

The macroeconomic impact of quantitative easing in the euro area

Against the backdrop of subdued inflation prospects and falling market-based inflation expectations at the zero lower bound on interest rates, the ECB Governing Council introduced an asset purchase programme (APP) in March 2015 and has since expanded this on multiple occasions. The declared aim of this programme is a sustained adjustment in the path of inflation towards inflation rates of below, but close to, 2% over the medium term.

As the euro area has no experience, to date, with the effectiveness of quantitative easing of this kind on real economic developments and inflation, model-based analyses play an important role in evaluating these non-standard monetary policy measures.

The simulations presented in this article show that the various model approaches differ considerably in terms of how they evaluate the effectiveness of quantitative easing on macroeconomic developments and inflation. Nevertheless, they bear out the experience of other currency areas – namely that, all other things being equal, quantitative easing can have an expansionary effect on aggregate demand and inflation.

In addition to those effects of quantitative easing intended by the ECB Governing Council, there is, however, also the potential for unwanted side effects. These include an increasing nexus between monetary and fiscal policy, risks relating to the profitability of financial institutions and an excessively high propensity to run risks. The longer the highly accommodative stance remains in place, the more likely its side effects are to deepen. This is why monetary policy, which is currently using expansionary measures in a bid to lift inflation from its very depressed level, must usher in the normalisation of monetary policy once it reaches a price path that is compatible with the Eurosystem's stability target – irrespective of the state of public finances or financial stability.

Non-standard Eurosystem measures since mid-2014

Eurosystem's resolute response to the financial crisis

Since 2007, the Eurosystem has adopted a range of non-standard measures to counteract the impact of the banking, financial and sovereign debt crisis. Prior to June 2014, its primary objective was to safeguard the functioning of the monetary policy transmission process.¹ The remaining scope for policy rate cuts increasingly became an issue during 2014 (see the chart below)² and, with inflation prospects subdued and market-based inflation expectations falling, a series of new non-standard measures was therefore gradually adopted from June 2014 onwards with the aim of achieving a more accommodative monetary policy stance (see the chart on page 31).

September 2014: ABSPP and CBPP3 launched

In June 2014, the Eurosystem announced the introduction of targeted longer-term refinancing operations (TLTROs). These allow banks to borrow from the Eurosystem at fixed interest rates for a period of up to four years in a series of eight operations conducted at quarterly intervals starting in September 2014.³ In September 2014, the Eurosystem also announced the launch of two further asset purchase programmes: the asset-backed securities purchase programme (ABSPP) and the third covered bond purchase programme (CBPP3).

In January 2015, the Eurosystem finally announced the introduction of the expanded asset purchase programme (APP) in order to further loosen its monetary policy stance. The majority of the ECB Governing Council deemed this measure necessary as the inflation forecasts and measures of market participants' long-term inflation expectations had fallen further despite the many measures taken. However, survey-based inflation expectations do not back up this decrease, which can be taken as a sign that the decline in market-based expectation measures could be related to an increasingly negative inflation risk premium (see the chart on page 32).

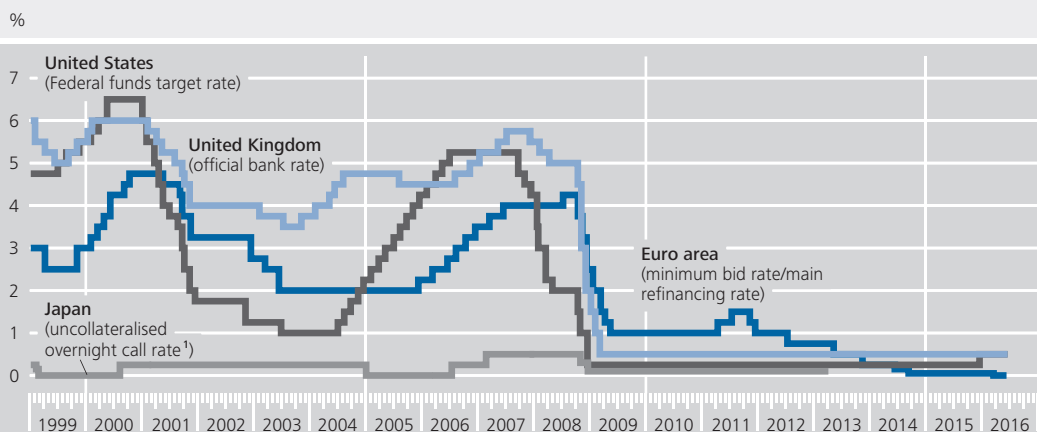
January 2015: quantitative easing announced (APP launched in March)

1 The non-standard measures implemented prior to June 2014 included the following asset purchase programmes: the covered bond purchase programme (CBPP1, July 2009 to June 2010, and CBPP2, November 2011 to October 2012), the securities markets programme (SMP, May 2010 to September 2012) and, lastly, outright monetary transactions (OMT, as of September 2012; no purchases to date).

2 This applies not only to the euro area but also to other currency areas.

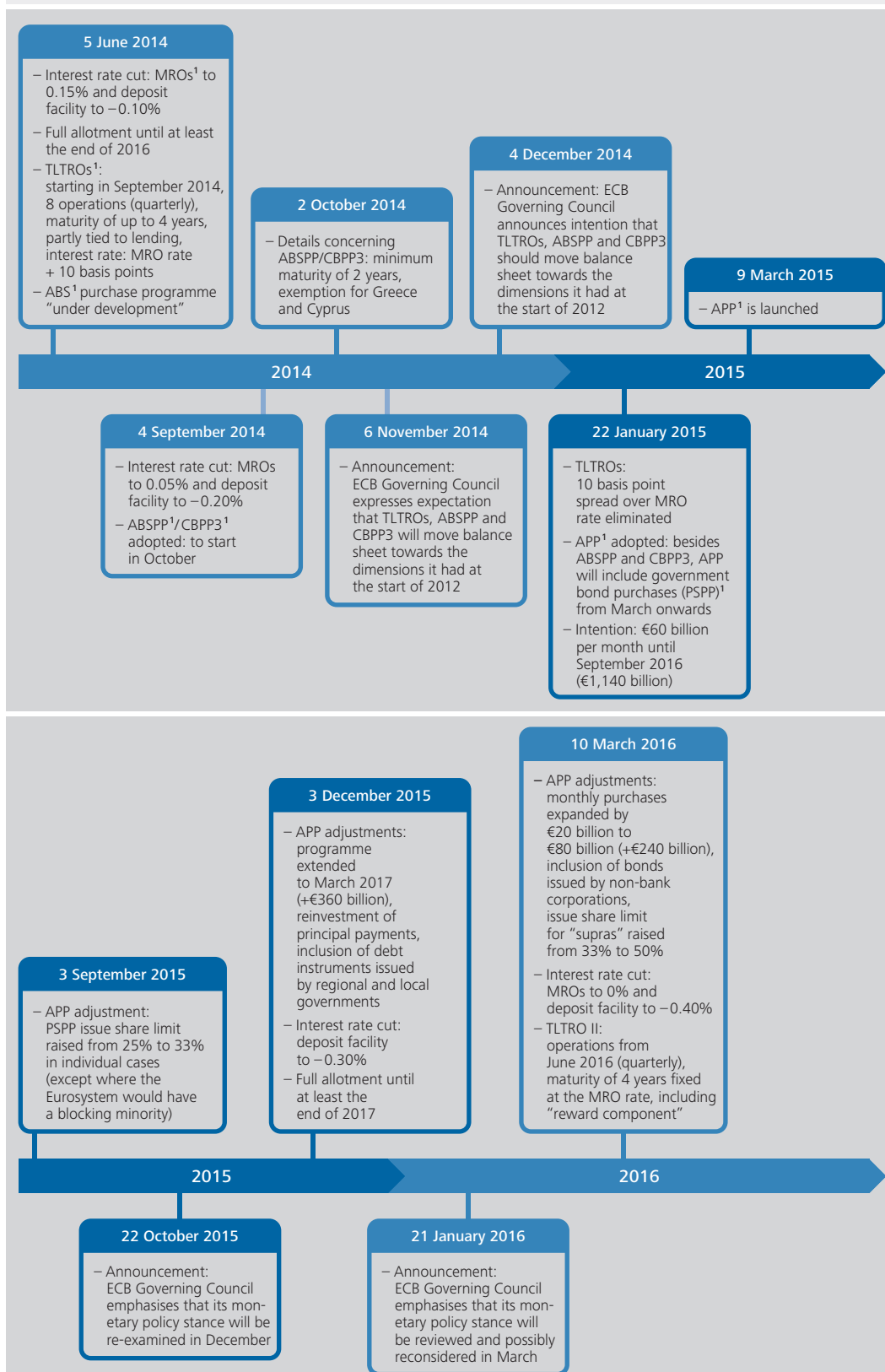
3 Importantly, the amounts that banks can borrow were linked, for the first two TLTROs, to their stock of eligible loans (loans to euro-area non-financial corporations and households, excluding loans to households for house purchases) as at 30 April 2014, while, for the remaining six operations, the evolution of eligible lending since May 2014 is key. The interest rate on the first two TLTROs was set at a ten basis point spread over the main refinancing rate prevailing at the time when each TLTRO was conducted. This spread was eliminated for the remaining six TLTROs.

Central bank interest rates



Sources: Respective central banks. **1** Uncollateralised overnight call rate target until 18 March 2001. Overnight call rate determined directly from the outstanding balance of the current accounts at the central bank as an operating target from 19 March 2001 to 8 March 2006 before returning to the overnight call rate target. Reintroduction of monetary base control from 4 April 2013.

