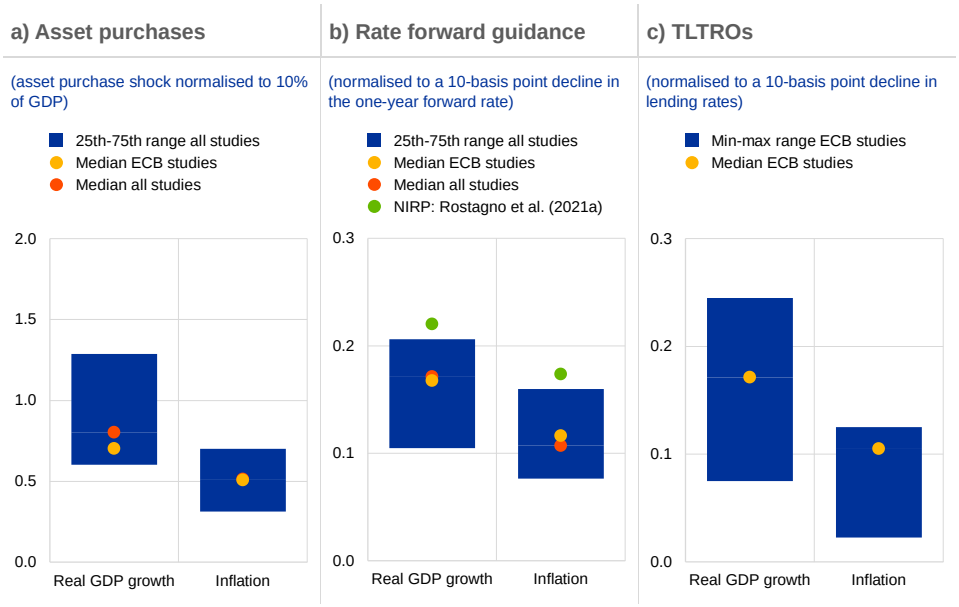
[25] See the July 2020 euro area bank lending survey. Altavilla, Barbiero, Boucinha and Burlon (2020c) show how the TLTROs act as a safeguard against upward pressures on funding costs.

[26] See Altavilla, Barbiero, Boucinha, Burlon (2020a) for a detailed account of the impact of TLTRO III on bank lending conditions during the pandemic.

[27] Several studies have singled out the macroeconomic stimulus provided via asset purchases; besides the references beneath Chart 10, panel a, see, e.g., Neri and Siviero (2019).

Chart 10

Estimated impact of the ECB's monetary policy measures on euro area inflation and growth: meta-analysis



Sources: Andrade et al. (2016), Burlon et al. (2015), Cova et al. (2019), Gambetti and Musso (2017), Gerke et al. (2018), Haldane et al. (2016), Hohberger et al. (2019), Kühl (2018), Mouabbi and Sahuc (2019), Nelimarkka and Kortela (2020), Pascual and Wieladek (2016), Sahuc (2016), Rostagno et al (2021a), ECB and ECB calculations.
Notes:
Panel a) The chart shows the median and 25th-75th interquartile range of estimates from a range of studies including those mentioned above, as well as the range of ECB estimates comprising the Eurosystem staff assessment based on a suite of structural and time series models, the extended New Area-Wide Model (NAWM-II), the ECB-BASE model and the assessment documented in Rostagno et al. (2021b). The estimate refers to the cumulative impact on euro area inflation and real GDP growth of an increase in the stock of asset purchases normalised to 10% of euro area GDP.
Panel b) The chart shows the median and 25th-75th range of estimates from the range of models developed by the Eurosystem FORE Taskforce (ECB Occasional Paper Series, 2021, forthcoming), comprising time series models and structural models, as well as the range of ECB staff estimates. The estimate refers to the cumulated impact on euro area inflation and real GDP growth of a forward guidance shock normalised to a 10-basis point decline in the one-year forward rate.
Panel c) The chart shows the median and minimum-maximum range of estimates from the range of ECB models, including the following six models: (1) Christiano, Motto and Rostagno (2010, 2014); (2) Altavilla at al. (2020b); (3) Darracq-Pariès and De Santis (2015); (4) a medium-scale Bayesian vector autoregression (BVAR) model for the euro area; (5) the NAWM-II; and (6) the ECB-BASE. The impact on inflation and real GDP growth refers to the cumulative impact over the simulation horizon.

For the TLTROs and the negative interest rate policy, a similarly broad-based synopsis regarding the macro impact is not feasible, as only a few estimates are available and they are often not fully comparable. However, there is broad-based evidence that the negative interest rate policy and the TLTROs had a distinct positive impact on loan growth. For example, Rostagno et al (2021a), based on a dense, controlled event study and using rate options to disentangle the effects of the negative interest rate policy and forward guidance, find that the impact on the far end of the yield curve and on the macro-economy of reductions in the policy rate to (more) negative levels has been stronger than similarly sized reductions in the policy rate in positive territory. The stronger yield effect has been associated with strong portfolio balancing as investors have sought to maintain positive nominal returns by lengthening the maturity of their fixed-income exposures. Furthermore, rate cuts in negative territory have triggered downward adjustments in the perceived lower bound. Coupled with forward guidance formulations hinting at the possibility of further rate reductions in the future, this effect has amplified the downward pressure

on interest rates along intermediate maturity segments of the yield curve.[28] At the same time, the impact of rate cuts in negative territory may diminish over time, especially to the extent that perceptions about the location of the lower bound stabilise and further cuts may bring the deposit facility rate progressively closer to the lower bound. As regards TLTROs, it is found that a TLTRO shock reducing the lending rate by 10 basis points tends to raise growth and inflation by around 0.2 and 0.1 percentage points respectively, according to the median impact across a range of ECB studies (Chart 10, panel c)).

As regards the overall effect, the subset of Eurosystem studies that the ECB regularly employs to inform its (broad) macroeconomic projection exercises suggests a discernible impact of the unconventional monetary policy measures on growth and inflation. By that score, the impact on the annual GDP growth rate of all unconventional policy measures taken since 2014 is estimated to be around 0.6 percentage points, on average, over the period 2015-20. Over the same period, the annual inflation rate would have been around 0.4 percentages points lower, on average, without the measures. Any econometric assessment of the impact of non-standard policy measures is subject to various margins of uncertainty, especially owing to the limited time series evidence that can be exploited to measure their effects with statistical precision. The range of (point) estimates emerging from Eurosystem studies shown in Chart 10 underscores this uncertainty.

At the same time, while years of unconventional policy recalibrations have been undeniably successful in stimulating growth and employment, inflation has remained persistently short of the ECB's policy aim. As for the apparent small effects on measured inflation, there are three potential explanations. First, there is evidence of an observationally flat Phillips curve (see work stream on inflation measurement (2021)), i.e. of a small measured sensitivity of price pressures to a reduction in economic slack. This reduced sensitivity, in turn, may simply reflect the fact that inflation typically does not rise sustainably in conditions – such as those prevailing for much of the period under observation – in which the amount of slack is not reabsorbed entirely. This mechanism indeed seems to have dampened the transmission of stimulus from the real economy to inflation formation, particularly as concerns the early (re)calibrations of the instruments. Second, non-monetary phenomena may have gone in the opposite direction to the monetary policy impulse to inflation. While persistent weakness in oil prices since 2012 can be mentioned as an important confounding factor generating persistent disinflation, and the tight fiscal stance since 2011 may have had the same effect, the euro exchange rate has at times also generated cross-currents affecting the transmission of monetary policy to prices. The announcement and early recalibrations of the ECB's unconventional measures have removed the risk of a break-up of the monetary union, which was still judged to be sizeable in 2014 and 2015, and this fostered an appreciation of the euro notwithstanding the decline in euro area interest rates, which has contributed to a persistent low inflation environment. Finally, inflation expectations have not remained insensitive to persistent negative shocks to measured inflation and have adjusted downwards over time, see Work stream on inflation measurement (2021). This

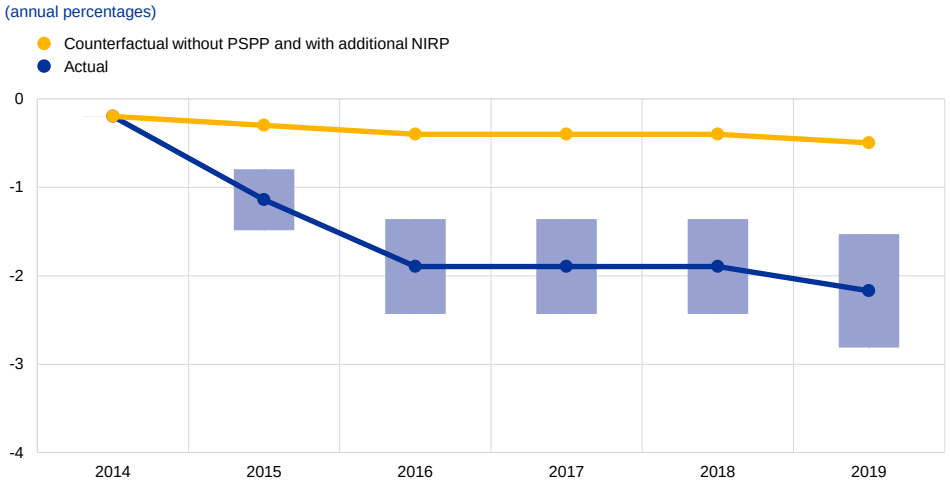
[28] On the latter dimension, see also the IMF paper by Agarwal and Kimball (2019) and the references therein.

phenomenon has been observed elsewhere, but it has been more pronounced in the euro area, possibly partly due to a perceived reluctance on the side of the ECB to embark on unconventional policy early in the post Great Financial Crisis phase and with sufficient conviction, see work stream on the price stability objective (2021). Overall, however, more analysis is needed to understand the drivers of inflation, both in the euro area and globally.

As for the efficiency of the specific instrument mix deployed in the past few years, counterfactual analysis suggests that the diversified set of measures taken since 2014 was superior to a policy response relying on a more restricted set of instruments. For instance, refraining from asset purchases would have necessitated cutting the deposit facility rate to levels testing its effective lower bound, with potentially more adverse side effects. Based on model-based counterfactual analysis, Chart 11 illustrates the extremely negative path of the deposit facility rate that would have delivered the same inflation impact in the absence of the PSPP. Conversely, abstaining from negative rate policy would have called for the Eurosystem to expand its asset portfolio far beyond the stock reached so far, entailing larger financial risks for the Eurosystem and a larger footprint on the affected markets.

Chart 11

Deposit facility rate: actual and no-APP counterfactual with additional negative interest rate policy



Source: ECB calculations.
Notes: The boxplot refers to a range of assessments, including the Eurosystem staff assessment based on a suite of structural and time series models, and the assessment documented in Rostagno et al. (2021b). The counterfactual without PSPP and with additional negative interest rate policy refers to a scenario in which the deposit facility rate path is adjusted so that the additional negative interest rate policy delivers the same impact on inflation as the PSPP.

2.4 Comparison with the international experience

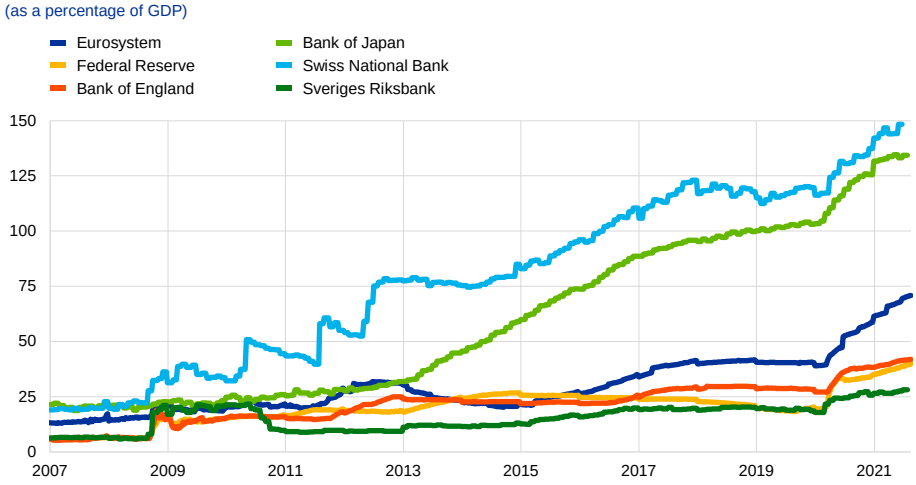
The ECB has adopted non-standard measures similar to those of other major central banks. Non-standard measures have been used in practically all advanced economies. While details have differed, the overall approach has been broadly the same. In particular, major central banks have undertaken large-scale asset

purchases, engaged in specific lending operations to provide liquidity support and/or to stimulate bank lending, and provided forward guidance. Differences mainly appear in central banks' assessments of the usefulness of negative interest rates. While the Bank of Japan, Sveriges Riksbank and the Swiss National Bank, along with the ECB (and the Danmarks Nationalbank), have implemented negative interest rates, the Federal Reserve System and the Bank of England have not resorted to this tool to date.

The balance sheets of all major central banks have increased significantly in size and associated risk since 2007, also as a reaction to the pandemic (Chart 12). As similar policy decisions have been taken at the effective lower bound on interest rates, balance sheet compositions and the challenges for risk management are now also more similar for major central banks today than they were in 2007, while credit operations with commercial banks continue to be most relevant for the Eurosystem with its bank-based financial structure.[29]

Chart 12

Central bank total assets in selected countries since 2007



Sources: ECB, Federal Reserve System, Bank of England, Bank of Japan, Swiss National Bank, Sveriges Riksbank, Eurostat and the Bank for International Settlements.
Notes: The Bank of England's balance sheet is approximated after 24 September 2014 since the institution only discloses 90% of its consolidated balance sheet after this date. The latest observations are for 25 September 2020 (ECB, Federal Reserve System and Bank of England), the end of August 2020 (Bank of Japan and Sveriges Riksbank) and the end of July 2020 (Swiss National Bank).

However, as a key distinguishing feature, the ECB's reliance on a broader counterparty and collateral framework allowed the Eurosystem to react flexibly to the banking-related part of the Great Financial Crisis and, more recently, enhanced the pandemic crisis response. Another distinctive feature is the timing and composition of asset purchases after the financial crisis. While the Federal Reserve System, for example, started its first wave of large-scale asset purchases in 2009 to decrease longer-term interest rates and provide further accommodation, the Eurosystem started outright monetary policy purchases on a relatively smaller scale in 2009 (focusing on private sector assets in its first covered bond purchase programme, CBPP1) and included government bonds more broadly only in 2015, as

[29] The Bank of Canada is an exception as it started its first-ever large scale asset purchases in 2020 in response to the COVID-19 crisis.

the prevailing degree of monetary accommodation was deemed insufficient to adequately address heightened risks of a too prolonged period of low inflation.[30]

[30] ECB government bond purchases under the Securities Market Programme (SMP) that started in May 2010 were of a different nature and had a different objective from the large-scale asset purchases of the Federal Reserve System and the sovereign bond purchases of the ECB under its APP (see the first footnote).

3 Analysis of side effects

The deployment of unconventional monetary policy measures can give rise to unintended side effects on financial markets, financial intermediaries and the real economy. Monetary policy instruments should be activated to the extent necessary and proportionate to achieving the central bank's statutory objective, i.e. potential negative side effects should be taken into account. Such side effects may vary over time and are likely to increase when unconventional monetary policy measures are used intensely over an extended period of time, despite the fact that the economy might adapt over time to a low interest rate world. Ideally, a quantitative framework should be used to jointly estimate the macroeconomic benefits of the new tools alongside their potential unintended effects. This would allow a fully consistent welfare analysis on the basis of which the positive impacts on employment and incomes could be measured against the potential costs in terms of decapitalisation of financial intermediaries and distortions in asset prices and other areas of economic life. In the absence of such a framework, the broad-based quantitative analysis of macroeconomic impacts has been complemented with a more eclectic and sectoral analysis of areas of vulnerability.[31] This section takes the latter approach. It starts with an assessment of the potential side effects on the functioning of financial markets, market valuation and financial risks. The analysis then moves to the transmission of monetary measures through financial intermediaries – focusing on both bank and non-bank intermediation – before covering potential unintended effects of the measures on the real economy – in particular on non-financial corporations and households.[32]

3.1 Functioning of financial markets

Since the start of the asset purchase programme (APP), Eurosystem asset purchases have constituted a sizeable share of secondary trading activity and led to a noticeable increase in holdings relative to the euro area government bond market (Chart 13). The Eurosystem accounts for between 5% and 20% of secondary market turnover in government bonds, broadly varying in line with the pace of purchases and falling below 5% only during the public sector purchase programme (PSPP) reinvestment phase before the start of purchases under the pandemic emergency purchase programme (PEPP). With the start of the PEPP, the share has increased and stabilised around 20%, at levels also seen in May 2016. At the end of 2020, the Eurosystem held around 30% of outstanding public sector bonds, compared with 22.5% of US Treasury securities held by the Federal Reserve System, 35% of UK Government securities held by the Bank of England and 46% of

31 Specifically, and unlike assessments of the macroeconomic effects of monetary policy, quantifications of side effects mostly originate from micro-econometric studies that typically allow for more robust identification approaches often at the cost of neglecting broader general equilibrium effects.