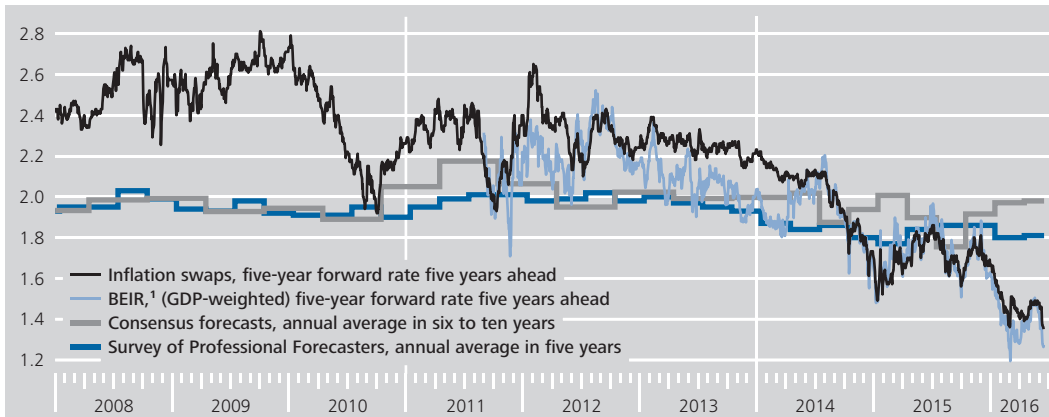
Chronology of selected Eurosystem monetary policy measures since 2014



¹ MROs: main refinancing operations; TLTROs: targeted longer-term refinancing operations; ABS: asset-backed securities; ABSPP: asset-backed securities purchase programme; CBPP: covered bond purchase programme; and APP: expanded asset purchase programme; PSPP: public sector purchase programme.

Long-term inflation expectations in the euro area

%, daily data



Sources: ECB, Consensus Economics, Thomson Reuters, EuroMTS and Bundesbank calculations. **1** Breakeven inflation rate (BEIR) = difference between the yield on a nominal bond and the yield on an inflation-linked bond of the same maturity.

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The APP marks the start of quantitative easing in the euro area as, in addition to ABSPP and CBPP3, which were introduced prior to this, its chief component is the comprehensive purchase of public sector securities (public sector purchase programme, or PSPP). Initially, total APP purchases were to amount to €60 billion a month until the end of September 2016, or beyond, if necessary, and, in any case, until a sustained adjustment was seen in the path of inflation that is consistent with the aim of achieving inflation rates below, but close to, 2% over the medium term.⁴ In the light of forecasts being revised downwards, the ECB Governing Council took the decision in December 2015 to extend the programme until March 2017.⁵ This was followed by the decision in March 2016 to increase the volume of monthly purchases by €20 billion to €80 billion from April 2016. As of June 2016, this also includes the purchase of

4 The individual components of the APP take differing forms with respect to risk-sharing. The ABSPP, CBPP3 and, as of March 2016, the corporate sector purchase programme (CSPP) are subject to full risk-sharing. Under the PSPP, 20% of asset purchases are subject to the principle of risk-sharing. Purchases of assets issued by European institutions – these assets make up 10% of the additional asset purchases under the PSPP and are acquired by the national central banks – are subject to loss-sharing. The ECB holds 10% of the assets purchased additionally under the PSPP. In March 2016, the decision was made to decrease the share of purchases of bonds issued by supranational institutions from 12% to 10% and to raise the share of purchases conducted by the ECB from 8% to 10% – overall, the risk-shared part of the PSPP remains unchanged at 20%. The remaining 80% of asset purchases by the national central banks under the PSPP are not subject to loss-sharing. For more on this, see the ECB press release of 22 January 2015, available at http://www.ecb.europa.eu/press/pr/date/2015/html/pr150122_1.en.html

5 The ECB Governing Council also decided to reinvest the principal payments on the assets purchased under the APP as they mature and to cut the interest rate on the deposit facility to -0.3%. Furthermore, it decided to continue conducting the main refinancing operations as fixed rate tender procedures with full allotment at least until the end of the last reserve maintenance period of 2017 and to include euro-denominated marketable debt instruments issued by regional and local governments located in the euro area in the list of assets that are eligible for regular purchases by the respective national central banks under the PSPP. For more on this, see also the introductory statement to the press conference on the monetary policy decisions of 3 December 2015, available at <http://www.ecb.europa.eu/press/pressconf/2015/html/is151203.en.html>

corporate bonds.⁶ The non-standard measures, particularly the PSPP, have, since August 2015, represented the most significant component of Eurosystem liquidity provision (see the adjacent chart).

Transmission channels of quantitative easing

Quantitative easing takes effect via various channels ...

The ultimate goal of quantitative easing is to raise the inflation rate. Much like conventional interest rate policy, quantitative easing also influences macroeconomic developments via various channels. The main way that this works is that asset prices or yields are influenced by purchases of government bonds. It is perhaps somewhat surprising, however, that, in theory, such purchases need not necessarily have an effect on asset prices and yields – and, by extension, on inflation. Therefore, we will first briefly outline the conditions under which any purchases of assets have an impact on macroeconomic developments before moving on to explain individual transmission channels.

Neutrality of asset purchases for monetary policy purposes?

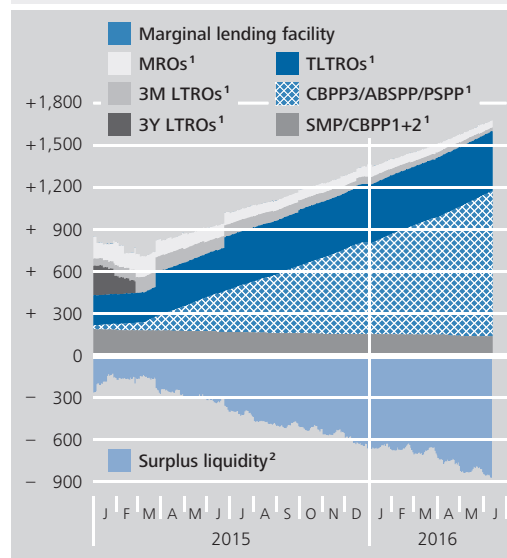
... but can, under strict conditions, also be neutral; ...

Traditionally, the “liquidity trap” plays a key role in the economic debate on the effectiveness of quantitative easing. If, at the zero lower bound on interest rates, risk-free, short-term assets (particularly government bonds) and central bank money are largely identical from the banks’ perspective, asset purchases by the central banks will only result in the volume of short-term government bonds held by banks falling and the amount of central bank money hoarded rising correspondingly. Purchases of these assets for monetary policy purposes would then be “neutral” in that they would have no effect on real economic activity and goods prices.

However, the purchase of long-term, possibly risky assets by a central bank can, under certain

Liquidity management in the Eurosystem

€ billion, daily data



Source: ECB. **1** MROs: main refinancing operations; 3M LTROs: longer-term refinancing operations (with a three-month maturity); 3Y LTROs: special-term refinancing operations (three-year maturity); TLTROs: targeted longer-term refinancing operations; CBPP: covered bond purchase programme (three different programmes); ABSPP: asset-backed securities purchase programme; PSPP: public sector purchase programme; and SMP: securities markets programme. **2** Central bank reserves + deposit facility – minimum reserve requirements. Excess liquidity is shown with an inverted sign.

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conditions, also be neutral in this sense.⁷ If the central bank assumes risks by purchasing assets that were initially held in the private sector, the real economic allocation remains unchanged if these risks – should they come to pass – ultimately have to be shouldered again by the pri-

⁶ Investment-grade euro-denominated bonds issued by non-bank corporations (ie excluding credit institutions and entities with a parent company that belongs to a banking group, banks and investment firms) established in the euro area were included in the list of assets that are eligible for regular purchases. Furthermore, the ECB Governing Council decided to cut the interest rates for main refinancing operations and the marginal lending facility by a further 0.05 percentage point and that of the deposit facility by a further 0.1 percentage point. It also decided to launch a new series of four targeted longer-term refinancing operations (TLTRO II), each with a four-year maturity. The lowest rate at which counterparties can borrow during these operations is the interest rate on the deposit facility at the time of allotment. For more on this, see also the ECB press release of 10 March 2016, available at <http://www.ecb.europa.eu/press/pr/date/2016/html/pr160310.en.html>

⁷ See N Wallace (1981), A Modigliani-Miller theorem for open-market operations, *American Economic Review* 71(3), pp 267-274; and M Woodford, Methods of policy accommodation at the interest-rate lower bound, speech held at the Jackson Hole Symposium, 31 August 2012.

vate sector through (additional) taxation (known as Wallace neutrality).

... however, Wallace neutrality is difficult to reconcile with monetary policy practice

However, this postulate of neutrality is based on a series of very strict assumptions (see the box on pages 36 and 37) that are likely too restrictive to apply in monetary policy practice.⁸ In particular, it cannot be assumed that the functioning of the financial markets is completely frictionless as the markets are affected, *inter alia*, by liquidity limitations (especially after the onset of the financial crisis), funding constraints and market segmentation. Furthermore, individual investors probably have a preference for certain maturities and asset classes that cannot be attributed to purely pecuniary differences. The conditions under which quantitative easing produces real economic effects that impact aggregate price developments via a multitude of channels are thus fulfilled (see the chart⁹ on page 35).

Portfolio rebalancing channel

Portfolio rebalancing channel based on imperfect substitutability of assets, ...

In the absence of Wallace neutrality, quantitative easing causes investors to adjust their portfolios in various ways; this is reflected in relative yield shifts for individual asset classes and, above all, a flattening of the yield curve. This portfolio rebalancing channel is based chiefly on what is referred to as the preferred-habitat theory to explain the yield curve,¹⁰ which combines the liquidity premium and market segmentation theories.¹¹

- The liquidity premium theory asserts that long-term assets with a residual maturity that exceeds risk-averse investors' (short) investment horizon are only bought if they promise a premium that grows over the investment horizon (term premium). According to this hypothesis, this term premium (which is constant within each maturity) is always positive.
- According to the market segmentation theory, certain investors have a preference for

specific (residual) maturities (preferred habitat), meaning that the term premium does not necessarily rise monotonously with residual maturity.¹² Market segmentation theory assumes that the bond market comprises individual segments; bonds in these segments are not completely interchangeable, and arbitrage opportunities are limited accordingly. Changes in the supply of and demand for specific bonds may therefore be reflected in a change in the market price of these bonds.

In this environment, the purchase of long-term government bonds influences the yield curve via several channels. On the one hand, purchasing long-term bonds lowers their supply in the market (segment) in which the purchases take place. Market segmentation means that investors with a preference for these bonds will be prepared to pay a higher price.¹³ This reduces the yield not only on this bond class but also on close substitutes. If, on the other hand, the central bank purchases very large volumes of long-term bonds, the average maturity of the portfolios held by investors – and therefore

... with asset purchases resulting in portfolio shifts

⁸ See D Kohn, speech held at the Conference on monetary-fiscal policy interactions, expectations, and dynamics in the current economic crisis, Princeton University, 23 May 2009.

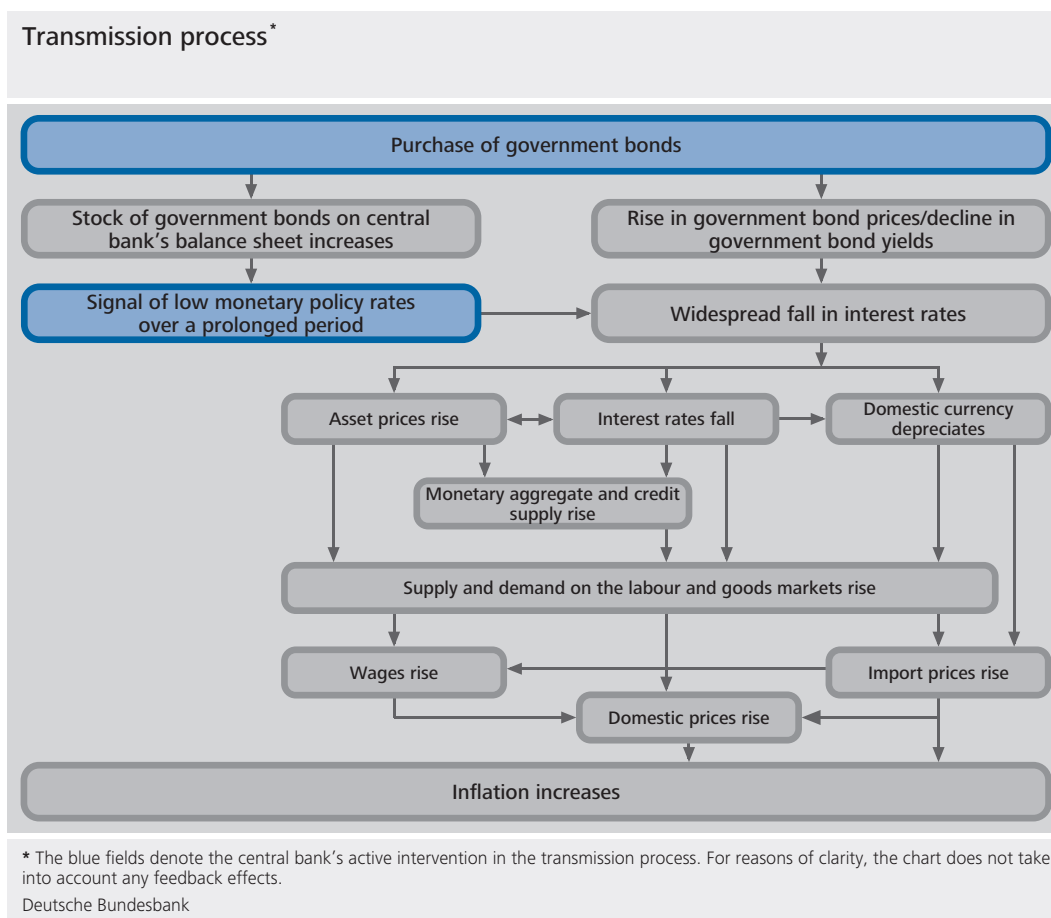
⁹ The channels depicted are widely considered the most significant in quantitative terms. A range of other channels can be found in the literature (see A Krishnamurty and A Vissing-Jorgensen (2011), The effects of quantitative easing on interest rates: channels and implications for policy, *Brookings Papers on Economic Activity* 43(2), pp 215-287), but these can be broadly subsumed under the channels presented here (see also S D'Amico, W English, D López-Salido and E Nelson (2012), The Federal Reserve's large-scale asset purchase programmes: rationale and effects, *The Economic Journal* 122(564), pp F415-F446).

¹⁰ See F Modigliani and R Sutch (1966), Innovations in interest rate policy, *American Economic Review* 56, pp 178-197; and D Vayanos and L-J Villa (2009), A preferred-habitat model of the term structure of interest rates, NBER Working Paper Series No 15487.

¹¹ See also O Issing (2011), *Einführung in die Geldtheorie*, 15th edition, Verlag Franz Vahlen, pp 125 ff.

¹² According to this theory, individual investors have heterogeneous preferences for bonds with different properties (eg a preference for certain maturities due to institutional or regulatory factors, as is the case for pension funds and life insurers) that cannot be attributed to purely pecuniary differences.

¹³ They would not be willing to pay a higher price if Wallace neutrality were to hold, but it is violated here due to the relevance of non-pecuniary factors to demand for securities (see the box on pp 36-37).



the aggregate term premium – will fall (duration effect).¹⁴

wise has a positive impact on aggregate demand and, ultimately, on inflation.

Excess liquidity can be used by banks to restore their optimal portfolio structure

Portfolio adjustments and therefore a potential fall in long-term yields can also be triggered in an environment in which negative interest is applied to central bank balances and in which the level of excess liquidity held by commercial banks is high.¹⁵ For example, a (sharp) increase in commercial banks' central bank account balances or the attendant rise in their excess liquidity¹⁶ following asset purchases can – irrespective of the maturity of the assets purchased – lead to a fall in long-term yields. The drop in long-term yields is a result of an increase in demand for long-term bonds on the part of commercial banks that, as part of their portfolio and balance sheet management, are attempting to restore their optimal profitability and risk structure by purchasing long-term bonds with a greater duration. The overall effect that it exerts on the yield curve means that any purchase of government bonds then like-

Signalling channel

The signalling channel is independent of the Wallace neutrality outlined above and is based on expectations theory, according to which the long-term interest rate is (approximately) equivalent to average short-term interest rate

Expansion in total assets as a signal of future monetary policy stance

¹⁴ While the duration effect affects the entire yield curve, the scarcity effect only causes changes in the market segment in which purchases are made.

¹⁵ See J Christensen and S Krogstrup, Transmission of quantitative easing: the role of central bank reserves, FRBSF Working Paper 2014-18.

¹⁶ Excess liquidity can be defined as central bank reserves + deposit facility – minimum reserve requirements. For information on the impact of Eurosystem asset purchases on TARGET2 balances, see Deutsche Bundesbank, German balance of payments in 2015, Monthly Report, March 2016, pp 37-56.

Wallace neutrality*

Assuming Wallace's postulate of neutrality holds true, purchases of risk-prone securities by a central bank count as neutral in that they do not engender any macroeconomic consequences. However, the postulate in question rests upon a number of assumptions.

- Any losses incurred by the central bank are offset and financed by private sector taxes.¹
- No financial frictions or constraints are in place; as many securities as desired can be acquired for the same price.² No market segmentation of any kind exists.³
- All eligible securities are valued solely on the basis of their pecuniary returns. As such, non-pecuniary factors that could play a role in the holding of certain assets remain disregarded.

Under the assumptions listed above, the private sector sees the value of a given asset as arising from the current value of those uncertain payoffs associated with the asset in question.⁴ Any simple reallocation of assets between the central bank and the private sector not resulting in a change in the real quantity of available resources for private consumption in different environments, or "states of the world" as Woodford puts it, then has no effect on the market price of a given asset, nor does it impact the economy as a whole.⁵

This result evidently contradicts the portfolio balance theory, according to which the purchase of risk-prone securities by the central bank gives rise to macroeconomic effects because it adds the risk to its own balance sheet. Conversely, the private sec-

tor may hold debt instruments – in the form of risk-free bonds, for example – which yield the same amount regardless of the state of the world. From the perspective of the private sector, purchases of risk-prone securities by the central bank have reduced the level of risk and changed the real quantity of resources available to the private sector.

In macroeconomic terms, however, this argument falls short of the mark. At the outset, purchases of risk-prone securities will shift the undesirable element of risk from the private to the public sector, which means that any losses that may arise are initially borne by the central bank. Should

* The following analysis is based on the speech "Methods of policy accommodation at the interest-rate lower bound", delivered by M Woodford at the Jackson Hole Symposium on 31 August 2012.

¹ See P Benigno and S Nisticò (2015), Non-neutrality of open-market operations, CEPR Discussion Paper, No 10594, p 7. The authors show that purchases remain neutral in character even when government makes no transfers. However, in such instances, the central bank needs to be able to absorb the incurred loss using future retained earnings. Neutrality hinges on the private sector ultimately compensating for the reduced central bank profits (transfers to the finance ministry) by rendering higher taxes. That being said, if the level of losses sustained by the central bank is "too high", the postulate of neutrality ceases to apply.