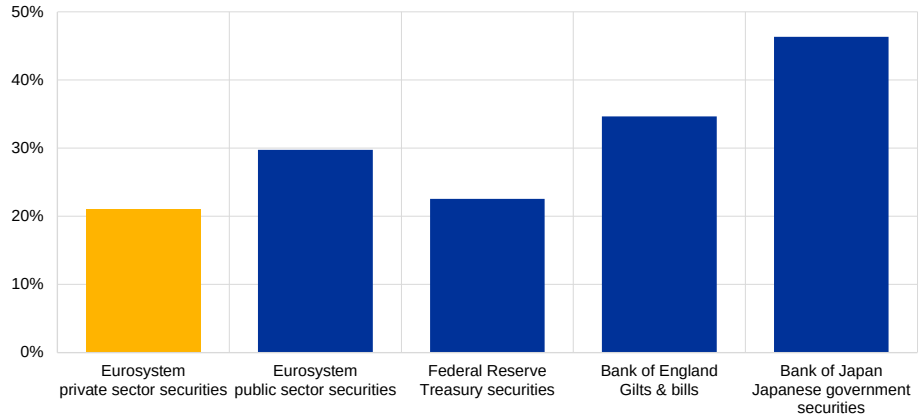
32 This paper does not cover potential side effects related to the impact of monetary policy measures on fiscal policy and in particular fiscal discipline, see work stream on monetary-fiscal policy interactions (2021) for further details.

Japanese Government securities held by the Bank of Japan.[33] The Eurosystem share in turnover is higher in narrower market segments, such as securities issued by EU supranational institutions, covered bonds and asset-backed securities. In the case of the corporate sector purchase programme (CSPP), some market participants voiced concerns about the potential crowding out of other investors. While it is difficult to dismiss this concern altogether, the market share of the CSPP in the eligible segments has remained relatively unchanged since the launch of the programme.

Chart 13

Central bank holdings of securities

(percentages of amounts outstanding, nominal)



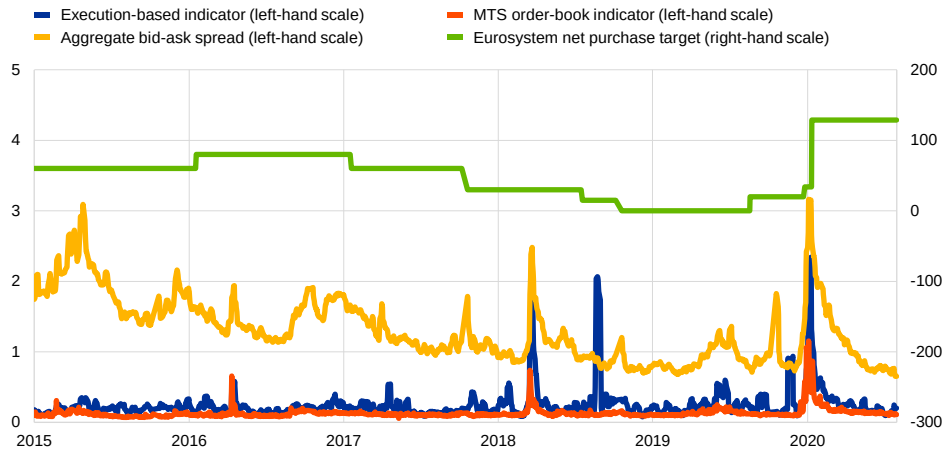
Sources: Bank of Japan, Bank of England, Board of Governors of the Federal Reserve System, ECB, Japanese Ministry of Finance, HM Treasury, US Treasury, Bloomberg and ECB calculations.
Notes: The securities considered include inflation-linked securities, which may not be eligible for purchase under the central bank's asset purchase programmes. The latest observation is for December 2020 or as available.

Despite an increased footprint, the Eurosystem purchase programmes are found to have a rather limited effect on bond market functioning under normal market conditions, while having been conducive to market functioning in times of market stress. This is illustrated by a wide range of indicators regularly monitored by the Eurosystem (Chart 14). There is no evidence of a systematic negative impact on government bond market functioning, as the spikes in bond market liquidity measures – signalling lower liquidity – are not observed around recalibrations of the APP but rather around political and economic events, such as the UK referendum on EU membership, the formation of the Italian government in May 2018 and the outbreak of the coronavirus in Europe. Aggregate bid-ask spreads for sovereign bonds have not pointed to a deterioration in market liquidity since the start of the APP in 2015.

[33] The universe of securities considered includes nominal and inflation-linked bonds, as well as bills.

Chart 14

Euro area sovereign bond market liquidity measures and pace of purchases



Sources: Reuters, EuroMTS and ECB calculations.
Notes: An increase (decrease) in the indicators implies a deterioration (improvement) in the liquidity situation. The MTS order book indicator is calculated for the second most recently issued ten-year sovereign bond by subtracting the sum of the five best quotes on the ask side of the order book from the same sum on the bid side, and dividing by the sum of the quoted ask and bid volume. The indicator is calculated for each country and then weighted by the national GDP to obtain a euro area aggregate indicator. The execution-based indicator uses price information for transactions under the PSPP and in public sector securities under PEPP. For a given bond transaction, this indicator is defined as the spread between the two best price quotes, divided by the duration of the bond. Only quotes that result in transactions are considered. A euro area-wide indicator is calculated as a volume-weighted average across all traded sovereign bonds. Green line: refers to monthly averages: total announced envelop of APP and PEPP divided by number of months for which the envelop has been announced.

Eurosystem asset purchases have not hampered bond market liquidity under normal market conditions. A sharp decrease in the depth of the German government bond market, as measured by the number of Bund futures contracts, at the start of the APP at the beginning of 2015 triggered some concerns about "collapsing market liquidity" due to the Eurosystem's asset purchases.[34] However, the decline reversed in the course of 2015 and, according to the same metric, market depth in German government bond markets has not declined systematically over the period of APP and PEPP purchases. Over time, assertions by financial market participants concerning potential adverse impacts of asset purchases on bond market liquidity or the crowding out of other investors have become less frequent with the experience of a central bank buying "alongside the market". In part, this result is due to careful purchase implementation, which aims to minimise the likelihood of market distortions.

Academic studies, ECB analysis and market intelligence have investigated the potential impact of asset purchases on sovereign bond market functioning with mixed results. Schlepper et al. (2020), for example, examine whether Bundesbank purchases may have had an unfavourable impact on the broader market functioning of German government bonds. The authors hypothesise that the presence of a large unidirectional buyer can impact relative bid-ask spreads and order book depth by exhausting dealers' capacity to bear risk. The results reported indicate that liquidity deteriorated up to late 2016, with larger effects in the case of

[34] Some observers conjecture that these liquidity effects may help to explain the "Bund tantrum" that started at the end of April 2015, i.e. just after the first APP purchases. German ten-year sovereign bond yields increased by 82 basis points (from 0.16% to 0.98%) within a six-week period.

bonds purchased by the Bundesbank.[35] At the same time, other studies, such as Jurkšas et al. (2018), analyse a range of euro area sovereign bond market liquidity metrics for the period between the start of PSPP purchases and early 2018, focusing on the dimensions of cost and depth. The analysis suggests that the liquidity situation in euro area sovereign bond markets did not deteriorate over this horizon, despite the build-up of PSPP holdings. In the same vein, gauging the impact of the Eurosystem's purchases on the relative bid-ask spread computed using quoted prices of sovereign bonds issued by the German government[36] suggests no systematic impact of purchases on bond market liquidity conditions.[37] On balance, available evidence suggests no material impact of asset purchases on market functioning across comparatively deep and liquid sovereign bond markets. However, in some smaller sovereign bond market segments, actual as well as expected Eurosystem bond purchases have at times lowered liquidity.

The integrity of price formation in euro area sovereign bond markets has largely been preserved. Market participants' perception of prices may have been conditioned by expectations concerning the Eurosystem's presence as a large buyer. At the same time, the ECB's measures appear not to have detached developments in sovereign and investment grade corporate bond spreads from changes in fundamentals or significantly hampered market discipline. This is evidenced, inter alia, by the fact that euro area sovereign bond spreads remained sensitive to macroeconomic surprises and changes in financial risk. In fact, those sensitivities have been much higher since the introduction of the ECB's asset purchase programmes than they were before the Great Financial Crisis (Chart 15). Beyond episodes of severe stress, changes in macroeconomic fundamentals and perceived debt sustainability remain the most important explanatory factors of changes in euro area spreads.

35 Larger effects are found during episodes of illiquidity and when yields are higher. Similarly, for the United States, Kandrac (2018) finds that asset purchases may impact trading volumes, trade sizes and the number of mortgage-backed security trades, while price formation was found not to have been impaired.

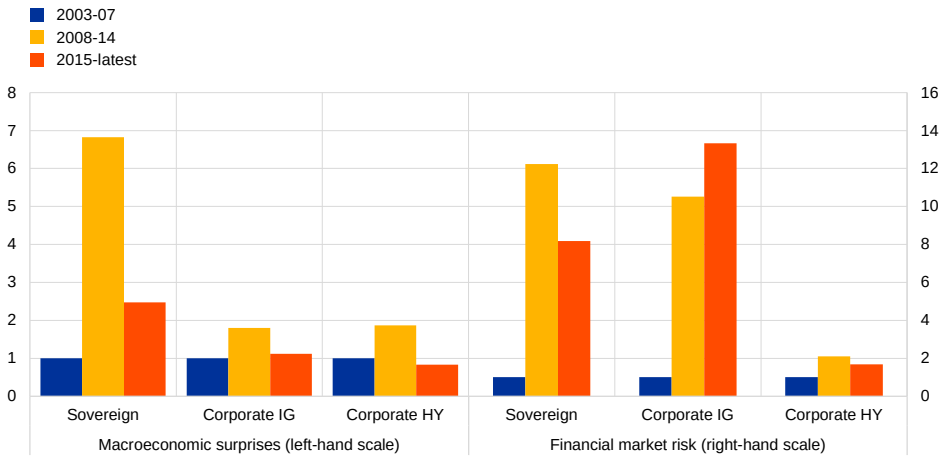
36 Similar results are obtained when bond market liquidity is computed using the daily difference between high and low traded prices, divided by the traded mid-price. See Corwin and Schultz (2012); and Abdi and Ranaldo (2017). Ordinary least square panel regressions at the country level are carried out on a month-window for the entire period of the programme. The dependent variable is daily changes of the bond market liquidity measure at the bond level with the main explanatory variable being: 1) a dummy variable taking the value of 1 if a specific bond is purchased on a given day under the PSPP and PEPP; or 2) the daily bond purchase volume implemented under the PSPP and PEPP. The explanatory variables are lagged at one day.

37 The results are broadly consistent with Schlepper and al. (2020), who show that the adverse impact of Bundesbank purchases on German government bond market liquidity conditions varies greatly with market conditions: it is considerably higher during episodes of illiquidity and when sovereign yields are higher. Further research hints towards a neutral or even positive impact of asset purchases on secondary market liquidity. Han and Seneviratne (2018) find no impact of non-standard monetary policy on liquidity in the euro area or Japan. Studies finding a positive impact of central bank asset purchases and bond market liquidity include Steeley (2015) in the case of the United Kingdom, Iwatsubo and Taishi (2016), and Christensen and Gillan (2017). Finally, Babbel et al. (2004), D'Amico and King (2013), and Kandrac and Schlusche (2013) all discuss market functioning, with no major effects from central bank purchases being pointed out.

Chart 15

Sensitivity of euro area sovereign and corporate spreads to risk factors

(sum of regression coefficients, regression coefficient)

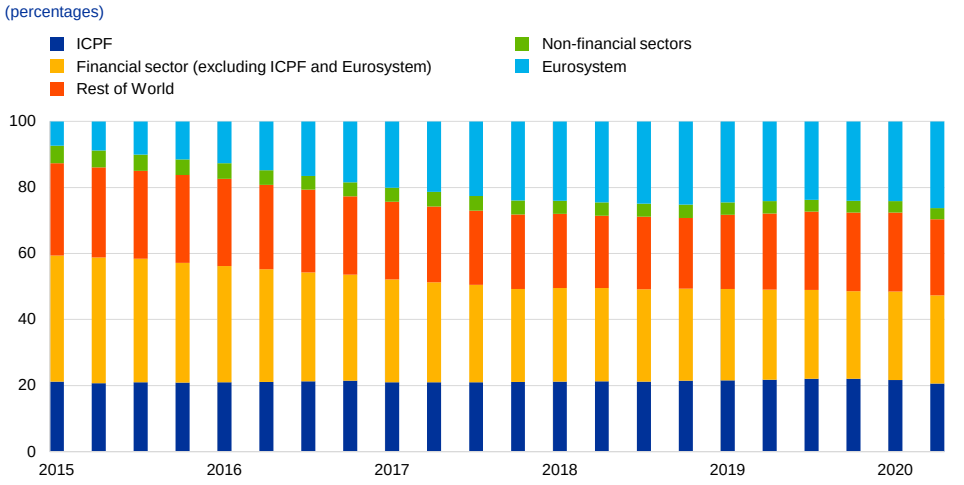


Sources: Bloomberg, Refinitiv and ECB calculations.
Notes: Sensitivity is defined as the (sum of) absolute values of estimated coefficients, where coefficients result from univariate regressions, spanning the indicated time period of daily changes in the ten-year euro area GDP-weighted sovereign spread over the ten-year overnight index swap (OIS) rate on euro area macroeconomic surprises or on a financial risk indicator. Macroeconomic surprises are standardised deviations of the median of analysts' forecasts from actual release values, collected by Bloomberg surveys. Financial market risk is proxied by the daily changes in the VSTOXX. The latest observation is for September 2020.

In addition, Eurosystem purchases had a bearing on the investor composition and overall market structure. Boermans and Keshkov (2018) find that the ownership concentration of eligible sovereign bonds increased relative to a control group during the life of the PSPP, potentially due to asymmetric portfolio rebalancing effects. They conclude that purchases had negative effects on the investor base and thereby potentially increased the fragility of the financial system. At the same time, Koijen et al. (2017) study the concentration of duration risk and sovereign credit risk among investors, induced by the PSPP. With the exception of certain limited types of investor, the authors do not find a clear concentration pattern in any particular sectors, suggesting that the consequences in terms of financial stability appear limited. At the same time, the composition of holders of euro area bonds has been altered, as Eurosystem holdings have replaced holdings of price sensitive investors. This development is illustrated by the reduction in financial sector and rest-of-the-world holdings of euro area government bonds (Chart 16).

Chart 16

Holders of euro area government bonds



Source: ECB calculations.

In times of market stress, as in March 2020, the Eurosystem's asset purchases had a clear stabilising impact and were conducive to market functioning. The deterioration in market liquidity observed in mid-March 2020 was one motivation for the launch of the PEPP and the related purchases contributed to a significant improvement. Analysis of yield reactions to asset purchases tends to confirm the notion that, under conditions of market distress, policy measures that absorb risk otherwise borne by investors tend to be more effective in compressing risk premia. The difference may also reflect that the PEPP averted an escalation of tail risks associated with pro-cyclical financial amplification mechanisms.