² For instance, the loan-in-advance constraint described by C T Carlstrom, T Fuerst and M Paustian (2014) in Targeting long rates in a model with segmented markets, Federal Reserve Bank of Cleveland Working Paper, pp 14-19.

³ While the quantitative easing administered by the central bank changes the level of state-dependent taxes, this is not reflected to the same extent in a corresponding change in the portfolio structure of those actors that are not affected by the central bank's purchasing activity (see also Woodford (2012), *op cit*, p 67).

⁴ The current value, for its part, is determined by the stochastic discount factor attached to the investor, which is in turn derived from the marginal utility of the income generated in different states of the world.

⁵ If the real available quantity of resources does not change in any specific state of the world, then the marginal utility of income remains unchanged, as does the stochastic discount factor.

the public sector subsequently raise taxes in order to fully absorb the losses incurred by the central bank, real after-tax income generated by the private sector will ultimately remain exposed to the risk in question, albeit only indirectly. Therefore, even in the wake of the central bank's purchasing activity, the private sector cannot consume more than it could previously. In this respect, any such purchases are neutral in nature inasmuch as they have no effect on aggregate demand or on price developments.

The assumptions that were outlined at the beginning of this analysis and that are of pivotal importance to the postulate of neutrality are, however, likely to be too restrictive for use in monetary policy practice. In particular, it can be assumed that different funding restrictions (such as loan-to-value ratios) or market segmentation are at play here. Individual investors may also exhibit a

preference for certain maturities that cannot be attributed to purely pecuniary differences. The conditions under which quantitative easing produces real economic effects that have an impact on aggregate price developments via a multitude of channels are thus fulfilled (see also the chart on page 35).⁶

⁶ The significance of possible financial restrictions and market segmentation is nonetheless not set exogenously but instead depends on the macroeconomic situation. For instance, market participants' risk aversion in times of crisis is likely to be far more pronounced, thus causing market segmentation to play a weightier role. This state dependence is likely to strengthen the impact of quantitative easing. See S Gürkaynak and J H Wright (2012), *Macroeconomics and the term structure*, *Journal of Economic Literature* 50(2), pp 331-367.

expectations.¹⁷ If, in addition to communicating the future evolution of policy rates (forward guidance), the central bank announces that it intends to purchase assets, market participants could interpret this as a further indicator of an expansionary monetary policy stance being maintained for some time to come. This would imply that what is being communicated is backed by concrete measures, supporting market participants in their perception of the future path of policy rates (at the effective lower bound, if applicable). If quantitative easing is interpreted as a signal that policy rates will remain at the effective lower bound for longer than previously expected, long-term interest rates would continue to fall in line with the expectations hypothesis.¹⁸ This would have a positive impact on general financing terms and therefore credit demand, stimulating aggregate demand and increasing inflation.¹⁹

A change in assets prices and yields through the portfolio rebalancing channel and the sig-

nalling channel creates the conditions under which quantitative easing can be transmitted through other channels.

Bank capital and balance sheet channel

The bank capital channel attributes special importance to a commercial bank's balance sheet position. If asset prices increase as a result of purchases, the assets of a bank, too, will in-

¹⁷ According to the expectations theory, an asset investment should generate the same expected yield in a given period of time, irrespective of whether the investment was made in the form of several short-term assets or a one-off longer-term bond. The assets are perfect substitutes for one another, which means that the signalling channel has an equal effect across all interest rates.

¹⁸ The literature also makes reference to what is known as the inflation channel, through which quantitative easing impacts directly on inflation expectations as well as influencing the distribution (ie uncertainty) of inflation expectations (see A Krishnamurty and A Vissing-Jorgensen (2011), *op cit*).

¹⁹ See also M Woodford (2012), *op cit*.

Bank capital channel: monetary policy transmission through a bank's capital position

crease. All other things being equal, the resulting profit has the effect of increasing commercial banks' capital. This increase enables commercial banks both to meet the higher capital requirements of a growing loan portfolio and facilitates their access to the funding needed to refinance their loans to enterprises, increasing banks' willingness to provide credit.

Balance sheet channel: monetary policy transmission via a borrower's net worth

What is known as the balance sheet channel applies similar reasoning to the borrower's financial situation.²⁰ The higher a borrower's capital (eg as a result of increasing asset prices induced by quantitative easing), the lower the credit default risk²¹ and the smaller the risk premium that lenders will demand to protect themselves against a default.²² Hence, external financing becomes more affordable for borrowers, making it easier for them to realise investment projects.

Exchange rate channel

Quantitative easing may result in exchange rate adjustments

The exchange rate channel is particularly important for open economies in which foreign trade makes up a notable share of economic activity. If an asset purchase programme causes the yields of assets denominated in domestic currency to fall in relation to those denominated in foreign currency, this will diminish the appeal of domestic bonds for foreign investors, and demand for domestic currency (which would be needed to purchase such bonds) will decline. This creates (at least temporary) downward pressure on the domestic currency.

First, such a depreciation makes exports of domestic goods and services cheaper, which tends to stimulate demand for such products from abroad. Second, foreign goods and services become more expensive for domestic consumers, causing domestic demand to focus increasingly on domestic rather than foreign products. Overall, this creates a positive effect in terms of (domestic) aggregate demand and spurs domestic inflation (due to higher prices for imported products, amongst other things).²³

Impact of quantitative easing in the euro area

According to the theoretical considerations, bond purchases should impact on aggregate demand and inflation via changes in financial market variables. Quantitative easing should, all other things being equal, cause long-term interest rates to fall, the euro to depreciate and – potentially with a certain lag – strengthen lending, consumption and investment activity. In a first step, selected financial market indicators are outlined below in order to obtain initial indications of whether their development is largely consistent with theoretical reasoning thus far. However, this anecdotal evidence should not be regarded as a conclusive empirical assessment or even as evidence supporting the theoretical statements. Subsequently, the effects of the APP on macroeconomic developments and inflation are analysed.

Asset purchases initially impact on financial market prices and later on real economy

Developments in selected financial market indicators

Long-term yields in the euro area and the euro's effective exchange rate had fallen perceptibly even before the APP was announced. According to the theoretical considerations

²⁰ Against this backdrop, borrowers are required to hold sufficient collateral for the lender to even consider them as potential clients. However, owing to asymmetries of information between the lender and the borrower, the lender is obliged to assess the borrower's collateral and investment project. This entails costs, which the lender offsets by charging an interest rate premium. Moreover, a greater probability of the borrower becoming insolvent results in a higher interest rate premium.

²¹ This is because if the borrower is willing to stake a large amount of capital, this suggests a high level of confidence in the investment project on the part of the party with the better information and represents an incentive for the borrower to undertake every effort to make the project a success so as not to forfeit his capital.

²² See also B S Bernanke, M Gertler and S Gilchrist (1999), The financial accelerator in a quantitative business cycle framework, in J B Taylor and M Woodford (eds), Handbook of macroeconomics 1, chapter 21, pp 1341-1393.

²³ If, in addition to the depreciation, inflation expectations increase (be it due to a higher level of aggregate economic activity or more expensive imports), real interest rates will also fall. However, lower yields in the euro area should induce expectations of an appreciation in the domestic currency through uncovered interest parity.

Long-term interest rates and effective exchange rate down even before APP purchases

regarding the signalling channel, expectation effects might have been a factor, given that expectations of a comprehensive Eurosystem purchase programme increased noticeably during the second half of 2014 and at the beginning of 2015. Yet, the monetary policy measures decided before the APP was announced, a less favourable development of the real economy and international influences, too, might have contributed to the decline in long-term interest rates and the depreciation of the euro.²⁴ Drawing conclusions about the isolated contribution of quantitative easing to the decline in yields is, therefore, difficult.

Interest rate expectations and term premium responsible for decline in longer-term interest rates

An analytical decomposition of the change in the ten-year interest rate only allows a distinction to be made between the contribution of interest rate expectations and the term premium (see the chart on page 40).²⁵ The results suggest that the decline in the ten-year interest rate was attributable to both a lower term premium and declining interest rate expectations, with the term premium initially of greater importance. Recently, however, the declining interest rate expectations have begun to carry more weight. In this context, developments between April and June 2015 were particularly striking when a range of factors temporarily caused longer-term interest rates to rise significantly and volatility in the financial markets was slightly elevated for a short period of time.²⁶ This example illustrates that changes in interest rate expectations and the term premium can also reflect different economic outlooks for the euro area, global influences and changes in preferences which are empirically difficult to distinguish from the effects of Eurosystem monetary policy measures.

Interest rates on loans to the non-financial private sector also falling

Besides the above-mentioned effects on long-term capital market rates, there was a general decline in interest rates on loans to the non-financial private sector in the euro area. Looking at corporate loans, the decline began back in spring 2014 and was particularly pronounced in countries where banks had raised their lend-

ing rates disproportionately strongly during the sovereign debt crisis (see the chart on page 41).

As with capital market yields, the isolated impact of the APP on lending rates cannot be determined *a priori* given that other determinants, including the other monetary policy measures, are likely to have played a role. However, the April 2016 Bank Lending Survey (BLS) provides more concrete indications that the APP may have helped ease lending policies. According to the BLS, the APP had an easing effect on the lending policies of the surveyed euro-area banks in the previous six months. Although the impact of the programme on credit standards for loans to non-financial corporations and households was minor, the questioned banks on balance reported a noticeable easing effect on the terms and conditions for new loans across all business lines.

Taken together, the expansionary monetary policy measures might also have supported credit growth. Annual growth rates of corpor-

According to BLS, APP has easing effect on lending policies

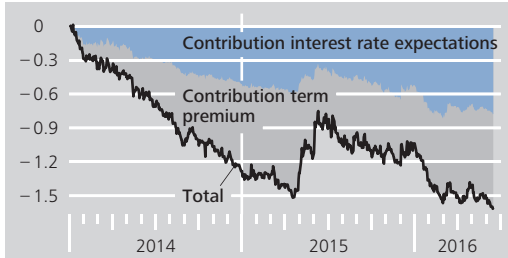
²⁴ With regard to the APP, an initial event study for the euro area identified a number of events prior to its official announcement which might have influenced market participants' expectations regarding the programmes and impacted on financial market prices. See C Altavilla, G Carboni and R Motto (2015), Asset purchase programmes and financial markets: lessons from the euro area, ECB Working Paper No 1864.

²⁵ The decomposition is based on the estimation approach by S Joslin, K J Singleton and H Zhu (2011), A new perspective on Gaussian dynamic term structure models, *The Review of Financial Studies* 24(3), pp 926-970. However, particularly in the context of a flattening yield curve and the existence of a potential zero lower bound on interest rates, the results are exposed to high levels of estimation uncertainty. Ten-year interest rates (see chart on p 40) are represented by the overnight index swap (OIS) curve as it does not limit the analysis to national government bond markets in which yields may be influenced by liquidity effects (especially German Federal bonds) or credit risks.

²⁶ This countermovement can, amongst other things, be attributed to previous exaggerations being corrected, the economic outlook stabilising, low market liquidity and further technical market factors. Against the backdrop of asset purchases conducted by central banks, such an at times perceptible correction in long-term interest rates could be observed not only in the euro area but also in the United States and Japan. See also S Steins Bisschop, M Boermans and J Frost (2016), A shock to the system? Market illiquidity and concentrated holdings in European bond markets, DNB Occasional Studies 14-1; and Deutsche Bundesbank, Financial markets, Monthly Report, August 2015, pp 37-47.

Cumulative change in the ten-year euro-area interest rate and decomposition into interest rate expectations and term premium

Percentage points, daily data



Sources: Bloomberg and Bundesbank calculations based on the estimation approach by Joslin, Singleton and Zhu (2011). The model was estimated on a monthly basis and, in a next step, adjusted to daily data from the overnight index swap (OIS) curve. Cumulation as from 1 January 2014.

Deutsche Bundesbank

ate loans in the large euro-area countries reached their lowest point at the end of 2013/ beginning of 2014 and subsequently recovered in line with real economic developments. Individual countries have recorded net inflows again since 2014, although credit growth has remained subdued on the whole (see the chart on page 42).

Quantifying APP's contribution to developments in individual financial market variables is difficult

These considerations on developments in selected financial market indicators alone highlight how difficult it is to identify and quantify the effects of quantitative easing in isolation. First, expectation effects make it harder to perform an event date analysis as the impact of the measures are priced in before the actual decision is taken or implemented. Second, developments in the relevant financial market variables are subject to numerous other influences besides quantitative easing, including other Eurosystem monetary policy measures as well as real economic factors and monetary policy decisions outside the euro area.

The impact of quantitative easing on the real economy and inflation

However, in the end it is not the impact of the APP on individual financial market variables

that is crucial in assessing the effectiveness of quantitative easing but rather a quantification of the programme's effects on macroeconomic developments and inflation. It should be noted in advance that no direct conclusions as to the effectiveness of the APP can be drawn from actual inflation trends in the recent past as hypothetical price developments without the APP cannot be observed. The macroeconomic time series for the euro area currently do not yet have sufficient information to enable an empirical evaluation of the APP's impact on inflation. Macroeconomic model simulations are therefore used below.

However, at the current juncture, no consensus has yet emerged in the literature regarding a universally accepted procedure for simulating the macroeconomic effects of monetary policy asset purchase programmes. Instead, a multitude of approaches is currently being used, which can roughly be divided into two groups.

- In the two-step (indirect) procedure, the impact of quantitative easing on long-term interest rates and other financial market variables is initially estimated using a partial or satellite model. In a second step, this estimation is used to determine the effects on aggregate demand and inflation. Under this approach, it is assumed that, within the relevant macroeconomic model (eg time-series models, traditional macroeconomic but also dynamic stochastic general equilibrium (DSGE) models), long-term interest rates will exogenously diminish by the value determined in the first step. Hence, the impact of quantitative easing on long-term interest rates is not determined within the model when using this procedure.²⁷

Evaluating macroeconomic impact of quantitative easing ...

... with the help of a two-step procedure or ...

²⁷ See, for example, C Baumeister and L Benati (2013), Unconventional monetary policy and the Great Recession: estimating the macroeconomic effects of a spread compression at the zero lower bound, *International Journal of Central Banking* 9(2), pp 165-212; J Fuhrer and G Olivei (2011), The estimated macroeconomic effects of the Federal Reserve's large-scale Treasury purchase program, *Federal Reserve Bank of Boston Public Policy Brief*; IMF, Unconventional monetary policies – recent experiences and prospects, *IMF Policy Papers*, 18 April 2013.

... a one-step
 direct approach

– By contrast, the one-step (direct) approach, which is always based on DSGE models, simultaneously estimates the impact of quantitative easing on both long-term interest rates and the resulting macroeconomic developments. The effect is thus determined within the model.²⁸ This procedure thus allows the influence asset purchases have on aggregate demand and inflation to be observed consistently within a single model framework.

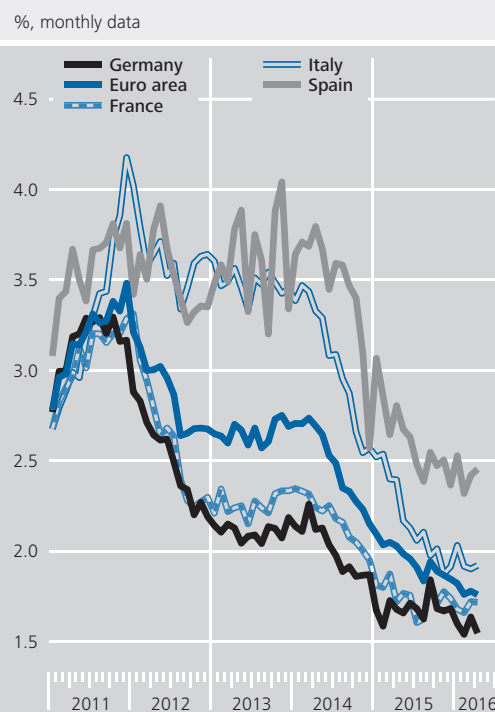
Bundesbank
 analyses are
 based on two
 DSGE models

The Bundesbank's internal analyses of the effects of the APP are primarily based on the direct method (see the chart on page 45). In the estimated DSGE models used here, as usual, conventional monetary policy affects macroeconomic developments owing to nominal rigidities (such as price and wage rigidities). In order for quantitative easing to have any impact on the real economy – ie so that Wallace neutrality (see the box on pages 36 and 37) does not apply –, additional frictions must be assumed. Two modelling approaches that include aspects of the portfolio rebalancing channel are therefore selected.

First modelling
 approach

The method that is probably the most commonly used is based on a principal-agent problem²⁹ in which, like in the deliberations involving the bank capital channel, a bank's equity capital plays a crucial role.³⁰ It assumes that a bank's loan supply is restricted by the amount of its equity capital. If asset prices in the capital markets rise as a result of asset purchases, the value of the assets held by the banks also goes up. The resulting boost to their capital makes it easier for banks to access other sources of funding which they need in order to expand their lending. The increase in the loan supply ultimately leads to growth in aggregate demand for goods. The original framework of the model can be expanded to integrate a further balance sheet restriction on the part of non-financial corporations. This can lead to other feedback effects on capital.³¹

Average interest rates on corporate loans in selected euro-area countries*



Source: ECB. * According to the harmonised euro-area MFI interest rate statistics. New business; interest rate aggregated across volumes and maturities.
 Deutsche Bundesbank

An alternative method of modelling the portfolio rebalancing effects is based on the idea that other participants are, like banks, also subject to constraints.³² For example, although banks can choose freely between corporate

Second model-
 ling approach

28 The strength of DSGE models lies in a microeconomic foundation of dynamic macroeconomic relationships. It is thus possible to analyse the impact of economic policy intervention, taking into account forward-looking expectations. See Deutsche Bundesbank, Development and application of DSGE models for the German economy, Monthly Report, July 2008, pp 31-46 and Deutsche Bundesbank, The importance of macroprudential policy for monetary policy, Monthly Report, March 2015, pp 56-61.

29 See M Gertler and P Karadi (2013), QE 1 vs. 2 vs. 3 ...: a framework for analyzing large-scale asset purchases as a monetary policy tool, International Journal of Central Banking 9(1), pp 5-53.