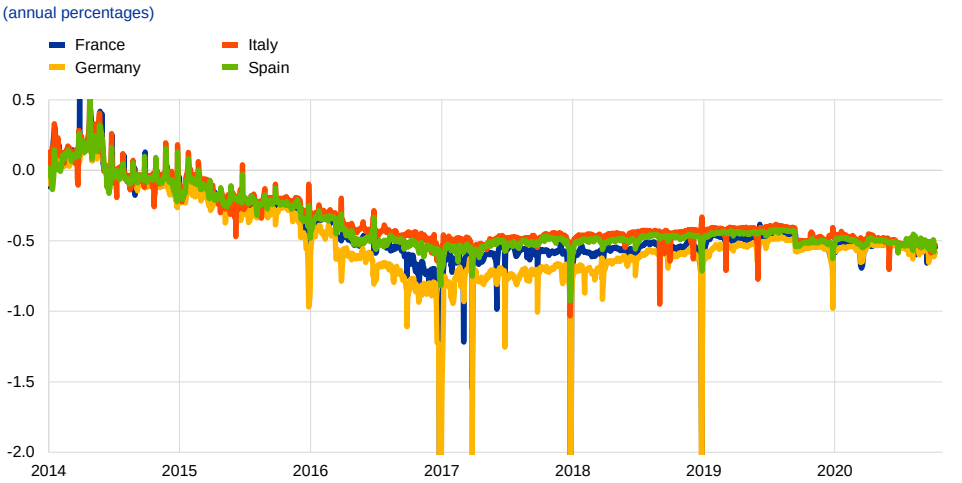
As regards euro area corporate bond markets, ECB staff analysis suggests that liquidity and broader market functioning has been resilient to the conduct of the CSPP. In fact, the examination of the price impact across trades conducted under the CSPP on secondary markets shows that even the largest trades did not have a material short-term impact on the market pricing of traded bonds. For fostering issuance, a potential decoupling of primary and secondary market activity did not occur despite sizeable private sector purchases. More generally, the stimulus to both primary and secondary markets may have contributed to accelerating the deepening of capital markets in the euro area.

Euro area repo markets have been affected by temporary collateral scarcity. Eurosystem asset purchases have effectively withdrawn securities that would otherwise have been used as collateral in repo transactions. This has at times led repo rates for safe forms of collateral, in particular German government bonds, to fall significantly below general collateral repo rates and the deposit facility rate. Moreover, the dispersion of repo rates has increased (Chart 17). This phenomenon, which could have disrupted the intermediation capacity of repo markets, has been mitigated by the deployment of Eurosystem securities lending facilities and, in particular, by accepting, as of 8 December 2016, cash as collateral in securities lending. In addition, the market has adapted with additional securities lending by

issuers and institutional investors and increased operational capacity to manage regulatory compliance, e.g. by netting repo trades. Repo rates against the collateral of various euro area government bonds have converged significantly since 2017 and quarter-end spikes have declined.[38]

Chart 17

Non-general collateral repo rates by collateral jurisdiction



Sources: BrokerTec and MTS.
Notes: Daily volume-weighted average repo transaction rate for overnight, tomorrow-next day and spot next maturities. The latest observation is for 12 October 2020.

The prolonged period of excess liquidity has heightened concerns about money market functioning and price discovery, while changing the structure of the repo market from a cash funding market to a market for sourcing collateral. Large amounts of excess liquidity injected into the banking system through the Eurosystem's asset purchases and credit operations have reduced banks' needs to raise funds in money markets. Therefore, volumes in interbank unsecured money markets and cash borrowing against general collateral in repo markets have declined with increasing amounts of excess liquidity since 2008 (Chart 18). At the same time, unsecured lending by banks has not only been declining due to excess liquidity but also to new regulation and banks' risk management considerations. The decline in cash-driven trading among banks may raise concerns in terms of money market functioning and challenge price discovery in that market segment.

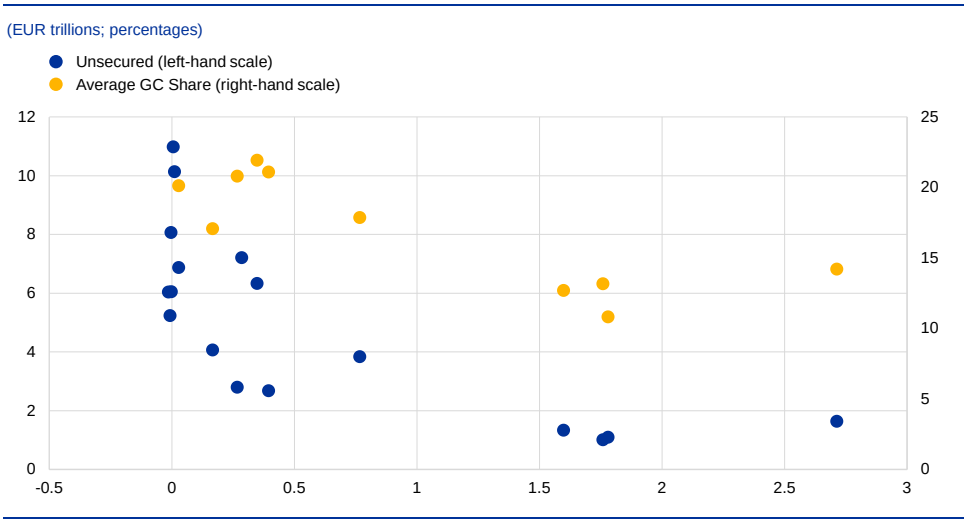
Money market lending activity has been dominated by non-bank financial institutions. As these "non-banks" lack access to the Eurosystem's deposit facility, they have deposited funds with banks that have access to the facility. This is evidenced by deposit shares in the unsecured money market segment, which shows that deposits are dominated by entities with no access to the facility (Chart 19). In the secured segment, a similar picture can be found for the non-cleared repo market, with non-banks making up the lion's share in that segment. While large volumes in the cleared repo segment are mainly interbank transactions, this activity may also reflect non-bank client orders.

[38] See, for example, Corradin, Eisenschmidt, Hoerova, Linzert, Schepens and Sigaux (2020).

The dominant share of non-bank trading in the money market has kept money market rates low and stable but has made them possibly less informative. Banks have had little need to tap the money market, as they have been flush with reserves. At the same time, increasing their balance sheet has implied possible regulatory cost, especially around quarter ends, such as leverage ratio-related costs, deposit insurance fees and other bank levies. Therefore, banks have tended to accept deposits from non-banks only with a premium, which has led overall market rates (notably the euro short-term rate, €STR) to trade at levels below the deposit facility rate. In addition, the trading volume behind benchmark rates such as the euro overnight index average (EONIA) and euro interbank offered rate (EURIBOR) have declined to very low levels casting doubt on the representativeness of market rates based on this very limited interbank activity. This is why these benchmark rates have been either replaced (EONIA with €STR) or reformed (hybrid EURIBOR) and their scope widened beyond the interbank sector to include borrowing from other financial corporations.

Chart 18

Excess liquidity reduces unsecured money market and general collateral repo market activity among banks

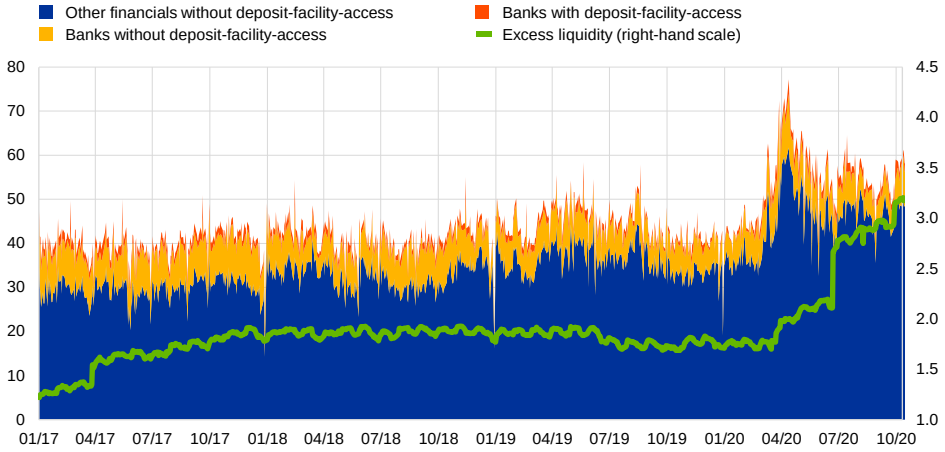


Sources: MMSR, EMMS, BrokerTec, MTS and ECB.
Notes: The x-axis shows the quarterly euro excess liquidity for every second quarter from 2003 to 2020. The y-axis shows the total quarterly unsecured transaction amount of 38 banks for every second quarter from 2003 to 2020 (left-hand scale) and the quarterly average share of general collateral trades in total repo volume (right-hand scale) for every second quarter from 2010 to 2020. The latest observation is for the second quarter of 2020.

Chart 19

Unsecured wholesale: deposit borrowing of banks per counterparty deposit facility access

(EUR billions, left-hand scale; EUR trillions, right-hand scale)



Sources: MMSR and ECB.
Notes: Shown is borrowing activity of MMSR reporting banks via deposits from financial counterparties at all maturities. The latest observation is for 31 October 2020.

3.2 Eurosystem balance sheet

The instrument mix deployed by the Eurosystem over the past few years has resulted in the largest Eurosystem balance sheet so far, and a commensurate amount of risk taken from the market.[39] The ECB's Governing Council considers this balance sheet expansion proportionate to address the monetary policy challenges faced in recent years given the information available, but the possibility of central banks incurring losses needs to be recognised. At the same time, as the balance sheet expands and additional risk is taken, monetary income also has the potential to increase, allowing a gradual build-up of financial buffers to cover financial risks.

The financial risks taken by the Eurosystem depend on the instrument mix it deploys. Chart 20 shows the mix of monetary policy operations since 2007. In the case of traditional collateralised lending operations, the Eurosystem is only indirectly exposed to the residual risks of the collateral it accepts.[40] In the case of asset purchases, the Eurosystem is, by contrast, directly exposed to the risks of the purchased assets. As a case in point, with its purchases of corporate bonds, the Eurosystem has taken on more idiosyncratic credit risk, which is mitigated through

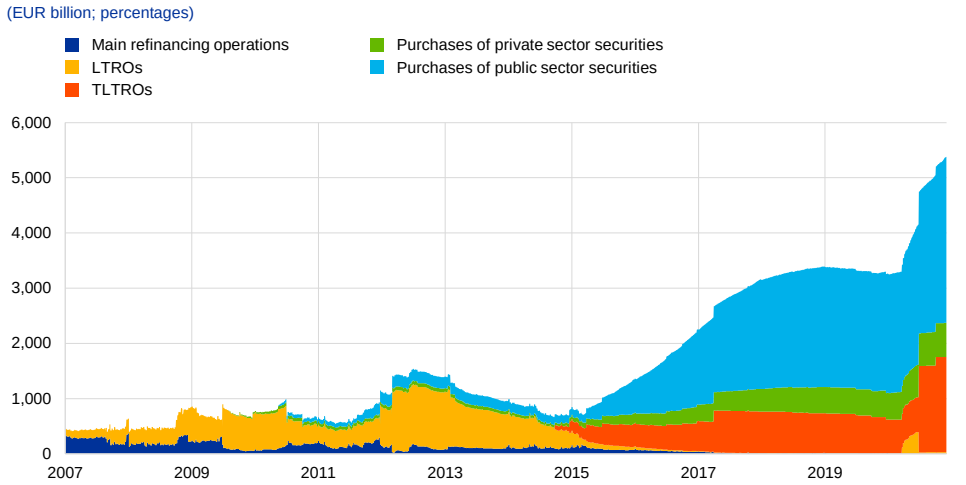
[39] Ex ante the – positive or negative – "spillover" risk effects of monetary policy measures on other parts of a central bank's balance sheet (i.e. risk endogeneity) are difficult to assess in terms of their depth and relative weight compared with exogenous factors. In 2020, the ECB's policy actions appear to have prevented a pro-cyclical general downgrading of euro area sovereigns and many private sector assets by credit rating agencies.

[40] The exposure is not direct, as it needs to be triggered by the default of a counterparty. The risk is residual, as it is mitigated by daily valuation and haircuts, which address risks incurred during the collateral liquidation process, catering for differences in liquidity, market and credit risk.

appropriate risk management measures, including limits that ensure diversification.[41] At the same time, the longer duration and higher credit risk of the outright monetary policy portfolios have led to profits that significantly exceed the normal "seigniorage income" from credit operations conducted at the main refinancing rate.

Chart 20

Selected monetary policy operations



Source: ECB.
Note: The latest observation is for 30 November 2020.

Overall, the Eurosystem aims to achieve the Governing Council's monetary policy objectives while only exposing itself to the level and type of financial risk that are proportionate to meeting those objectives. The risks for the Eurosystem balance sheet are thus considered a potential side effect of its monetary policy actions, which the Eurosystem manages considering its policy objectives, rather than optimising a financial risk-return trade-off like private investors.

3.3 Market valuation

Despite the observed compression in yields, evidence of overvaluation in the euro area investment grade corporate bond market has so far not been apparent, given the significant monetary policy and fiscal support, in contrast to stretched valuations observed in the smaller high-yield market segment. The excess bond premium for euro area investment-grade corporates, which captures the risk compensation in excess of the one implied by ratings and the expected default of issuers, does not signal systematic overvaluation during the period 2014-19. Except for a short spell in 2018, the excess bond premium has fluctuated close to zero, well above the pre-financial crisis levels that pointed to market exuberance. At the same time, corporate bond spreads have remained more compressed than during episodes of similar macroeconomic conditions in the past,

41 In calculating the commercial paper limits that apply for individual issuers, factors such as the issuer's total outstanding amount of eligible commercial papers and the overall size of its commercial paper programme are taken into account.

largely reflecting unprecedented fiscal and monetary policy support. Low yield and spread levels have encouraged corporate sector leverage. In the high-yield euro area corporate bond segment, which is not part of Eurosystem asset purchases, valuations appear stretched.

Euro area equity does not, on average, show clear signs of overvaluation at the current juncture. For instance, accounting-based valuation metrics for equity in the euro area have only seen a moderate increase since 2014 – in stark contrast to developments observed in the United States – and several such metrics, including the cyclically adjusted price-to-earnings (Shiller P/E) ratio, suggest that overall euro area equity valuations are currently only slightly above historical averages, while market valuations of banks remain at low levels. As regards the impact of the ECB's monetary policy on euro area equity prices, the evidence is mixed: some analysis stresses that monetary policy affects stock prices mainly via improvements in firms' earnings outlooks and discount rates, while attributing a minor role to changes in the equity risk premium[42]; others stress that QE coincided with exuberant investor behaviour in European equity markets[43].

Annual house price growth has been on the rise in the euro area since 2014, with house prices having risen above fundamentals in some parts of the single currency area (Chart 21a). More recently, annual house price growth climbed from negative rates at the start of 2014 to around 4.5% in 2016, remaining around that level until the first half of 2020. Based on a valuation model that benchmarks observed property prices against "fundamental factors", euro area house prices have risen above fundamentals in recent years but with substantial dispersion across countries and across areas within countries. Property markets in some countries show signs of overvaluation in general, with real estate prices in some metropolitan areas being stretched relative to historical valuation metrics. That said, the heterogeneity in real estate vulnerabilities across countries and regions shows that other factors besides monetary policy have also been at play in recent years, notwithstanding that low mortgage rates have certainly been an enabling condition.

Against the backdrop of a rising property market, banks in the majority of the euro area countries ramped up loan-to-value and loan-to-income ratios for residential real estate loans between 2016 and 2018 (Chart 21b). Given the size of banks' residential real estate portfolios and the risk of property market corrections, this development has certainly increased the risk that a property market correction might bring about losses for lenders.

42 See Kapp and Kristiansen (2021).

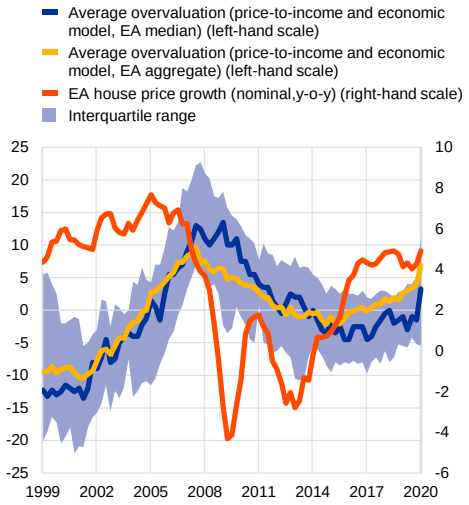
43 See Hudepohl,van Lamoen and de Vette (2021).