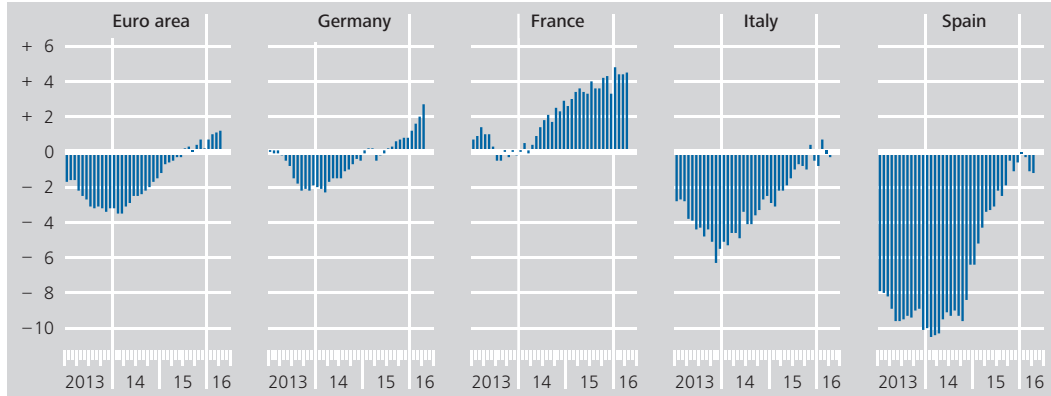
30 Owing to the asymmetric distribution of information between banks and households, households only entrust a limited proportion of their savings to banks because they fear that banks with insufficient capital will not use deposits solely in the interests of these households.

31 See M Kühl (2014), Mitigating financial stress in a bank-financed economy: equity injections into banks or purchases of assets?, Deutsche Bundesbank Discussion Paper No 19/2014.

32 See C Carlstrom, T Fuerst and M Paustian (2014), Targeting long rates in segmented markets, Federal Reserve Bank of Cleveland Working Paper, pp 14-19.

Loans to non-financial enterprises*

Adjusted for securitisation, year-on-year percentage change



Sources: ECB and Bundesbank calculations. * Non-financial corporations. The implementation of ESA 2010 means that, as from December 2014, holding companies of non-financial groups have been reclassified from the non-financial corporations sector to the financial corporations sector in banks' monthly balance sheet statistics.

Deutsche Bundesbank

and government bonds (which banks presumably consider to be perfect substitutes), they are restricted in terms of their funding. In order to receive additional deposits from households, banks must hold more capital. Households, too, are constrained in terms of their investment options because they face funding restrictions.³³ Furthermore, they can only invest their savings with banks, not other assets. By influencing yields on public-sector bonds, government bond purchases by central banks also have an impact on yields on corporate bonds and therefore ultimately on households' funding restriction.³⁴

Results suggest APP has a positive effect, ...

The results of the Bundesbank's model simulations of the impact of the APP – as announced in January 2015 and launched in March – on real gross domestic product (GDP) and inflation are presented in the chart on page 45. Model 1 in the chart refers to the modified version of the first modelling approach, while Model 2 refers to the second modelling approach. All in all, the estimates for the macroeconomic effects of the APP point to a positive real economic effect accompanied by positive inflationary effects. The macroeconomic effects of the APP as presented in the chart disregard parameter and data uncertainty, which is inevitably associated with the estimations of both models. If these uncertainties, too, were to be mapped

explicitly, the range of results presented in the chart would be much wider. The high level of uncertainty raises the question, in particular, of how statistically significant the results are. Comparable simulation or estimation results are found for the purchase programmes of the US Federal Reserve and the Bank of England (see the box on pages 46 to 50).

The simulations show that, based on the announced purchase path of the APP, the two model types result in fairly different quantita-

33 In this model, households issue the corporate bonds because they accumulate the physical capital. This assumption is made solely for the purpose of simplification and does not affect the model's key findings.

34 A third approach focuses exclusively on households. It assumes that not all households are homogeneous, and that only some can invest their savings in the market for longer-term bonds. Although the remaining households can participate in both the market for short-term bonds and in the market for longer-term bonds, unlike the other households, they must pay a premium if they wish to participate in the market for longer-term bonds. The assumed market segmentation means that purchases of (longer-term) government bonds reduce the longer-term yields on the bonds and increase their price and correspondingly the incurred savings, giving the restricted households, in particular, scope for greater consumption. See H Chen, V Cúrdia and A Ferrero (2012), The macroeconomic effects of large-scale asset purchase programmes, *The Economic Journal* 122(564), pp F289-F315.

... although results of the observed models vary significantly

tive estimations.^{35, 36} For example, the models differ from one another by around 1 percentage point in their assessment of the impact on real economic developments in 2016 and 2017; the differences between the inflation rates according to each model are even larger. As research currently stands, these two model types map the lower and upper bounds for the effectiveness of quantitative easing – at least for the DSGE model category.³⁷

As mentioned at the beginning of this article, the ECB Governing Council has decided to expand the asset purchase programme. The additional effect of its decision in December 2015 on the inflation rate in 2016 to 2018 is likely to be between 0.1 and 1.0 percentage point per year.³⁸

Both the design of the analysis ...

The results of the simulations shown here are heavily dependent on the underlying assumptions. These include, on the one hand, the way in which the expectation formation process is modelled. The better a monetary policy measure is anticipated, the more strongly behaviour is modified in the present (frontloading). In other words, the more transparent the communication surrounding a purchase programme, the larger its macroeconomic impact. On the other hand, assumptions about the form of the purchase path, including the exit strategy from the purchase programme, heavily influence the simulation results.³⁹

... and the choice of model have an impact on the simulation results

The ceiling that Model 2 represents can be seen as too optimistic because the frictions the model contains may overstate the reality. This model assumes, for instance, that investors' initially binding funding restrictions will continue to be eased for as long as the central bank maintains its quantitative easing programme. In practice, this is not always necessarily the case. For example, funding restrictions might conceivably be eased once a certain purchase volume has been reached, and any additional purchases would therefore have no extra effect on the real economy and inflation.

It must also be remembered that the model simulations disregard any structural breaks that may have taken place since the onset of the financial crisis. They also fail to take into account that aggregate demand has been subject to significant levels of uncertainty in the wake of the financial crisis. Against this backdrop, private consumer demand and aggregate investment could show a comparatively weak response to the Eurosystem's monetary policy measures in the current environment.

All in all, at the current juncture, the analysis of the quantitative effects of monetary policy purchase programmes involves greater uncertainty about the scale of the effects compared with the effects of traditional interest rate policy. Nevertheless, the simulation results presented here bear out the qualitative results of other studies (see the box on pages 46 to 50), namely that, all other things being equal, quantitative easing can have a positive effect on aggregate demand and inflation.

Results for euro area consistent with estimates for other currency areas

³⁵ Nevertheless, both models replicate the stylised facts relating to the quantitative impact of an interest rate policy measure.

³⁶ There is also considerable variation in the results for the United States and the United Kingdom (see the box on pp 46-50).

³⁷ Additional estimates relating to the APP by the ECB are within the range described here. See M Draghi (2016), Delivering a symmetric mandate with asymmetric tools: monetary policy in a context of low interest rates, speech held at the Oesterreichische Nationalbank on 2 June 2016. One of the main reasons for the relatively large effects that are observed in the context of Model 2 in comparison to Model 1 is that credit-constrained investment demand is a key restriction and reacts sensitively to the easing of funding restrictions in response to monetary policy. In simple terms, the differences between the models described here are due to the fact that, in the context of the second model, the underlying restrictions are "amplified", whereas in the first model, the opposite is sometimes true for certain restrictions – here, through falling interest rates, purchases of government bonds lead to a decline in banks' profitability. However, this effect does not play a significant role in the second model.

³⁸ According to rough calculations, the expansion of the APP announced in March 2016 will probably have a slightly smaller impact than the expansion announced in December 2015.

³⁹ For more information about the underlying models, see M Kühl, The effects of government bond purchases on leverage constraints of banks and non-financial firms, Deutsche Bundesbank Discussion Paper, forthcoming; and R Gerke, S Giesen and D Kienzler (2015), On the effects of the APP in a model with segmented markets, mimeo.

Potential implications of a prolonged period of expansionary monetary policy

Besides the desired implications, quantitative easing can, however, also entail risks and unwanted side effects.

Fiscal policy implications of asset purchases

Governments' financing conditions are becoming decoupled from capital market conditions

The nexus between monetary and fiscal policy is becoming stronger as a result of the purchase of government bonds in the euro area. The extensive purchase programmes are turning Eurosystem central banks into the biggest creditors of their home governments. For a significant share of sovereign debt, government financing costs are therefore becoming decoupled from capital market conditions.⁴⁰ In other words, for government bonds purchased by central banks, interest rates are no longer being differentiated according to the soundness of a country's public finances (which is otherwise a principle of capital market funding). On the whole, this weakens market discipline which would, along with the fiscal rules, help ensure sustainable budgeting in the euro area. There is thus reason to fear that efforts for consolidation in the euro area will wane.⁴¹ The more fiscal policymakers come to rely on the very favourable financing conditions, the more resistant they may subsequently be to normalising monetary policy, should this become necessary in the light of price developments.

The impact of quantitative easing on banks' profitability

Impact of the low-interest-rate level on earnings uncertain a priori

There are recurrent concerns that the prolonged period of low interest rates could seriously impair the earnings position of banks and other financial institutions. Similar fears are being voiced about quantitative easing, which can affect profitability in different ways. For

one thing, quantitative easing leads to a further decline in the general interest rate level (see page 38 et seq). For another, it plays a major role in the flattening of the yield curve.⁴² All other things being equal, the zero lower bound on interest rates poses something of an impediment to the drop in deposit funding costs. *A priori*, in an environment of low interest rates, quantitative easing may have both a positive and negative impact on banks' profitability.⁴³

All else being equal, a flatter yield curve erodes banks' interest margins and thus reduces the earnings of financial institutions, especially those which rely primarily on classic deposit and lending business. The low lending rates created by monetary policy (implicitly assuming interest rate pass-through) reduce interest income (per individual loan) for banks whose main business is lending. At the same time, the zero lower bound on interest rates hinders deposit funding costs from falling further.⁴⁴ The assets and liabilities side of banks' balance sheets consequently adapt asymmetrically to the interest rate floor. The degree to which the compression of the interest margin negatively affects banks' profitability overall thus depends

Low-interest-rate environment may impair the interest margin, ...