Chart 21

Real-estate markets

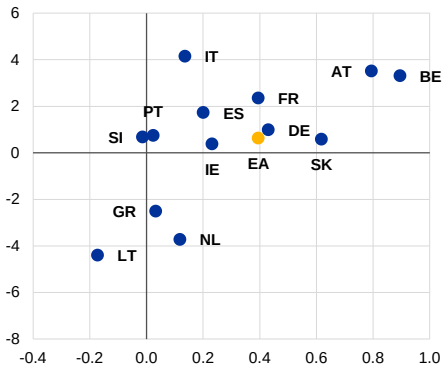
a) House prices and valuation estimates

(percentages; annual percentage changes)



b) Change in loan-to-value and loan-to-income ratios for residential real estate loans

(y-axis: change in loan-to-value ratio; x-axis: change in loan-to-income ratio; percentage points)



Sources: Panel a) – Eurostat and ECB calculations; panel b) – 2019 SSM credit underwriting data collection exercise and Lang et al. (2020).
Notes: Panel a) – the average overvaluation is calculated from price-to-income ratios and an econometric model. The econometric model includes real disposable income per household, real mortgage rates and real housing capital stock. The euro area value is obtained as an aggregation of country estimates. The latest observation for panel a) is for the first quarter of 2020.

3.4 Bank and non-bank intermediation

Lower interest rates and non-standard monetary policy easing measures have the potential to weaken the financial position of banks by compressing net interest margins. Forward guidance, negative interest rates, and asset purchases have compressed interest rates at longer maturities more strongly than at shorter maturities. The resultant decline in the difference between long and short-term rates has reduced the margin that banks can earn from maturity transformation. More importantly, banks have been reluctant to charge negative rates on retail deposits, most notably those held by households, and this downward rigidity has also led to a compression in net interest margins, especially at lower levels of interest rates. These two effects are widely documented in the literature.[44] Moreover, the negative interest rate policy, together with the liquidity injected by the TLTROs and asset

[44] See e.g. Alessandri and Nelson (2015), Kerbl and Sigmund (2016), Borio et al. (2017), Klein (2020) and Freriks and Kakes (2021).

purchases, has led to a direct cost for banks due to the charge on their holdings of excess liquidity, although this is contained by the two-tier system.[45]

Considering the balance of positive and negative impacts, the profitability of euro area banks has not been adversely affected by the ECB's monetary policy easing measures. A comprehensive analysis of banks' business operations in times of unconventional policies reveals that, while monetary policy easing has contributed to a reduction in banks' net interest margins, the resulting negative impact on bank profitability has been offset by the positive effect of monetary policy on the reduction of credit risk and the expansion of lending volumes. The downward rigidity of interest rates for retail deposits seems particularly binding for household deposits. At the same time, banks have increasingly been able and willing to apply negative rates on clients' deposits, not exclusively but most notably on corporate deposits. Close to 36% of deposits by firms carried rates below zero in the euro area as of June 2021. Anecdotal evidence suggests that negative remuneration mainly applies to larger deposits, often above an exemption threshold. Evidence shows that the pass-through of negative rates to deposit rates became stronger as policy rates moved deeper into negative territory.[46] Moreover, the application of negative rates has continued to widen in scope, with more than 25% of the distribution of new corporate deposits steadily below 0%, and an increasing share of banks with rates at or below -20 basis points (Chart 22). An increasing pass-through of negative rates to retail deposits could reduce the downward pressure on net interest margins, although the cushion is only partial, since much of the margin compression is due to the ongoing repricing of assets, as outstanding bonds and loans receiving higher returns mature and are replaced by lower coupon and low rate exposures. Several studies have indeed found that negative rates lowered loan rates and stimulated credit growth.[47]

There is however an ongoing debate over the extent of the transmission of negative rates. Most papers find that negative rates continue to be passed through to deposit rates when policy rates are negative,[48] although some other studies point to a significant in the pass-through.[49] However, the transition of deposit rates into negative territory observed so far indicates some substantial sluggishness. Furthermore, owing to some degree of substitutability between cash and bank deposits, the room for banks to reduce deposit rates to more negative levels is limited by the existence of a "lower bound" type of threshold at which the cost for the

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45 The two-tier system of reserve remuneration was introduced on 30 October 2019. It exempts part of credit institutions' excess liquidity holdings (i.e. reserve holdings in excess of minimum reserve requirements) from negative remuneration at the rate applicable on the deposit facility. The two-tier system, therefore, aims to support the bank-based transmission of monetary policy, while preserving the positive contribution of negative rates to the accommodative stance of monetary policy and to the continued sustained convergence of inflation to the ECB's aim (see the ECB's press release entitled "ECB introduces two-tier system for remunerating excess liquidity holdings" of 12 September 2019 for details).

46 See Altavilla, C., Burlon, L., Giannetti, M. and Holton, S. (2021).

47 For a survey of the early experience with negative rates in Europe and Japan, see also Lilley and Rogoff (2020).

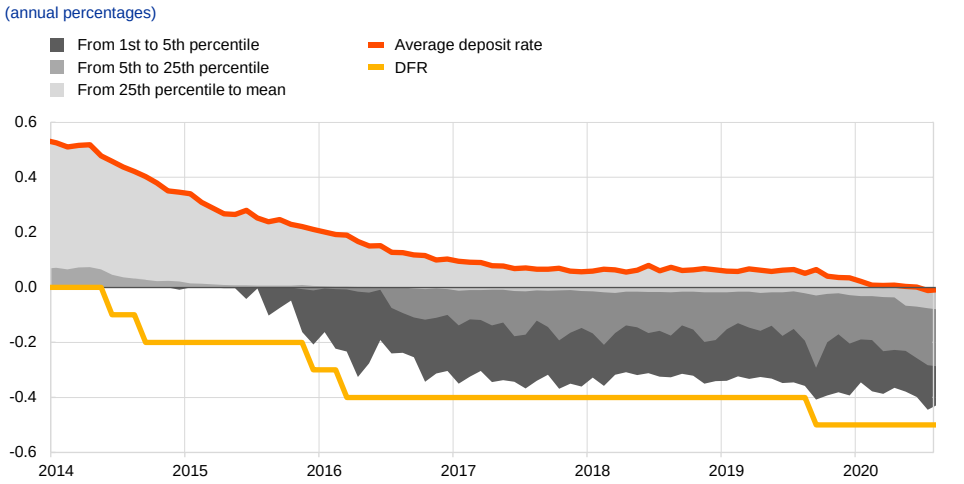
48 See Ulate, M. (2021), Demiralp, S., Eisenschmidt, J. and Vlassopoulos (2021), Altavilla, C., Burlon, L., Giannetti, M. and Holton, S. (2021a), de Groot, O. and Haas, A. (2020), Bottero, M., Minoiu, C., Peydró, J.-L., Polo, A., Presbitero, A. and Sette, E. (2019), Krogstrup, S., Kuchler, A., and Spange, M. (2020), Klein, M. (2020) and Altavilla, C. Canova F. and Ciccarelli M. (2020b).

49 See Eggertsson, G.B., Juelsrud, R.E., Summers, L.H., and Wold, E.G. (2019), Heider, F., Saidi, F., and Schepens, G. (2019) and Bittner, C., Bonfim, D., Heider, F., Saidi, F., Schepens, G. and Soares, C. (2020).

money-holding sector of holding deposits would exceed the cost of storage of physical cash and the value of the transaction services provided by electronic deposits, driving depositors to convert their deposit balances into currency. That said, there is no evidence that such a threshold rate has been reached, as no significant outflows of deposits have been observed generally or specifically for banks charging negative rates. At the same time, the unconventional monetary policies deployed by the ECB have exerted a positive effect on banks' bottom lines through various general equilibrium channels, by reducing the amount of non-performing assets on banks' balance sheets and fostering a stronger demand for loans that would have been observed in different conditions.

Chart 22

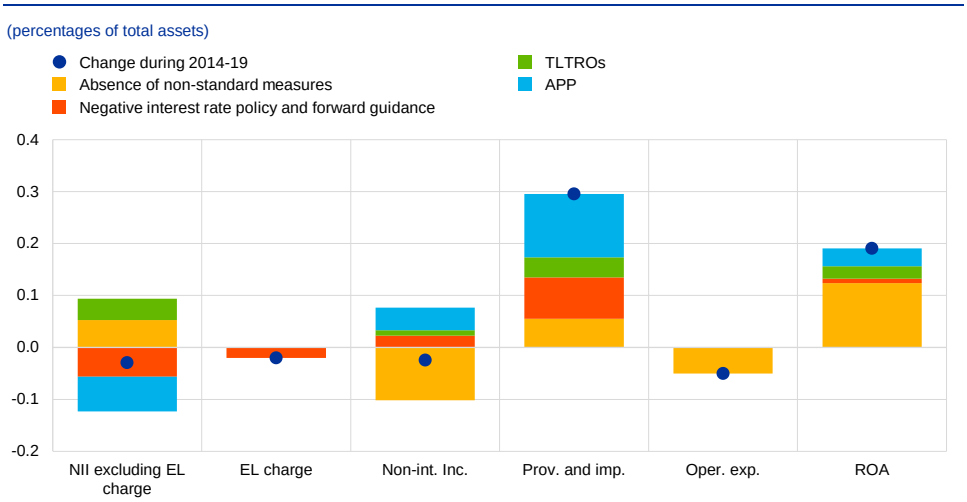
Evolution of deposit rates for non-financial corporations



Sources: ECB and ECB calculations.
Notes: The red line is a composite indicator of the average deposit rate on new deposits. This indicator is computed by taking the weighted average of deposit rates on new deposits with an agreed maturity and on overnight deposits, where the weights are outstanding amounts of these two categories. Rates on new deposits with an agreed maturity are a weighted average of rates on new deposits for each maturity (up to 2 years and over 2 years). The shaded areas refer to different quantiles of the distribution of deposit rates. The latest observation is for July 2020.

Chart 23

Changes in bank profitability between 2014 and 2019 and the impact of non-standard monetary policy measures



Sources: ECB and ECB calculations.
Notes: The sample is balanced (covering 194 euro area banks) and adjusted for major mergers and acquisitions. NII is net interest income, EL is excess liquidity, Non-Int. Inc is non-interest income, Prov.&Imp. Is provision and impairments, Oper. Exp is operational expenses, ROA is return on assets. The sign of provisions and impairment is inverted so that a positive number refers to a positive contribution to bank profits. The "EL charge" is net of savings due to the two-tier system for reserve remuneration. The impact of non-standard monetary policy measures is obtained using a Bayesian vector autoregression (BVAR) model in line with Rostagno et al (2019). For technical details on the model, see Altavilla et al (2018).

Indeed, counterfactual analysis shows that the negative effect of monetary policy easing on net interest income has been offset by a positive effect on borrower creditworthiness. The results of a model-based assessment of the impact of non-standard measures on bank profitability are reported in Chart 23. The exercise, conducted using a Bayesian vector autoregression (BVAR) model, decomposes actual developments in bank profitability and its components (the red diamonds) into a part that represents the estimated impact of the ECB's instruments under consideration (the yellow, dark blue and light blue segments of the bars) and one which would have been observed under the counterfactual scenario (the grey segment of the bars).[50] While the estimated impact of the instruments on net interest income is generally negative, the positive impact of policy easing on non-interest income is relatively small and short-lived, as it mainly reflects the effect of decreases in interest rates on the value of the securities held by banks. However, the instruments are estimated to have accounted for a significant share of the observed decline in loan loss provisions. The TLTROs and the two-tier system of reserve remuneration have provided meaningful sources of support for banks' margins.

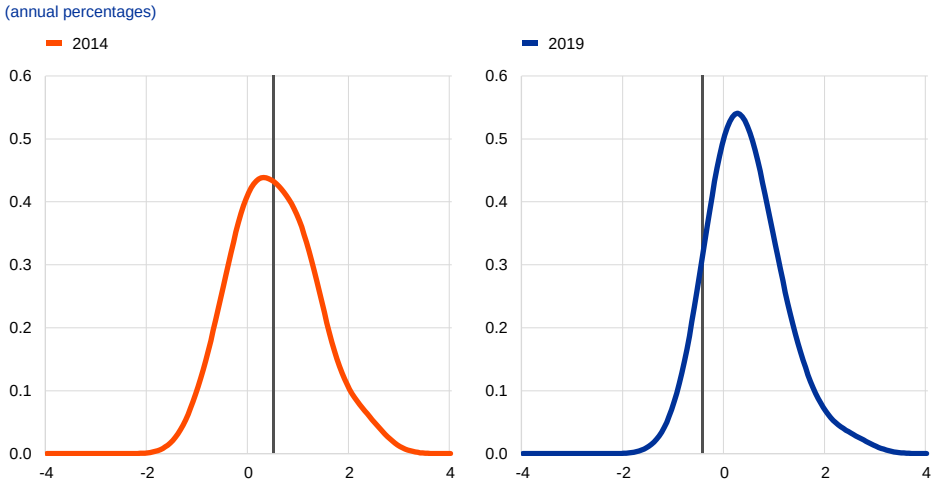
Empirical bank-level analysis suggests that the reversal rate has not been reached. The relationship between risk-adjusted margins on loans and the (net) return on alternative investments points to an increase in banks' incentives to lend to the real economy over the past few years, which suggests that the "reversal rate" – a level of interest rate so low that it would lead banks to withdraw from lending to the

[50] A recent article (see Bundesbank, 2020) focusing on German banks, also find that the profitability of German intermediaries has been overall stable during the NIRP period.

broader economy – has not been reached.[51] The same indication derives from the fact that loans to the private sector have, on average, increased since 2014. Analysis using micro-data sources, which allow connection of the borrowers' side to the lenders' side of the loan market, can provide a measure of the risk-adjusted return on loans per country and allows a comparison between such a metric and a "hurdle rate" – the return on alternative portfolios of assets – that banks consider when lending to non-financial companies. The comparison of the two measures offers an estimate of the euro area banking systems' distance from the "reversal rate". Chart 24 illustrates developments in the distribution of banks according to their risk-adjusted margins (bell-shaped curves) and the (net) return on alternative investments (vertical bars). In 2014 a large share of the banking population was below this "hurdle" rate – i.e. a large part of the distribution fell to the left of the vertical line – which monetary policy easing had pushed to the right, increasing the relative attractiveness of loan creation for banks. While policy easing also led to a decline in lending rates, this was largely offset by lower funding costs and the cost of risk (despite the increase in capital requirements), thereby avoiding a shift to the left in the distribution of risk-adjusted margins.

Chart 24

Distribution of risk-adjusted margin versus the hurdle rate



Sources: ECB and ECB calculations.
Notes: The distribution is based on a balanced sample of 74 euro area banks. The hurdle rate is proxied by the yield to maturity on ten-year euro area sovereign bonds. The risk-adjusted margin is computed as the interest rate on new loans to non-financial corporations, net of funding costs and expected losses. Expected losses are based on banks' internal rating-based models. Funding costs are a weighted average between the cost of debt and equity, where the weights are capital requirements, i.e. the product of the regulatory capital ratio (including macroprudential buffers and Pillar 2 requirements). The cost of equity is based on Altavilla et al. (2021). The cost of debt includes (net) interbank funding, borrowing from the Eurosystem, deposits and debt securities.

Notwithstanding the low interest rate environment, banks appear to have priced the extra credit risk they have been taking on when expanding their lending volumes appropriately, with a view to commanding adequate premia to compensate for it. Specifically, compared with a counterfactual scenario for developments in lending margins and in default probabilities if banks had not taken

[51] See Rostagno et al. (2021b). Arce et al. (2021a) also find that while the reversal rate might be reached by some undercapitalized banks that are adversely affected by negative interest rates, there seems to be no aggregate effect on the supply of lending to nonfinancial corporations.

on greater risk, the additional risk-taking by banks has, in general, led to an increase in margins sufficient to compensate for the associated increase in expected risk.[52]

At the same time, specific loan categories may warrant close monitoring. For example, banks have expanded their relatively riskier but more profitable consumer credit business considerably. Increasing risk-taking in this segment seemed to have been motivated by profitability considerations, as consumer loans offer bigger lending margins than other loans. Moreover, the accelerating loan growth in this segment was spearheaded by banks that are lending to riskier borrowers.[53] In addition, the average duration of banks' loan and securities portfolios has increased in recent years. Notable is the longer maturity of residential real estate mortgages, which in addition are more frequently granted at fixed rates with rate fixation periods of ten years or more. In fact, also in countries in which banks have historically originated predominantly floating rate mortgages, the share of fixed rate loans increased after 2015. Prima facie this implies higher levels of duration and interest rate risks for banks. Moreover, the risk-taking channel is likely to gain importance if interest rates are held low for longer. A number of recent studies investigate the risk-taking behaviour of banks in an environment of negative policy rates.[54] Taken together, the results point to mixed evidence concerning excessive risk-taking associated with the negative interest rate policy. In this context, micro- and macroprudential measures have been instrumental in mitigating excessive risk-taking in the banking sector.[55] More broadly, this highlights the importance of establishing an effective macroprudential framework for banks, including by ensuring adequate macroprudential space.

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52 Lending margins are defined in this analysis as the difference between each bank's lending rate and its weighted average cost of funding, and borrower risk is measured by the probability of default estimated by banks using internal rating-based models.

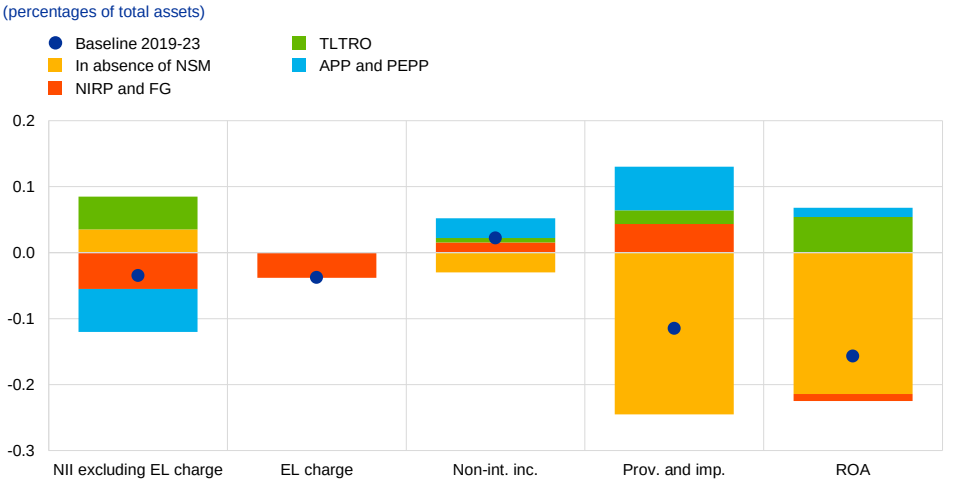
53 See the ECB's Financial Stability Review, May 2018.

54 Bubeck et al. (2019) find that, following the introduction of the negative interest rate policy, banks characterised by a larger share of deposits tend to increase their holdings of high-yield securities. Based on a sample of syndicated loans, representing a small share of the outstanding amount of loans, Heider et al. (2019) show that banks whose business model is particularly exposed to the low interest rate environment may take on systematically greater risk than their peers. At the same time, Bottero et al. (2019) present evidence that the higher level of ex ante risk of borrowers as a result of the broadening of credit supply did not translate into an increase in non-performing loans. In addition, Arce et al. (2021a) document a positive relationship between capital ratios and risk-taking for those banks adversely affected by the negative interest rate policy.

55 See Altavilla, Laeven and Peydró (2020c) on the complementarities between monetary policy and macroprudential policy in shaping the evolution of bank credit.

Chart 25

Changes in bank profitability between 2019 and 2023 and the impact of non-standard monetary policy measures



Sources: ECB and ECB calculations.
Notes: The sample is balanced (covering 194 euro area banks) and adjusted for major mergers and acquisitions. NII: net interest income, EL: excess liquidity, Non-Int. Inc: non-interest income, Prov.&Imp.: provision and impairments, ROA: return on assets. The sign of provisions and impairment is inverted so that a positive number refers to a positive contribution to bank profits. The "EL charge" is net of savings due to the two-tier system for reserve remuneration. The impact of the instruments is obtained using a Bayesian vector autoregression (BVAR) model. For technical details on the model see Altavilla et al (2018). The baseline scenario is a conditional forecast where bank profitability is projected and is conditional on the baseline embedded in the December 2020 macroeconomic projections for the euro area.

The persistence of low interest rates for a longer period of time, coupled with an increase in credit risk, such as the increase associated with the pandemic, can worsen the financial position of banks (Chart 25). As mentioned above, the positive effect on non-interest income is short-lived, whereas the compression of net interest income is persistent.[56] Moreover, the impact on net interest income deteriorates as rates remain low for longer and the stock of (longer-term, fixed-rate) assets progressively reprices, thus compressing the margin between their returns and the returns on lower duration liabilities.[57] When quantifying the contribution of the monetary measures until 2023, model-based simulations point to a contained positive impact of monetary policy but with some heterogeneity across instruments. TLTROs are the measure with the most positive effect, supporting all major components of banks' profits. Asset purchases are predicted to provide ongoing yet limited support, as the negative impact on the net interest income component is still offset by the boost that such a policy provides to the macro-economy.[58] The contribution of the negative interest rate policy is expected to turn slightly negative overall. The deterioration compared with the backward-looking analysis is largely due to the more significant impact of the combined measures on net interest income and the increase in the excess liquidity charge on account of the large and growing volume of excess liquidity. While this is partly offset by the TLTROs and other sources of savings in funding costs, there is limited space for deposit rates to

56 See also Brunnermeier and Koby (2018).

57 See Altavilla et al. (2018), Claessens et al. (2018) and Deutsche Bundesbank (2018).

58 Before the pandemic, the space for further savings through this channel was declining, as the cost of provisioning for expected loan losses was already compressed, especially in certain countries. However, the health crisis has led to an increase in credit risk across the euro area, an increase which would be more significant in the absence of the PEPP.

continue to decline, especially for households. Finally, while banks have remained active in wholesale debt markets, the increased reliance of banks on central bank funding can also pose risks related to a potential decline in the disciplining force of market-based financing.[59]

Turning to non-bank intermediaries, the financial position of insurance corporations and pension funds (ICPFs) is under stress because of the protracted period of low interest rates. The sustained low interest rate environment spanning the entire yield curve, driven predominantly by the trend decline in the equilibrium real interest rate, r*, was transmitted to ICPFs' financial positions via two channels. First, it gradually compressed investment income. Second, it increased the value of ICPFs' liabilities more than their assets owing to the typical negative duration gap on ICPFs balance sheets.[60] While the former effect has incentivised ICPFs to rebalance their portfolio towards riskier assets, the latter weakened ICPFs' financial positions when long-term rates declined strongly and decreased its importance as rates levelled off.[61]

The contraction of margins following the generalised decline in the returns on financial assets has led non-banks to increase their exposure to riskier and less-liquid funds and asset classes. As a response to low yields, euro area insurers increased their holdings of riskier asset classes, such as BBB-rated and high-yield bonds, equity and investment fund shares, over the last years. They also ventured into alternative assets, such as infrastructure, private equity funds and real estate loans.[62] At the same time, ICPFs reduced their holdings of highly liquid securities and extended the maturity of bond portfolios. Exacerbated by the reduction of liquid asset holdings in recent years, some ICPFs also faced liquidity strains owing to exceptionally large variation margin calls on their derivative portfolios during the market turmoil of March 2020. The portfolio rebalancing of ICPFs has been accompanied by an increase in financial stability risks driven by rising correlations, diminished diversification and concentrated positions. Regulatory, supervisory and macroprudential policies need to contribute to containing financial stability risks, and an enhancement of the macroprudential framework for non-banks is warranted.

59 See e.g. Bats and Hudepohl (2018).

60 The duration of ICPF liabilities tends to exceed that of their assets, resulting in a negative duration gap. Hence, the value of their liabilities increases more than that of their assets when rates decline ("balance sheet revaluation effect"). Granular transaction level derivative contracts data show that European ICPFs, however, tend to (partly) hedge against this interest rate risk by entering pay-float interest rate derivative contracts (see Abad et al., 2016, p. 20).

61 See also BIS (2018).

62 See Fache and Giuzio (2020).

3.5 Firms and households

3.5.1 Effects of monetary policy on productivity[63]

Productivity is a real-economy phenomenon and its evolution predominantly hinges on the structural features of the economy, as well as on the design of national fiscal, structural and financial sector policies. In addition, an accommodative monetary policy stance has, under certain circumstances, the potential to stimulate investment and productivity. However, in recent years it has increasingly been argued that very low interest rates over a long period of time could have negative effects on resource allocation and productivity through the way interest rates interact with financial frictions, stemming from weak banks' balance sheets or weak banking supervision, among others. In fact, there are several channels through which monetary policy can affect productivity, though the net effect is ambiguous and needs to be determined empirically.

For instance, the interaction between an accommodative monetary policy and financial frictions might lead to adverse effects on productivity. These negative effects might be driven by different sources. First, in the presence of financial constraints or frictions[64] due to high indebtedness, poor or low collateral levels or asymmetric information, a low interest rate environment could disincentivise the necessary balance sheet repair of firms and banks.[65] At the same time, such an environment could encourage a reallocation of resources towards low productivity firms or low productivity sectors with a higher net worth (e.g. construction), or low leverage[66] or less asymmetric information (e.g. older firms and less intangible assets).[67] Moreover, monetary policy could also affect resource reallocation through the lending decisions of banks. Some authors have argued that, in a low interest rate environment, banks relax lending standards and tend to increase their exposure towards low-productivity firms, with negative effects on aggregate productivity.[68]

For the euro area, empirical evidence points to limited adverse effects of low and negative interest rates on productivity and firm dynamics. The results of the analysis detailed in work stream on productivity, innovation and technological progress (2021) show that, by stimulating aggregate demand and easing financing conditions, monetary policy accommodation has ultimately supported the market

63 This section draws on the analysis of the work stream on productivity, innovation and technological progress established in the context of the Strategy Review, see work stream on productivity, innovation and technological progress (2021) for further details.

64 See Bianchi et al. (2018), Cloyne at al. (2018), Neuhann and Saidi (2018), Ferrando and Ruggieri (2018), Ikeda and Kurozumi (2019), Levine and Warusawitharana (2019) and Manaresi and Pierri (2017).

65 See Storz et al. (2017) and Gropp et al. (2017).

66 See Borio et al. (2015), Gopinath et al. (2017) and Uras (2017).

67 See Bianchi et al. (2018), Cloyne et al. (2018), Neuhann and Saidi (2018), Levine and Warusawitharana (2019) and Caggese and Perez-Orive (2017).

68 See Banerjee and Hofmann (2018), Albrizio et al. (2019) and Acharya et al. (2019).

entry of firms.[69] Importantly, these positive effects tend to offset the potential negative effects driven by the presence of financial frictions.

Empirical evidence also suggests positive effects of an accommodative monetary policy on "within-sector" resource allocation. The analysis in ECB (2021) found the following results. First, the econometric evidence collected for some euro area countries (Spain Italy and Portugal) suggests that monetary policy easing enables financially constrained firms with high marginal revenue productivity of capital to increase their investments by relatively more than other firms in the same sector.[70] Second, the monetary policy measures announced and implemented by the ECB over the past few years have not facilitated the survival of non-viable firms.[71] This is also reflected in the fact that, while the availability of credit improved for all firms, access was significantly lower for financially fragile firms.[72] Third, using different data for France, the analysis suggest that the share of low solvency firms benefiting from exceptionally low rates has remained very limited.[73] Overall, the evidence does not indicate a widespread misallocation of resources following an improvement in the overall terms and conditions agreed in the loan contracts. The improvement in financing conditions is rather associated with a smoother policy transmission to firms. Importantly, in most cases these easier conditions resulted in more credit allocated to healthier firms.

In theory, a protracted period of monetary policy accommodation could support the survival of non-viable or distressed firms, often referred to as "zombies". In principle, an accommodative monetary policy stance may lower the productivity threshold required for profitability and ease financing conditions, which facilitates the entry and survival of firms, even if non-viable.[74] The net effect on aggregate productivity depends on the type of entrants and incumbents that survive, as well as on their interaction and their respective shares in the aggregate. Weakly capitalised banks, for example, might have an incentive to continue lending to low productivity or even distressed firms, thereby avoiding the recognition of non-performing loans.[75] This is the so-called "zombie lending" phenomenon, and it can be driven by the reduced opportunity costs for banks to clean up their balance sheet as well as by increased incentives to "evergreen" loans, i.e. refinance existing loans to firms that face a higher rollover risk. The negative impact on productivity could be further amplified if zombie firms crowd out investment in more productive firms by

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69 Garga and Singh (2021), Moran and Queralto (2017), Anzoategui et al. (2019), Schmöller and Spitzer (2021) and Jordà et al. (2020).

70 This sub-section is based on Albrizio and González (2020). The choice of these countries is due to data availability.

71 Analysis based on the ECB Survey on Access to Finance of Enterprises (SAFE). Given that survey data is particularly timely, spanning from 2009 to the end of 2019, the analysis covers monetary policy decisions taken by the ECB since the Great Financial Crisis.

72 Financial fragility is defined as: i) a measure of vulnerability derived directly from the survey replies (vulnerable firms); ii) a measure based on the interest coverage ratio ("zombie" firms), as in Adalet McGowan et al. (2018); and iii) the Altman Z-score.

73 This analysis is an updated version of "Corporate Loans at Particularly Low Rates in France" by S. Avouyi- Dovi, B. Bureau, R. Lecat, C. O'Donnell and J-P. Villetelle. Quarterly Selection of Articles, Banque de France Bulletin, spring 2016.

74 Anzoategui et al. 2019, Syverson, 2011, Bergin and Corsetti, 2008, Hamano and Zanetti, 2020, Garga and Singh, 2021, Colciago and Silvestrini, 2020, Hartwig and Lieberknecht. 2020.

75 Caballero et al. (2008), Banerjee and Hofmann (2018), Storz et al. (2017), Schivardi et al. (2021), Andrews and Petroulakis (2019) and Altavilla et al. (2020c).

absorbing resources and, thus, worsening resource allocation. Whereas the direction of the effect on productivity is unambiguously negative, its relative size, dynamics and impact on aggregate productivity remains an empirical question.

Empirical analysis shows that the share of zombie firms in some euro area countries has decreased since 2014. The analysis covers five euro area countries (Belgium, Italy, the Netherlands, Portugal and Finland) over the period 2000-17 and defines "zombies" according to their interest coverage ratio, in line with Adalet McGowan et al. (2018).[76] On average across countries, the share of zombies increased up to 2013-14 and decreased thereafter, falling to 7% in 2017 for all active firms (Chart 26). Moreover, the results for the euro area based on the Survey of Access to Finance of Enterprises (SAFE) suggest that credit allocation has, in general, not been adversely affected. The only exception is represented by large "distressed" firms, which are found to have improved their access to finance following the easing in lending conditions. This result suggests that size can be an important factor behind distressed borrowers to extract rents from lenders. At the same time, while a long-lasting accommodative monetary policy stance may have contributed to prolonging the survival of a subset of distressed firms, the overall impact on aggregate productivity growth has likely been small.[77] This hypothesis is also supported by the relative stability of the rate of entry of firms into financial distress, which goes against the materialisation of zombie.

Overall, these findings highlight the importance of policies that aim to facilitate the allocation of resources towards more innovative and productive firms. Most notably, this includes measures to address any remaining bank weaknesses and incentivise banks to move decisively to shed bad assets. It also points to the importance of improving legal frameworks, such as insolvency laws, and addressing capacity constraints in the courts. The positive impact of such structural policies would be particularly strong in periods of economic upswing, when the entry of new firms is high and incumbent firms face possibilities to expand.