⁴⁰ Since the purchases ultimately increase banks' excess liquidity, the bottom line is that governments are obtaining this share of their funding at the – currently negative – deposit rate.

⁴¹ If cyclical improvements are factored out of the euro-area countries' budget deficits, adjusted for interest expenditure, the relevant primary surpluses have either moved sideways or have even dropped over the past two or three years.

⁴² For more information about the effects of low interest rates on the profitability of German banks and life insurers, see Deutsche Bundesbank, Financial Stability Review 2015.

⁴³ In quantitative terms, the impact of a low-interest-rate policy on the financial industry could differ from the impact of quantitative easing. See M Woodford (2016), Quantitative easing and financial stability, NBER Working Paper No 22285.

⁴⁴ There are currently no signs that banks are reducing deposit rates to below zero on a large scale. Their reluctance to charge negative interest rates on deposits, particularly those of retail customers, may be due to fears of a widespread withdrawal of deposits and a loss of customers, which could ultimately jeopardise individual banks' business models.

on factors such as how heavily they rely on deposit funding or other sources of income.⁴⁵

... nonetheless, positive effects on profitability are possible

However, the very expansionary monetary policy can also have a positive impact on banks' profitability. First, despite the interest rate floor for deposits, the cost of obtaining funding via the interbank market and the central bank could continue to fall.⁴⁶ Second, higher asset prices mean that banks can realise a (one-off) gain by selling some of their holdings (see pages 37

⁴⁵ The negative impact on banks whose funding comes primarily from deposits by retail customers and enterprises is expected to be stronger because, unlike for deposit funding conditions, the zero lower bound does not represent the lower limit for financing costs in the capital market. In the short term, the negative impact will also be greater for banks that provide loans at variable rates or that issue a large volume of short-term loans, because, in these cases, interest income reacts more sharply and more rapidly to lower interest rates than at other banks. Furthermore, the interest margin does not have the same degree of influence on overall profitability at all banks. The extent to which shrinking interest margins weigh on banks' profitability therefore ultimately depends on their business model. Profitability depends, among other things on banks' ability to compensate for low interest margins with other sources of income such as commission, fees or gains from capital market exposures. The degree to which this is possible could be limited in a competitive market environment. At present, the margins for consumer credit in Germany are tending to widen, while margins for loans to enterprises are showing a tendency to narrow somewhat. See Deutsche Bundesbank, Indications of portfolio shifts into higher-yielding assets in Germany, Monthly Report, May 2016, pp 34-37.

⁴⁶ All other things being equal, a negative interest rate on deposits and excess liquidity impairs banks' profitability. On the other hand, following the ECB Governing Council's monetary policy decisions, as of March 2016, banks (ex post) have been able to obtain liquidity from the Eurosystem at a negative interest rate under certain conditions.

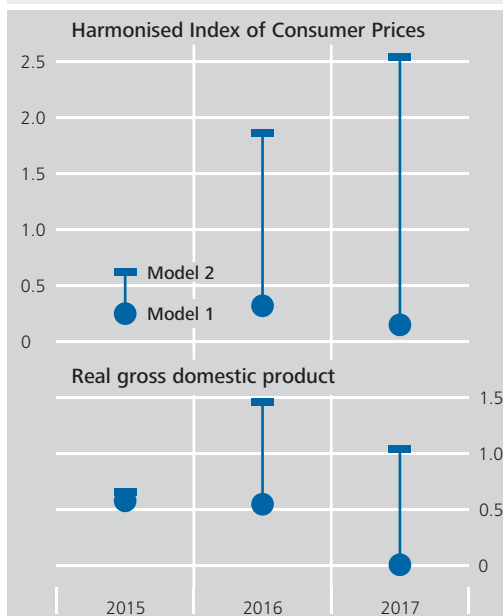
⁴⁷ If the effects causing poorer profitability are dominant in relation to those resulting in improved profitability, banks could respond by increasing their lending rates or possibly by reducing risk on their balance sheets. The latter could be achieved either by lowering the volume of new lending or by substituting riskier loans, as they mature, with less risky new loans. On the other hand, banks might see this as an incentive to compensate for any loss of earnings by taking on more risk. If, however, the dominating effects are those which lead to increased profitability, the prolonged period of expansionary monetary policy should have a favourable impact on lending, in turn with positive implications for economic activity and inflation. A positive net effect on profitability could reduce structurally weak banks' motivation to make balance sheet adjustments, though, potentially causing their postponement.

⁴⁸ See R Busch and C Memmel (2015), Banks' net interest margin and the level of interest rates, Deutsche Bundesbank Discussion Paper No 16/2015.

⁴⁹ See C Borio, L Gambacorta and B Hofmann (2015), The influence of monetary policy on bank profitability, BIS Working Paper No 514.

Macroeconomic effects of the euro-area asset purchase programme

Percentage points, as of 22 January 2015



Source: Bundesbank calculations. Model 1 is based on M Kühl, The effects of government bond purchases on leverage constraints of banks and non-financial firms, Deutsche Bundesbank Discussion Paper, forthcoming. Results for Model 2 are based on R Gerke, S Giesen and D Kienzler (2015), On the effects of the APP in a model with segmented markets, mimeo. Deutsche Bundesbank

and 38). Finally, inasmuch as the low-interest-rate environment and quantitative easing help the economy to pick up, they can have a positive effect on banks' profitability via macroeconomic "feedback effects": amidst increasing credit demand, the "quantitative effect" could offset the narrow interest margin. Because the creditworthiness of new and existing borrowers also generally increases in the context of improved economic activity, the number of loan defaults tends to fall, which also boosts profits.

Which effects will ultimately dominate, however, cannot be determined on the basis of these theoretical considerations alone.⁴⁷ Some empirical studies indicate a positive correlation between the interest rate level and the slope of the yield curve, on the one hand, and banks' profitability, on the other.⁴⁸ This therefore means – all other things being equal – that a lower interest rate level and a more gently sloping yield curve impair the banking sector's profitability.⁴⁹ However, this is only the case when

Currently no reliable evidence of deterioration in banks' profitability

The effects of quantitative easing in the United States and the United Kingdom

Initial estimates of the effectiveness of asset purchase programmes are available for both the United States and the United Kingdom. For the United States, triggered by the subprime crisis, the Fed has started several successive so-called large-scale asset purchase programmes (LSAP 1 to 3).¹ In the United Kingdom the Bank of England likewise announced a purchase programme, the asset purchase facility (APF),² shortly after LSAP 1 had been launched.³

Model-free event studies have frequently been run in order to analyse the effects of such purchase programmes on long-term interest rates. Such studies look at changes in yields within a short timeframe surrounding the announcement of a monetary policy measure. These approaches are based on the assumption that, when such an announcement is made, the announcement itself is the primary reason for the main movements in yields. The monetary policy announcement thus dominates all other shocks that typically determine movements in yields. This is why high-frequency data are usually used in such event studies, so that the effect of the announcement of a monetary policy measure can be identified with a certain degree of precision.

However, if monetary policy decisions are taken “in a package”, the main difficulty lies in disentangling the announcement effects of quantitative easing from the other measures in the package.⁴ Moreover, the event-study approach has its limitations if the measures have shifted expectations already prior to the announcement.

A second approach to analysing the effects of quantitative easing on long-term interest rates is based on the estimation of dynamic

term structure models. Such models, which depict the cross-sectional and time-series variations of interest rates of different maturities,⁵ can be used for purposes such as

¹ LSAP 1 was announced in November 2008 and reviewed and expanded significantly in March 2009. Under this programme, the Fed announced that it would purchase a total of US\$1,750 billion in financial assets. LSAP 2 was announced in November 2010, with purchases of government bonds coming to a total of US\$600 billion by the end of the second quarter of 2011. LSAP 3 was announced in September 2012, yet without announcing the extent of asset purchases ex ante. Under this programme, the Fed initially purchased a monthly volume of US\$40 billion in mortgage-backed securities (MBS). In December 2012, the Fed decided to purchase an additional US\$45 billion worth of government bonds every month. See Board of Governors of the Federal Reserve System press releases published on 25 November 2008, 18 March 2009, 23 September 2009, 3 November 2010, 13 September 2012 and 12 December 2012 (<http://www.federalreserve.gov/newsevents/press/monetary/2016monetary.htm>).

² Under its APF1 programme, the Bank of England purchased a total of £200 billion worth of assets between March 2009 and January 2010 (see Bank of England, Quarterly Bulletin Q3 2011, pp 200-212). The programme was expanded in several steps between October 2011 and July 2012; the total size of purchases under the programme currently stands at £375 billion (around 18% of UK GDP in 2015). See Bank of England, Minutes of the Monetary Policy Committee meeting held on 4 and 5 July 2012. Available at <http://www.bankofengland.co.uk/publications/minutes/Documents/mpc/pdf/2012/mpc1207.pdf>.

³ The volume of asset purchases announced by the Fed under the various LSAPs is equivalent to around 25% of US GDP in 2015. To put that figure into perspective: asset purchases by the Bank of England represent around 18% of UK GDP, and the announced asset purchase programme (APP) by the Eurosystem corresponds to around 17% of euro-area GDP (likewise using 2015 as the benchmark).

⁴ See also D L Thornton, An evaluation of event-study evidence on the effectiveness of the FOMC's LSAP program: are the announcement effects identified? Federal Reserve Bank of St Louis Working Paper 2013-033B.