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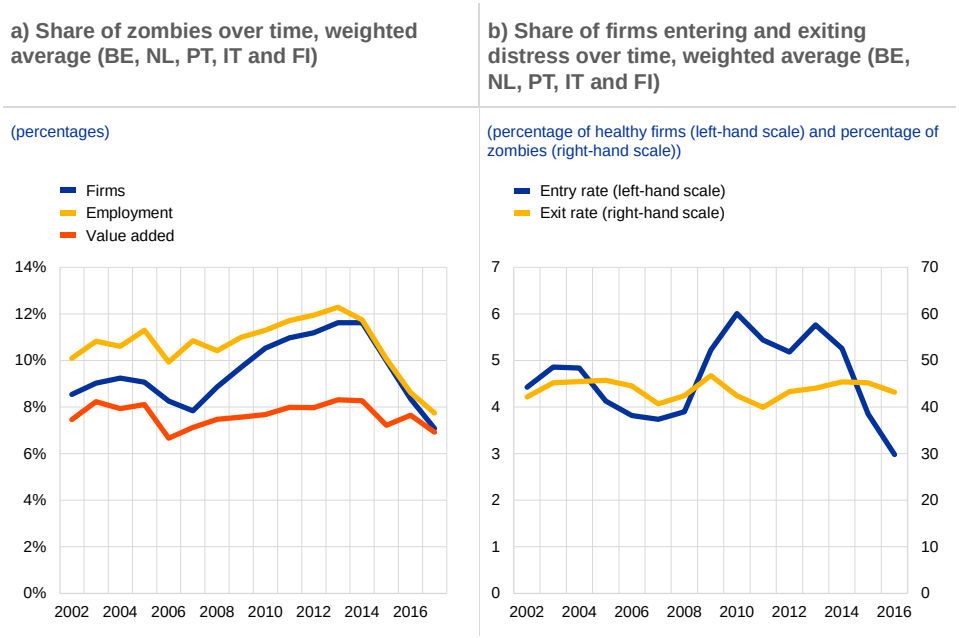
76 The literature has used different criteria to identify zombie firms, including: i) receiving credit at subsidised rates (Caballero et al., 2008); ii) low/negative profitability (e.g. Schivardi et al., 2019 and Storz et al., 2017); iii) the inability to make interest payments (e.g. Adalet McGowan et al., 2018 and Acharya et al., 2019); and iv) a combination of these criteria. The criteria used here follow more closely Adalet McGowan et al. (2018) and define zombies as firms with an interest coverage ratio that is less than 1 for three consecutive years. The use of the interest coverage ratio to identify zombies is important for a number of reasons. First, as subsidised loans are not a key issue in our sample, firm performance measures that rely on the ratio seem more appropriate for capturing distressed firms than measures based on interest payments. In addition, as Adalet McGowan et al. (2018) note, interest coverage ratios encompass channels other than subsidised credit through which zombie firms may be kept alive (e.g. government guarantees to firms). Second, the data on interest payments by those firms operating in the six countries covered in the empirical analysis are not sufficiently detailed to construct measures similar to those used by Hoshi (2006), Caballero et al. (2008) and Schivardi et al. (2018). Importantly, Schivardi et al. (2018) document that, in their sample, the definition based on the interest coverage ratio is almost a strict subset of that based on the comparison between return to assets and their measure of the cost of capital for the safest borrowers in their sample.

77 For a comprehensive analysis, see work stream on productivity, innovation and technological progress (2021).

Chart 26

Share of "zombie" firms and dynamics of firms' distress



Sources: Central Balance Sheet Database, Cerved Centrale dei Bilanci, Istituto Nazionale Previdenza Sociale, Nationale Bank van België/Banque Nationale de Belgique Central Balance Sheet Office, Statistics Finland and Statistics Netherlands (CBS).
Notes: "Zombies" are defined as firms with a ratio of earnings before interest and taxes (ebit) and interest paid+financial charges of below 1 (ebit/interest < 1) for three consecutive years. Manufacturing includes NACE rev. 2 sectors 10-33 and private services includes sectors 45-63 and 69-82.

3.5.2 Distributional effects of monetary policy

Side effects of monetary accommodation could also be observed for specific groups of households because of the heterogeneous composition of their wealth and sources of income. For example, 60% of euro area households are homeowners, of which about one-third have a mortgage, and about 25% own real estate other than their main residence.[78] Similarly, households in the lowest income quintile earn only roughly 20% of their gross income as employee income and a relatively large share as unemployment benefits; by contrast, for households in the top quintile, the share of income arising from unemployment benefits is extremely low and the share of financial and rental income amounts to 10% of total gross income. Since monetary policy decisions produce effects on many economic variables, from rent on housing and mortgage interest rates to employment, households will be affected in different ways by measures of monetary policy accommodation.

The transmission of effects from the APP on household income works mainly via unemployment and wages. First, and most importantly, previously unemployed individuals become employed, generally experiencing a substantial increase in their income as a result. The probability of this outcome depends on their demographic characteristics (such as their age, education, marital status and the number of

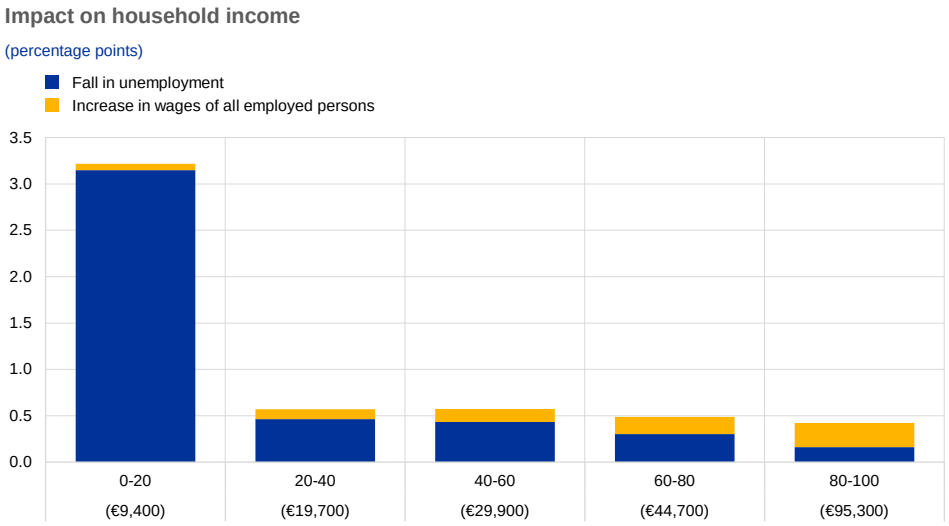
[78] The household data cited in this section are available from the 2017 wave of the Household Finance and Consumption Survey.

children they have). Empirically, the aggregate decline in the unemployment rate (by about 0.7 percentage points) tends to mainly benefit those households with incomes in the lowest 20%, whose unemployment rate falls by more than 2 percentage points. By contrast, the unemployment rate in other income quintiles falls by less than 0.5 percentage points. The second most important channel of transmission is represented by wage dynamics: wages increase for all employed individuals.

Overall, the expansionary monetary policy of the ECB has been especially beneficial for vulnerable households (Chart 27).[79] The labour market impact of the APP is estimated to have produced a marginal reduction in income inequality. Changes in unemployment rates substantially affect household income: incomes increase considerably as previously unemployed workers start earning wages instead of receiving unemployment benefits. Analysis of the impact of the APP on inequality finds that the APP-related reduction in the unemployment rate has had a large impact on the bottom 20% of the income distribution, with mean income in that quantile increasing by more than 3%, and a slight associated reduction in the Gini coefficient.[80]

Chart 27

Household income and the APP



Sources: Eurosystem Household Finance and Consumption Survey (HFCS)`, ECB calculations and Lenza and Slacalek (2018).
Notes: The chart shows the percentage change in mean income across income quintiles. It also shows the decomposition of the change into the extensive margin (transition from unemployment to employment) and the intensive margin (increase in wages). The numbers in brackets show the initial levels of mean gross household income in each quintile. The statistics cover the euro area, which is modelled here as an aggregate of Spain, Germany, France and Italy. The bars are ordered (left to right) from the poorest 20% to the richest 20% of the income distribution.

79 These results largely correspond to those of a growing literature estimating the distributional effect of monetary policy in the euro area. See Colciago, Samarina and de Haan (2019) for a review of the literature and Adam and Tzamourani (2016), Aino and Mäki-Fränti (2020), Banco de Portugal (2017), Casiraghi et al. (2018), Deutsche Bundesbank (2016), Gautier, Penalver and Savignac (2020) and Slacalek, Tristani and Violante (2020) for additional perspectives.

80 The Gini coefficient measures the deviation of the distribution of income among individuals/households from a perfectly equal distribution. A value of 0 represents absolute equality and a value of 100 absolute inequality.

4 Concluding remarks

The analysis documented in this paper provides evidence that the monetary policy measures adopted since 2014 have delivered effective stimulus to the economy and inflation. Combining the instruments of negative interest rates, forward guidance, asset purchases and targeted longer-term refinancing operations has helped to ease financial conditions at times when the standard policy instrument – setting short-term interest rates in positive territory – was constrained and the equilibrium real interest rate ranged around historical lows. Considering all the measures taken since mid-2014, the impact of all unconventional monetary policy measures on the annual GDP growth rate is estimated to be around 0.6 percentage points, on average, over the period 2015-20. Over the same period, the annual inflation rate would have been around 0.4 percentages points lower, on average, without these measures. At the same time, the estimated policy impact on growth and inflation is surrounded by various margins of uncertainty. As a further result of the analysis, when monetary policy is operating near the effective lower bound, a combination of instruments is generally more efficient than relying on a single instrument.

Diversification and flexibility will remain an essential guiding principle for the ECB's instrument choice, as encounters with the effective lower bound are likely to be more frequent than was judged to be the case in the past, on account of the decline in the natural rate of interest. In fact, in episodes in which policy rates are perceived to be approaching the effective lower bound, further deposit facility rate reductions to more negative levels might lose some of the extra traction on yields and financial conditions that they have demonstrated in recent years. Similarly, the use of other policy instruments, such as forward guidance and asset purchases, is also likely to face constraints, putting a premium on flexibility and adaptability.

State-contingent flexibility in the use of instruments may also be needed to react to risks of fragmentation that may impair the transmission of the single monetary policy to all euro area market segments and jurisdictions. These risks may require the use of the Eurosystem's balance sheet through various instruments, in a state-contingent way, as a powerful and direct mechanism for easing conditions uniformly across markets and jurisdictions, particularly in conditions in which regular transmission channels cannot be confidently relied upon to transmit the stimulus. This has become evident at the time of the financial turmoil following the pandemic shock. The PEPP, with its flexibility of purchases over time, across asset classes and among jurisdictions, helped restore market liquidity, stabilise markets conditions and avert tail risks. Moreover, thanks to its dual purpose, the PEPP not only contributed to backstopping the market but provided essential policy stimulus to support the economy and help accelerate inflation convergence during the pandemic.

Nevertheless, the choice and use of policy instruments in the vicinity of the effective lower bound requires a careful cost-benefit analysis. Monetary policy, notably the use of unconventional tools, can give rise to unintended side effects, in particular on financial markets, intermediaries and the real economy. The evidence presented in this paper shows that side effects have largely been contained, with the benefits of the policy measures outweighing their possible adverse effects. At the same time, side effects may vary over time and are likely to increase when unconventional monetary policy measures are used intensely over an extended period of time, despite the fact that the economy might gradually adapt to a low interest rate world. The costs of a highly accommodative stance, including excessive risk-taking by banks and non-bank intermediaries, depressed bank profitability, market functioning and moral hazard, might increase the longer the instruments are in place. In addition, financial instability may create considerable risks to price stability in the medium term, in either direction. These challenges, however, should first and foremost be addressed by other policy authorities using appropriate policies, such as fiscal or micro- and macro-prudential policies.

Moreover, the effectiveness of policy instruments may diminish over time, although the empirical evidence is still inconclusive. With respect to financing conditions, the pass-through of changes in policy rates to bank lending rates and deposit rates falls in the vicinity of the effective lower bound.[81] All else being equal, the lower the pass-through of interest rate changes to bank rates, the smaller the effect of monetary policy on aggregate demand. Similarly, bond purchases will lose effectiveness in changing financial prices, as the amount of duration risk available in the market for this instrument to withdraw shrinks over time with a trend fall in interest rate volatility (Greenwood and Vayanos (2014) and King (2019)). The empirical evidence on the extent to which such diminishing effects are prevalent in the euro area, however, is necessarily scant and not yet conclusive. For instance, Grande, Grasso and Zinna (2019) show empirically that the impacts of central bank purchase announcements become smaller the lower the bond yield volatility and the further the shadow short-rate is below the effective lower bound. However, the authors argue that the Eurosystem's asset purchases remain effective overall given the ample amount of duration risk still available in euro area sovereign bond markets. Rostagno et al. (2021a) find that the impacts of the APP and the PEPP announcements on financial market prices appear to have remained broadly similar over time, irrespective of market functioning or the stock of previous purchases. The authors stress that later rounds of asset purchases were largely anticipated by market participants and, as a result, the expected effects of the programmes were already incorporated into market prices by the time of the formal announcements, thus making the effect on yields upon later announcements smaller. The paper also finds no evidence that the transmission of a given change in long-term interest rates induced by an asset purchase programme through the economy might have lost potency. With respect to the real economy, a nascent literature finds diminishing returns of a given adjustment in yields on the macroeconomy as the level of yields falls or as the period of very low interest rates extends over time. This might be the

[81] See Eggertsson et al. (2019), Borio and Gambacorta (2017), Heider et al. (2019) and Darracq-Pariès, Kok and Rottner (2020).

case if the slope of the aggregate demand or "IS" curve changes, for example because the share of financially constrained firms declines, such that investment – the most credit-sensitive component of demand – becomes less responsive to the cost of borrowing over time, or simply because incentives to bring consumption forward over time fall as interest rates approach levels closer to zero.[82] Here too, while the literature seems to agree that the impact of policy actions on growth and inflation varies with the state and structure of the economy and that the impact is smaller outside crisis times, no firm conclusions have been reached on the degree to which a general trend of diminishing macro effects prevails for euro area monetary policy instruments.[83]

Any change to the use of policy instruments should prove to be effective for the pursuit of the ECB's price stability mandate, while duly ensuring to minimise possible adverse side effects. Any potential adjustment in the set of policy tools must ensure that the measures continue to be proportionate to the ECB's monetary policy objectives and comply with the monetary financing prohibition, while respecting the principle of an open market economy with free competition and other general principles of EU law, such as the principle of equal treatment.

When the toolkit is evolving, mitigating measures can be designed to help offset adverse side effects that could threaten the transmission mechanism of monetary policy, but such measures will also face their own limitations. Mitigating measures help to safeguard or expand the policy space for existing instruments and may reduce the need for introducing new instruments. The two-tier system is a case in point, as it allowed the ECB to cut policy rates further into negative territory while mitigating, in part, the potential adverse impact on bank profitability and, ultimately, monetary policy transmission. It is an important tool for offsetting part of the costs of this policy in an environment of excess liquidity. Similarly, possible negative effects of asset purchases on bond and repo market functioning have been mitigated by the securities lending facility, most notably by introducing the option to use cash as collateral.

Apart from the potential need to expand the instrument set to deliver the required accommodation, structural changes in financial markets and financial intermediation may challenge the conduct and implementation of monetary policy. These challenges relate to (i) the growing importance of non-bank financial intermediation in the financial system and (ii) an increased and more uncertain demand by financial intermediaries for central bank liquidity.

Increasing non-bank financial intermediation can influence the way monetary policy is transmitted through the financial system to the real economy. Over recent years, non-bank financial intermediaries have increased their share in the

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82 See for example Van den End et al. (2020) and Borio and Hofmann (2017).

83 One particular channel that could be at play is via negative income effects. While the fact that the euro area household saving rate has failed to decline since the start of the APP can be attributed, to a large extent, to the persistent uncertainty that has surrounded the macroeconomic landscape over the period, particularly in the two years leading up to the pandemic, this evidence could also be interpreted as the result of incipient negative income effects associated with lower returns on pension wealth starting to influence saving behaviour in some regions of the euro area. Survey evidence suggests that households' purchase intentions have stagnated over the past three years.

financial system.[84] In particular, the non-bank financial sector has expanded its role in financing the euro area real economy via equity and credit (loans and debt securities). This increased presence may have important implications for the efficacy of policy instruments and the way the financial sector transmits the policy impulse to the real economy, which warrants further analysis.

Furthermore, the possible changed demand of banks for central bank reserves – owing to new regulation, segmentation in money markets and precautionary motives – may impact the way central banks can implement their monetary policy. Since the start of the Great Financial Crisis, the demand for central bank reserves has increased significantly. Moreover, it has varied over time, making it more difficult to predict. This higher and more uncertain demand for central bank reserves is likely related to a number of structural factors, such as the introduction of new liquidity regulation, higher segmentation in money markets, precautionary motives of banks for holding central bank liquidity and the way monetary policy is implemented. In these conditions, the steering of liquidity and short-term money market rates by the central bank becomes more challenging. This may have important implications for the future design of a central bank's operating system, notably the choice between a floor and corridor system of policy interest rates.

[84] In fact, the total assets of the non-bank financial sector accounted for about 55% of the assets of the financial sector (including the Eurosystem) at the end of 2019, up from 45% ten years earlier.

References

Abad, J., Aldasoro, I., Aymanns, C., D'Errico, M., Fache Rousova, L., Hoffmann, P., Langfield, S., Neychev, M. and Roukny. T. (2016), "Shedding light on dark markets: First insights from the new EU-wide OTC derivatives dataset", *ESRB Occasional Papers*, No 11.

Abdi, F. and Ranaldo, A. (2017), "A Simple Estimation of Bid-Ask Spreads from Daily Close, High, and Low Prices", *Review of Financial Studies*, Vol. 30, Issue 12, pp. 4437-4480.

Abidi, N., Flores, I.M. and Eterovic, N.A. (2017), "Who benefits from the corporate QE? A regression discontinuity design approach", *Working Paper Series*, No 2145, ECB.

Acharya, V., Eisert, T., Eufinger, C. and Hirsch, C. (2019), "Whatever It Takes: The Real Effects of Unconventional Monetary Policy", *Review of Financial Studies*, Vol. 32, Issue 9, pp. 3366-3411.

Adalet McGowan, M., Andrews, D. and Millot, V. (2018), "The walking dead? Zombie firms and productivity performance in OECD countries", *Economic Policy*, Vol. 33, Issue 96, pp. 685-736.

Adalid, R., Falagiarda, M. and Musso, A. (2020), "Assessing bank lending to corporates in the euro area since 2014", *Economic Bulletin*, Issue 1, ECB.

Adam, K. and Tzamourani, P. (2016), "Distributional consequences of asset price inflation in the Euro Area", *European Economic Review*, Vol. 89, pp. 172-192.

Afonso, A. and Sousa-Leite, J. (2019), "The transmission of unconventional monetary policy to bank credit supply: evidence from the TLTRO", *Working Papers*, No 201901, Banco de Portugal.

Agarwal, R. and Kimball, M. (2019), "Enabling Deep Negative Rates to Fight Recessions: A Guide", *IMF Working Paper*, WP/19/84.

Aino, S. and Mäki-Fränti, P. (2020), "Monetary policy and inequality", mimeo, Suomen Pankki – Finlands Bank.

Albertazzi, U., Becker, B. and Boucinha, M. (2020), "Portfolio rebalancing and the transmission of large-scale asset programmes: evidence from the euro area", *Journal of Financial Intermediation*.

Albrizio, S., Conesa, M., Dlugosch, D. and Timiliotis, C. (2019), "Unconventional monetary policy and productivity: Evidence on the risk-seeking channel from the US corporate bond markets", *OECD Productivity Working Papers*, No 17.

Albrizio, S., Flores, J. and Furceri, D. (2020) "Non-linear Macro and Distributional Effects of US Monetary Policy", mimeo, Banco de España.

Albrizio, S. and González, B. (2020), “Monetary policy and capital misallocation in Europe”, unpublished working paper, Banco de España.

Alessandri, P. and Nelson, B.D. (2015), “Simple banking: profitability and the yield curve”, Journal of Money, Credit and Banking, Vol. 47, No 1, pp. 143-175.

Altavilla C., Carboni G. and Motto R. (2015), “Asset Purchase Programmes and Financial Markets: evidence from the Euro Area”, *Working Paper Series,* No 1864 ECB (forthcoming in the *International Journal of Central Banking*).

Altavilla, C., Boucinha, M. and Peydró, J.-L. (2018), “Monetary policy and bank profitability in a low interest rate environment”, *Economic Policy*, Vol. 33, Issue 96, pp. 531-586.

Altavilla, C., Brugnolini, L., Gürkaynak, R., Motto, R. and Ragusa, G. (2019), “Measuring Euro Area Monetary Policy”, *Journal of Monetary Economics*, Vol. 108, pp. 162-179.

Altavilla, C., Barbiero, F., Boucinha, M. and Burlon, L. (2020a), “The great lockdown: pandemic response policies and bank lending conditions”, *Working Paper Series*, No 2465, ECB.

Altavilla, C., Canova, F. and Ciccarelli, M. (2020b), “Mending the broken link: heterogeneous bank lending and monetary policy pass-through”, *Journal of Monetary Economics*, Vol. 110, Issue C, pp. 81-98.

Altavilla, C., Laeven, L. and Peydró, J.-L. (2020c), “Monetary and Macroprudential Policy Complementarities: evidence from European credit registers”, *CEPR Discussion Paper*, No 15539.

Altavilla, C., Burlon, L., Giannetti, M. and Holton, S. (2021), “Is there a zero lower bound? The effects of negative policy rates on banks and firms”, *Journal of Financial Economics*, forthcoming.

Andrade, P., Breckenfelder, J., De Fiore, F., Karadi, P. and Tristani, O. (2016), “The ECB's asset purchase programme: an early assessment”, *Working Paper Series*, No 1956, ECB.

Andreeva, D. and Garcia-Posada, M. (2019), “The impact of the ECB’s targeted long-term refinancing operations on banks’ lending policies: the role of competition”, *Working Paper Series*, No 2364, ECB.

Andrews, D. and Petroulakis, F. (2019), “Breaking the shackles: Zombie firms, weak banks and depressed restructuring in Europe”, *Working Paper Series*, No 2240, ECB.

Anzoategui, D., Comin, D., Gertler, M. and Martinez, J. (2019), “Endogenous Technology Adoption and R&D as Sources of Business Cycle Persistence”, *American Economic Journal: Macroeconomics*, Vol. 11, Issue 3, pp. 67-110.

Arce, Ó., García-Posada, M., Mayordomo, S. and Ongena, S. (2021a), “Adapting lending policies when negative interest rates hit banks’ profits”, *Working Paper Series*, No 1832, Banco de España.

Arce, Ó., Gimeno, R. and Mayordomo, S. (2021b), “Making room for the needy: the credit reallocation effects of the ECB’s corporate QE”, Review of Finance, Vol. 25, Issue 1, February 2021, pp. 43-84.

Avouyi-Dovi, S., Bureau, B., Lecat, R., O’Donnell, C. and Villetelle, J.-P. (2016), “Corporate loans at particularly low rates in France”, *Quarterly Selection of Articles, Banque de France Bulletin*.

Babbel, D.F., Merrill, C.B., Meyer, M.F. and de Villiers, M. (2004), “The Effect of Transaction Size on Off-the-Run Treasury Prices”, *The Journal of Financial and Quantitative Analysis*, Vol. 70, No 3, pp. 595-611.

Balfoussia, H. and Gibson, H. (2016), “Financial conditions and economic activity: the potential impact of the targeted long-term refinancing operations (TLTROs)”, *Applied Economics Letters*, pp. 1-8.

Banco de Portugal (2017), “Distribution Mechanisms of Monetary Policy in the Portuguese Economy”, *Economic Bulletin*, pp. 93-110.

Banerjee, R. and Hofmann, B. (2018), “The rise of zombie firms: causes and consequences”, *BIS Quarterly Review*, pp. 1-12.

Barbiero, F. and Burlon, L. (2020), “The new series of quarterly targeted longer-term refinancing operations: impact on funding costs and transmission”, Box 1 in “Assessing bank lending to corporates in the euro area since 2014”, *Economic Bulletin*, Issue 1, ECB.

Bartocci, A., Burlon, L., Notarpietro, A. and Pisani, M. (2021), “Macroeconomic Effects of Non-Standard Monetary Policy Measures in the Euro Area: The Role of Corporate Bond Purchases”, *The Manchester School*, Vol. 89, Issue S1, pp. 97-130.

Bats, J. and Hudepohl, T., 2018. Revisiting the central bank’s lender of last resort function. Occasional Studies, 16-4, De Nederlandsche Bank.

Bats, J. and Hudepohl, T. (2019), “Impact of targeted credit easing by the ECB: bank-level evidence”, *Working Papers*, No 631, De Nederlandsche Bank.

Benetton, M. and Fantino, D. (2018), “Competition and the pass-through of unconventional monetary policy: evidence From TLTROs”, *Temi di Discussione (Working Papers)*, No 1187, Banca d’Italia.

Bergin, P.R. and Corsetti, G. (2008), “The extensive margin and monetary policy”, *Journal of Monetary Economics*, Vol. 55, Issue 7, pp. 1222-1237.

Bernardini, M. and De Nicola, A. (2020), “The market stabilization role of central bank asset purchases”, *Bank of Italy Working Paper 1310*, December 2020.

Bianchi, A. and Fernandez-Corugedo, E. (2018), “Uncertainty, Financial Frictions, and Nominal Rigidities: A Quantitative Investigation”, *Journal of Money, Credit and Banking*, Vol. 50, No 4, pp. 603-636.

BIS (2018), Financial stability implications of a prolonged period of low interest rates, Bank for International Settlements, Committee on the Global Financial System Papers, No 61.

Bittner, C., Bonfim, D., Heider, F., Saidi, F., Schepens, G. and Soares, C. (2020), “Why so negative? The effect of monetary policy on bank credit supply across the euro area”, unpublished working paper.

Blaes, B., Kraaz, B. and Offermanns, C. (2019), “The effects of the Eurosystem's APP on euro area bank lending: Letting different data speak”, *Discussion Paper*, No 26/2019, Deutsche Bundesbank.

Boeckx, J., de Sola Perea, M. and Peersman, G. (2020), “The transmission mechanism of credit support policies in the euro area”, *European Economic Review*, Vol. 124, pp. 103-403.

Boermans, M. and Keshkov, V. (2018), “The impact of the ECB asset purchases on the European bond market structure: Granular evidence on ownership concentration”, *Working Papers*, No 590, De Nederlandsche Bank.

Borio, C.E. and Hofmann, B. (2017), “Is monetary policy less effective when interest rates are persistently low?”, *BIS Working Papers*, No 628.

Borio, C. and Gambacorta, L. (2017), “Monetary policy and bank lending in a low interest rate environment: diminishing effectiveness?”, *Journal of Macroeconomics*, Vol. 54, pp. 217-231.

Borio, C., Gambacorta, L. and Hofmann, B. (2015), “The influence of monetary policy on bank profitability”, *BIS Working Papers*, No 514.

Borio, C., Gambacorta, L. and Hofmann, B. (2017), “The effects of monetary policy on bank profitability”, *International Finance*, Vol. 20, No 1, pp. 48-63.

Bottero, M., Minoiu, C., Peydró, J.-L., Polo, A., Presbitero, A. and Sette, E. (2019), “Negative Monetary Policy Rates and Portfolio Rebalancing: Evidence from Credit Register Data”, *IMF Working Paper*, WP/19/44.

Boucinha, M. and Burlon, L. (2020), “Negative rates and the transmission of monetary policy”, *Economic Bulletin*, Issue 3, ECB.

Brunnermeier, M.K. and Koby, Y. (2018), “The Reversal Interest Rate”, *NBER Working Paper*, No 25406.

Bubeck, J., Maddaloni, A. and Peydró, J.-L. (2019), “Negative Monetary Policy Rates and Systemic Banks’ Risk-Taking: Evidence from the Euro Area Securities Register”, *Working Papers*, No 1128, Barcelona Graduate School of Economics.

Burlon, L., Gerali, A., Notarpietro, A. and Pisani, M. (2015), “Inflation, financial conditions and non-standard monetary policy in a monetary union. A model-based evaluation”, *Temi di discussione* (*Working Papers*), No 1015, Banca d’Italia.

Caballero, R.J., Hoshi, T. and Kashyap, A.K. (2008), “Zombie Lending and Depressed Restructuring in Japan”, *American Economic Review*, Vol. 98, No 5, pp. 1943-1977.

Caggese, A. and Perez-Orive, A. (2017), “Capital Misallocation and Secular Stagnation”, *Finance and Economics Discussion Series*, No 2017-009, Board of Governors of the Federal Reserve System.

Casiraghi, M., Gaiotti, E., Rodano, L. and Secchi, A. (2018), “A ‘reverse Robin Hood’? The distributional implications of non-standard monetary policy for Italian households”, *Journal of International Money and Finance*, Vol. 85, Issue C, pp. 215-235.

Christensen, J. and Gillan, J. (2017), “Does Quantitative Easing Affect Market Liquidity?”, *Working Paper Series*, No 2031-26, Federal Reserve Bank of San Francisco.

Christiano, L., Motto, R. and Rostagno, M. (2010), “Financial factors in economic fluctuations”, *Working Paper Series*, No 1192, ECB.

Christiano, L., Motto, R. and Rostagno, M. (2014), “Risk Shocks”, *American Economic Review*, Vol. 104, No 1, pp. 27-65.

Claessens, S., Coleman, N. and Donnelly, M. (2018), “‘Low-For-Long’ Interest Rates and Banks’ Interest Margins and Profitability: Cross-Country Evidence”, *Journal of Financial Intermediation*, Vol. 35, Issue A, pp 1-16.

Cloyne, J., Ferreira, C., Froemel, M. and Surico, P. (2018), “Monetary Policy, Corporate Finance and Investment”, *NBER Working Paper*, No 25366.

Colciago, A. and Silvestrini, R. (2020), “Monetary policy, productivity, and market concentration”, *Working Papers*, No 685, De Nederlandsche Bank.

Colciago, A., Samarina, A. and de Haan, J. (2019), “Central Bank Policies and Income and Wealth Inequality: A Survey”, *Journal of Economic Surveys*, Vol. 33. Issue 4, pp. 1199-1231.

Corwin, S. and Schultz, P. (2012), “A Simple Way to Estimate Bid-Ask Spreads from Daily High and Low Prices”, *The Journal of Finance*, Vol. 67, Issue 2, pp. 719-760.

Cova, P., Pagano, P. and Pisani, M. (2019), “Domestic and International Effects of the Eurosystem Expanded Asset Purchase Programme: A Structural Model-Based Analysis”, *IMF Economic Review*, Vol. 67, Issue 2, pp. 315-348.

Corradin, S., Eisenschmidt, J., Hoerova, M., Linzert, T., Schepens, G. and Sigaux, J.-D. (2020), “Money markets, central bank balance sheet and regulation”, *Working Paper Series*, No 2483, ECB.

Costain, J., Nuno, G. and Thomas, C. (2021), “The Term Structure of Interest Rates in a Heterogeneous Monetary Union”, Banco de Espana, mimeo.

Cravo Ferreira, M. (2019), “What happens when the ECB opens the cash tap? An application to the Portuguese credit market”, dissertation, Universidade Católica Portuguesa.

D’Amico, S. and King, T.B. (2013), “Flow and stock effects of large-scale treasury purchases: Evidence on the importance of local supply”, *Journal of Financial Economics*, Vol. 108, Issue 2, pp. 425-448.

Darracq Pariès, M., Kok, C. and Rottner, M. (2020), “Reversal interest rate and macroprudential policy”, *Working Paper Series*, No 2487, ECB.

Darracq-Paries, M. and De Santis, R. (2015), “A non-standard monetary policy shock: The ECB's 3-year LTROs and the shift in credit supply”, *Journal of International Money and Finance*, Vol. 54, pp. 1-34.

De Groot, O. and Haas, A., 2019. "The Signalling Channel of Negative Interest Rates". *SSRN Electronic Journal*.

De Santis, R., Geis, A., Juskaite, A. and Vaz Cruz, L. (2018), “The impact of the corporate sector purchase programme on corporate bond markets and the financing of euro area non-financial corporations”, *Economic Bulletin*, Issue 3, ECB.

De Santis, R. and Holm-Hadulla, F. (2020), “Flow Effects of Central Bank Asset Purchases on Sovereign Bond Prices: Evidence from a Natural Experiment”, *Journal of Money, Credit and Banking*, Vol. 52, No 6, pp. 1467-1491.

De Santis, R. and Zaghini, A. (2019), “Unconventional monetary policy and corporate bond issuance”, *Working Paper Series*, No 2329, ECB.

Demiralp, S., Eisenschmidt, J. and Vlassopoulos, T. (2021), “Negative interest rates, excess liquidity and retail deposits: Banks’ reaction to unconventional monetary policy in the euro area”, *European Economic Review*, Vol. 136, pp. 1-29.

Deutsche Bundesbank (2016), “Distributional effects of monetary policy”, *Monthly Report*, September, pp. 13-36.

Deutsche Bundesbank (2018), “The importance of bank profitability and bank capital for monetary policy”, *Monthly Report*, January, pp. 27-52.

Eggertsson, G., Juelsrud, R.E., Summers, L.H. and Wold, E.G. (2019), “Negative Nominal Interest Rates and the Bank Lending Channel”, *NBER Working Paper*, No 25416.

Eser, F., Lemke, W., Nyholm, K., Radde, S. and Vladu, A.L. (2019), “Tracing the impact of the ECB’s asset purchase programme on the yield curve”, *Working Paper Series*, No 2293, ECB.

Esposito, L., Fantino, D. and Sung, Y. (2020), “The impact of TLTRO2 on the Italian credit market: some econometric evidence”, *Temi di Discussione (Working Papers)*, No 1264, Banca d’Italia.

European Central Bank (2017), “The targeted longer-term refinancing operations: an overview of the take-up and their impact on bank intermediation”, *Economic Bulletin*, Issue 3, Frankfurt am Main.

European Central Bank (2018), *Financial Stability Review*, Frankfurt am Main, May.

Fache Rousová, L. and Giuzio, M. (2019), “Insurers’ investment strategies: pro- or countercyclical?”, *Working Paper Series*, No 2299, ECB.

Ferrando, A. and Ruggieri, A. (2018), “Financial constraints and productivity: Evidence from euro area companies”, *International Journal of Finance & Economics*, Vol. 23, Issue 3, pp. 257-282.

Flanagan, T. (2020), “Stealth Recapitalization and Bank Risk Taking: Evidence from TLTROs”, *Working Paper,* University of Michigan.

Freriks J. and J. Kakes (2021), “Bank interest rate margins in a negative interest rate environment, Working Paper No. 721, De Nederlandsche Bank.

Galema, R. and Lugo, S. (2021), “When Central Banks Buy Corporate Bonds: Target Selection and Impact of the European Corporate Sector Purchase Program”, *Journal of Financial Stability*, Vol. 54.

Gambetti, L. and Musso, A. (2017), “The macroeconomic impact of the ECB's expanded asset purchase programme (APP)”, *Working Paper Series*, No 2075, ECB.

Garga, V. and Singh, S. (2021), “Output Hysteresis and Optimal Monetary Policy”, *Journal of Monetary Economics,* Vol. 117, pp. 871-886.

Gautier, E., Penalver, A. and Savignac, F. (2020), “Monetary Policy and Inequality: Where Do We Stand?”, *Eco Notepad*, Post no 151, Banque de France.

Gerke, G., Giesen, S. and Kienzler, D. (2018), “Uncertainty about QE effects when an interest rate peg is anticipated”, *Discussion Paper*, No 12/2018, Deutsche Bundesbank.

Gibson, H., Hall, S., Petroulas, P. and Tavlas, G. (2020), “On the effects of the ECB’s funding policies on bank lending”, *Journal of International Money and Finance*, Vol. 102, Issue C, pp. 102-112.

Grande, G., Grasso, A. and Zinna, G. (2019) “The effectiveness of the ECB’s asset purchases at the lower bound”, *Questioni di Economia e Finanza* (*Occasional Papers*), No 541, Banca d’Italia.

Gopinath, G., Kalemli-Özcan, Ş., Karabarbounis, L. and Villegas-Sanchez, C. (2017), "Capital Allocation and Productivity in South Europe*", *The Quarterly Journal of Economics*, Vol. 132, Issue 4, pp. 1915-1967.

Grandi, P. and Guille, M. (2021), "The Upside Down: Banks, Deposits and Negative Rates", available at SSRN: https://ssrn.com/abstract=3363743 or http://dx.doi.org/10.2139/ssrn.3363743.

Greenwood, R. and Vayanos, D. (2014), "Bond Supply and Excess Bond Returns", *Review of Financial Studies*, Vol. 27, Issue 3, pp. 663-713.

Gropp, R., Mosk, T., Ongena, S. and Wix, C. (2016), "Banks Response to Higher Capital Requirements: Evidence from a Quasi-Natural Experiment", *The Review of Financial Studies*, Vol. 32, Issue 1, pp. 266-299.

Grosse-Rueschkamp, B., Steffen, S. and Streitz, D. (2019), "A capital structure channel of monetary policy", *Journal of Financial Economics*, Vol. 133, Issue 2, pp. 357-378.

Haldane, A., Roberts-Sklar, M., Young, C. and Wieladek, T. (2016), "QE: The Story So Far", *Staff Working Papers*, No 624, Bank of England.

Hamano, M. and Zanetti, F. (2020), *Monetary policy, firm heterogeneity, and product variety*, University of Oxford.

Hammermann, F., Leonard, K., Nardelli, S. and von Landesberger, J. (2019), "Taking stock of the Eurosystem's asset purchase programme after the end of net asset purchases", *Economic Bulletin*, Issue 2, ECB.

Han, M.F. and Seneviratne, M. (2018), "Scarcity effects of quantitative easing on market liquidity: Evidence from the Japanese government bond market", *IMF Working Paper*, No 18/96.

Hartwig, B. and Lieberknecht, P. (2020), "Monetary policy, firm exit and productivity", *Discussion Paper*, No 61/2020, Deutsche Bundesbank.

Heider, F., Saidi, F. and Schepens, G. (2019), "Life below Zero: Bank Lending under Negative Policy Rates", *Review of Financial Studies*, Vol. 32, Issue 10, pp. 3728-3761.

Hohberger, S., Priftis, R. and Vogel, L. (2019), "The macroeconomic effects of quantitative easing in the euro area: evidence from an estimated DSGE model", *Journal of Economic Dynamics and Control*, Vol. 108, Issue C.

Hudepohl, T., van Lamoen, R. and de Vette, N. (2021), "Quantitative easing and exuberance in stock markets: Evidence from the euro area", *Journal of International Money and Finance*, Vol. 118.

Ikeda, D. and Kurozumi, T. (2019), "Slow Post-financial Crisis Recovery and Monetary Policy", *American Economic Journal: Macroeconomics*, Vol. 11, Issue 4, pp. 82-112.

Iwatsubo, K. and Taishi, T. (2016), “Quantitative Easing and Liquidity in the Japanese Government Bond Market”, *International Review of Finance*, Vol. 18, Issue 3, pp. 463-475.

Jordà, Ò., Singh, S. and Taylor, A. (2020), “Longer-Run Economic Consequences of Pandemics”, *Working Paper Series*, No 2020-09, Federal Reserve Bank of San Francisco.

Jurkšas, L., Kapp, D., Nyholm, K. and von Landesberger, J. (2018), “Euro area sovereign bond market liquidity since the start of the PSPP”, *Economic Bulletin*, Issue 2, ECB.

Kandrac, J. and Schlusche, B. (2013), “Flow Effects of Large-Scale Asset Purchases”, *Economics Letters*, Vol. 121, Issue 2, pp. 330-335.

Kandrac, J. (2018), “The Cost of Quantitative Easing: Liquidity and Market Functioning Effects of Federal Reserve MBS Purchases”, *International Journal of Central Banking*, Vol. 14, Issue 5, pp. 259-304.

Kapp, D. and Kristiansen, K. (2021), “Euro area equity risk premia and monetary policy: a longer-term perspective”, *Working Paper Series*, No 2535, ECB.

Kerbl S. and Sigmund M. (2016). “From low to negative rates: an asymmetric dilemma”, *Oesterreichische Nationalbank Financial Stability Report*, Vol. 32, pp. 120-137.

King, T. (2019), “Expectation and Duration at the Effective Lower Bound”, *Journal of Financial Economics*, Vol. 134, Issue 3, pp. 736-760.

Klein, M. (2020), “Implications of negative interest rates for the net interest margin and lending of euro area banks”, *BIS Working Paper*, No 848, Bank for International Settlements, March.

Koijen, R.S., Koulischer, F., Nguyen, B. and Yogo, M. (2017), “Euro-area quantitative easing and portfolio rebalancing”, *American Economic Review*, Vol. 107, No 5, pp. 621-27.

Krogstrup, S., Kuchler, A. and Spange, M. (2020), “Negative interest rates: The Danish experience”, VoxEU.

Kühl, M. (2018), “The Effects of Government Bond Purchases on Leverage Constraints of Banks and Non-Financial Firms”, *International Journal of Central Banking*, Vol. 14, Issue 4.

Kwapil C. and Rieder K. (2021), “The effects of the monetary policy response to the COVID-19 pandemic: preliminary evidence from a pilot study using Austrian bank-level data”, *Monetary Policy & the Economy*, , Issue Q4/20-Q1/, Oesterreichische Nationalbank, pp. 131-152.

Laine, O.-M. (2021), “The Effect of Targeted Monetary Policy on Bank Lending”, *Journal of Banking and Financial Economics*, Vol. 1, Issue 15, pp. 25-43.

Lang, V., Mihalyi, D. and Presbitero, A. (2020), “Borrowing costs after debt relief”, VoxEU.

Lenza, M. and Slacalek, J. (2018), “How does monetary policy affect income and wealth inequality? Evidence from quantitative easing in the euro area”, *Working Paper Series*, No 2190, ECB.

Levine, O. and Warusawitharana, M. (2019), “Finance and productivity growth: Firm-level evidence”, *Journal of Monetary Economics*, Vol. 117, Issue C, pp. 91-107.

Li, C. and Wei, M. (2013), “Term Structure Modeling with Supply Factors and the Federal Reserve's Large-Scale Asset Purchase Programs”, *International Journal of Central Banking*, Vol. 9, Issue 1, pp. 3-39.

Lilley, A. and Rogoff, K. (2020), “The Case for Implementing Effective Negative Interest Rate Policy”, in Cochrane, J. and Taylor, J. (eds.), *Strategies for Monetary Policy*, Hoover Institution Press, Stanford.

Manaresi, F. and Pierri, N. (2017), “Credit Constraints and Firm Productivity: Evidence from Italy”, *Mo.Fi.R. Working Papers*, No 137, Money and Finance Research group (Mo.Fi.R.) – Univ. Politecnica Marche – Dept Economic and Social Sciences.

Moran, P. and Queralto, A. (2017), “Innovation, Productivity, and Monetary Policy”, *International Finance Discussion Papers*, No 1217, Board of Governors of the Federal Reserve System.

Mota, L. and Papoutsi, M. (2020), “Understanding the effects of unconventional monetary policy on corporate bond market in the euro area”, *mimeo*.

Mouabbi, S. and Sahuc, J.G. (2019), “Evaluating the Macroeconomic Effects of the ECB’s Unconventional Monetary Policies”, *Journal of Money, Credit and Banking*, Vol. 51, No 4, pp. 831-858.

Nelimarkka, J. and Kortela, T. (2020), “The effects of conventional and unconventional monetary policy: identification through the yield curve”, *Bank of Finland Research Discussion Papers*, No 3, Suomen Pankki – Finlands Bank.

Neri, S. and Siviero, S. (2018), “The Non-Standard Monetary Policy Measures of the ECB: Motivations, Effectiveness and Risks”, *Credit and Capital Markets – Kredit und Kapital*, Vol. 51, Issue 4, pp. 513-560.

Neuhann, D. and Saidi, F. (2018), “Do universal banks finance riskier but more productive firms?”, *Journal of Financial Economics*, Vol. 128, Issue 1, pp. 66-85.

Offermanns, C.J. and Blaes, B.A. (2019), “The Effects of Unconventional Monetary Policies on the Lending Activity of German Banks”, mimeo.

Pascual, A. and Wieladek, T. (2016), “The European Central Bank’s QE: A New Hope”, *CESifo Working Paper Series*, No 5946.

Plessen-Mátyás, K., Kaufmann, C. and von Landesberger, J. (2021), "Funding behaviour of debt management offices and the ECB's Public Sector Purchase Programme", *Working Paper Series*, No 2552, ECB.

Rostagno M., Altavilla C., Carboni, G., Lemke, W., Motto, R. and Saint-Guilhem, A. (2021a), "Combining negative rates, forward guidance and asset purchases: identification and impacts of the ECB's unconventional policies", *Working Paper Series*, No 2564, ECB.

Rostagno, M., Altavilla, C., Carboni, G., Lemke, W., Motto, R., Saint-Guilhem, A. and Yiangou, J. (2021b), *Monetary Policy in Times of Crisis: A Tale of Two Decades of the European Central Bank*, Oxford University Press

Sahuc, J.G. (2016), "The ECB's asset purchase programme: A model-based evaluation", *Economics Letters*, Vol. 145, Issue C, pp. 136-140.

Schlepper, K., Hofer, H., Riordan, R. and Schrimpf, A. (2020), "The market microstructure of central bank bond purchases", *The Journal of Financial and Quantitative Analysis*, Vol. 55, No 1, pp. 193-221.

Schivardi, F., Sette, E. and Tabellini, G. (2020), "Identifying the Real Effects of Zombie Lending", *The Review of Corporate Finance Studies*, Vol. 9, Issue 3, pp. 569-592.

Schivardi, F., Sette, E. and Tabellini, G. (2021), "Credit misallocation during the European financial crisis", *Economic Journal*, forthcoming.

Schmöller, M. and Spitzer, M. (2021), "Endogenous TFP, business cycle persistence and the productivity slowdown in the euro area", *Working Paper Series*, No 2401, ECB.

Slacalek, J., Tristani, O. and Violante, G. (2020), "Household Balance Sheet Channels of Monetary Policy: A Back of the Envelope Calculation for the Euro Area", *Journal of Economic Dynamics and Control*, Vol. 115, Issue C.

Steeley, J. (2015), "The side effects of quantitative easing: Evidence from the UK bond market", *Journal of International Money and Finance*, Vol. 51, pp. 303-336.

Storz, M., Koetter, M., Seltzer, R. and Westphal, A. (2017), "Do we want these two to tango? On zombie firms and stressed banks in Europe", *Working Paper Series*, No 2104, ECB.

Syverson, C. (2011), "What Determines Productivity?", *Journal of Economic Literature*, Vol. 49, Issue 2, pp. 326-365.

Tan, G. (2019), "Beyond the zero lower bound: negative policy rates and bank lending", *Working Papers*, No 649, De Nederlandsche Bank.

Todorov, K. (2020), "Quantify the quantitative easing: Impact on bonds and corporate debt issuance", *Journal of Financial Economics*, Vol. 135, Issue 2, pp. 340-358.

Ulate, M. (2021), “Going Negative at the Zero Lower Bound: The Effects of Negative Nominal Interest Rates”, *American Economic Review*, Vol. 111, No 1, pp. 1-40.

Uras, B. and Wang, P. (2017), “Production Flexibility, Misallocation and Total Factor Productivity”, *NBER Working Paper*, No 23970.

Vayanos, D. and Vila, J. (2021), “A Preferred-Habitat Model of the Term Structure of Interest Rates”, *Econometrics*, Vol. 89, Issue 1, pp. 77-112.

Van den End, J.W., Konietschke, P., Samarina, A. and Stanga, L. (2020), “Macroeconomic reversal rate: evidence from a nonlinear IS-curve”, *Working Papers*, No 684, De Nederlandsche Bank.

Van Dijk, M. and Dubovik, A. (2018), “Effects of Unconventional Monetary Policy on European Corporate Credit”, *CPB Discussion Paper*, No 372, CPB Netherlands Bureau for Economic Policy Analysis.

Vlieghe, G. (2018), “The yield curve and QE”, Speech given by Gertjan Vlieghe, Bank of England, at Imperial College Business School, 25 Sept 2018.

Work stream on inflation measurement (2021), “Inflation measurement and its assessment in the ECB’s monetary policy strategy review”, *Occasional Paper Series*, No 264, ECB, September.

Work stream on monetary-fiscal policy interactions (2021), “Monetary-fiscal policy interactions in the euro area”, *Occasional Paper Series*, No 272, ECB, September.

Work stream on the price stability objective (2021), “The ECB’s price stability framework: past experience, and current and future challenges”, *Occasional Paper Series*, No 269, ECB, Frankfurt am Main, September.

Work stream on productivity, innovation and technological progress (2021), "Key factors behind productivity trends in EU countries”. *Occasional Paper Series*, No 268, ECB, September.

Zaghini, A. (2019), “The CSPP at work: Yield heterogeneity and the portfolio rebalancing channel”, *Journal of Corporate Finance*, Vol. 56, pp. 282-297.

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