⁵ There are three factors in particular which influence the term structure: (1) market participants' expectations regarding the future movements of short-term interest rates, (2) uncertainty about the expected pattern of interest rates and thus about interest rate risk, and (3) various other factors which impact on securities prices (including the securities' liquidity, institutional and regulatory aspects which could lead to a market segmentation and permit limited arbitrage opportunities between securities with varying residual maturities).

disentangling term premiums and expectation components from yields.⁶

Current studies corroborate for both approaches that quantitative easing reduced both the slope and the level of the yield curve.⁷ It is hard to tell, however, which of the transmission channels discussed in the main article assumes a particularly prominent role. Whereas model-free event studies often (but not always) produce indications of the signal channel,⁸ term structure models often (but likewise not always) find that the portfolio rebalancing channel is of particular importance.⁹ The variety of methods used limits somewhat the comparability of the various studies on the effects of quantitative easing on sovereign bond yields. Differences in the selection of data

⁶ Disentangling these quantities and their movement over time before and after the announcement and implementation of quantitative easing provides valuable information that contributes to a better understanding of their transmission. However, the benefits of this procedure are also limited if expectations have already shifted prior to the announcement, or if the idea is to disentangle announced monetary policy measures from other news.

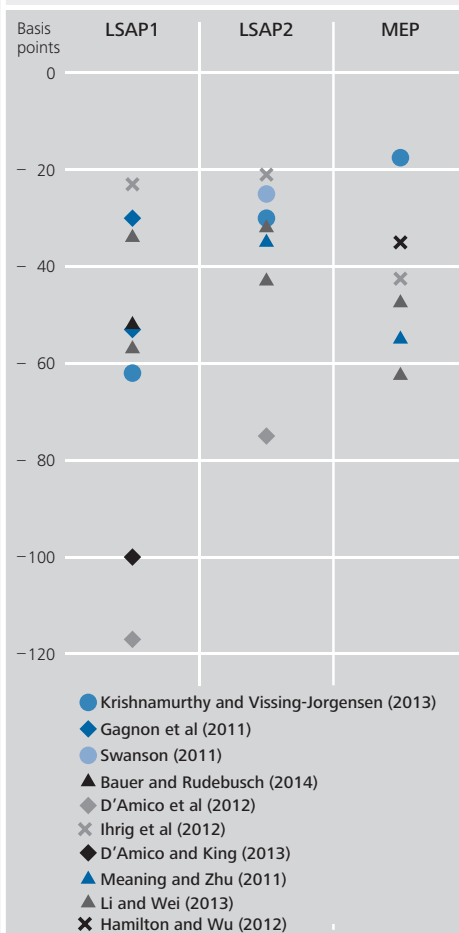
⁷ See also S D'Amico, W English, D López-Salido and E Nelson (2012), The Federal Reserve's large-scale asset purchase programmes: rationale and effects, *The Economic Journal* 122(564), pp F415–F446; E T Swanson (2011), Let's twist again: a high-frequency event-study analysis of Operation Twist and its implications for QE2, *Brookings Papers on Economic Activity* 43(1), pp 151–207; J D Hamilton and J C Wu (2012), The effectiveness of alternative monetary policy tools in a zero lower bound environment, *Journal of Money, Credit and Banking* 44(1), pp 3–46; R Greenwood and D Vayanos (2014), Bond supply and excess bond returns, *Review of Financial Studies* 27(3), pp 663–713; M A S Joyce, A Lasaosa, I Stevens and M. Tong (2011), The financial market impact of quantitative easing, *International Journal of Central Banking* 7(3), pp 113–161.

⁸ See M D Bauer and G D Rudebusch (2014), The signaling channel for Federal Reserve bond purchases, *International Journal of Central Banking* 10(3), pp 233–289, and A Krishnamurthy and A Vissing-Jorgensen (2011), The effects of quantitative easing on interest rates: channels and implications for policy, *Brookings Papers on Economic Activity* 43(2), pp 215–287.

⁹ See S D'Amico et al (2012), op cit, and J Gagnon, M Raskin, J Remache and B Sack (2010), Large-scale asset purchases by the Federal Reserve: did they work? Federal Reserve Bank of New York Staff Reports No 441.

The effects of quantitative easing programmes (LSAP1, LSAP2 and MEP) on 10-year US Treasury yields

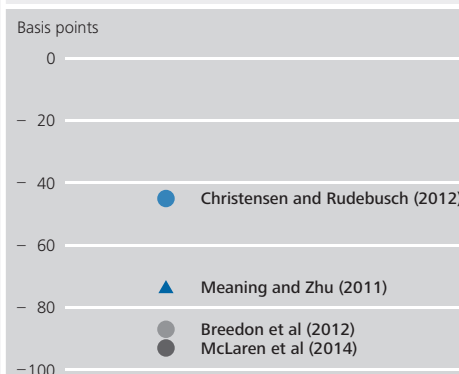
Scaling: purchase volume of US\$1 trillion



Deutsche Bundesbank

The effects of quantitative easing (AFP1) on UK gilt 10-year yields

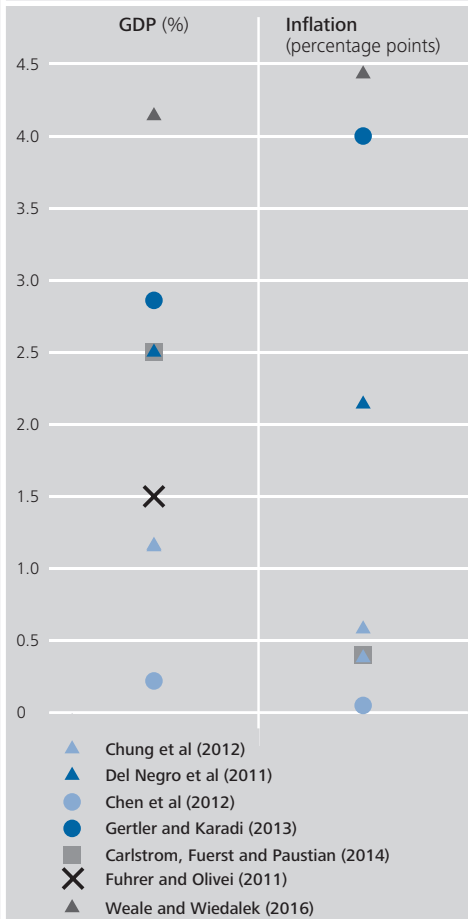
Scaling: purchase volume of £200 billion



Deutsche Bundesbank

The macroeconomic effects of quantitative easing programmes (LSAP1 and LSAP2) in the United States

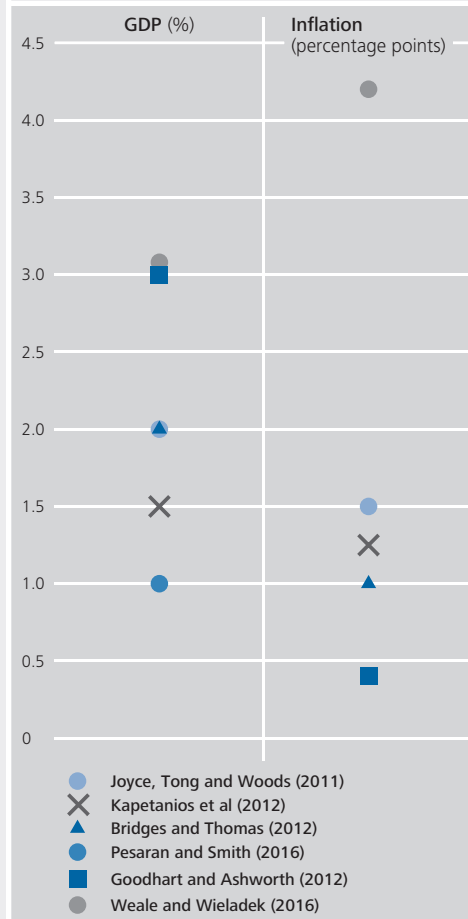
Scaling: purchase volume of US\$1 trillion; highest estimated impact on GDP and inflation levels



Deutsche Bundesbank

The macroeconomic effects of quantitative easing (APF1) in the United Kingdom

Scaling: purchase volume of £200 billion; highest estimated impact on GDP and inflation levels



Deutsche Bundesbank

and time horizons further limit comparability.¹⁰

Whereas selected estimates of the effects of LSAP 1 and LSAP 2 on longer-term interest rates are illustrated in the upper chart on page 47, the lower chart on the same page shows the results of the corresponding estimations for APF1. The effects of LSAP 1 and LSAP 2 are largely located in a corridor of between -20 and -60 basis points;¹¹ those of APF1, within a corridor of around -40 to -90 basis points.¹²

Studies for real GDP and inflation – based on the direct and indirect methods explained

on pages 40 and 41 – find expansionary effects for both the United States and the United Kingdom. For the Federal Reserve programmes the estimated effects on GDP range from around 0.2 to 4.1 percentage points, while the impact on inflation is

¹⁰ Whereas the major part of the literature analyses the effects of quantitative easing on government bond yields, a very few papers also examine the impact on corporate credit. See also S Gilchrist and E Zakrajsek (2012), Credit spreads and business cycle fluctuations, *American Economic Review* 102(4), pp 1692-1720.

¹¹ In order to be able to compare the analysed Federal Reserve programmes (LSAP 1, LSAP 2 and the Maturity Extension Program (MEP; see Federal Reserve press release of 21 September 2011)), the respective effect was scaled linearly to a size of US\$1 trillion.

¹² The results for the Bank of England's APF were scaled to £200 billion.

located in a band between 0.1 and 4.4 percentage points (see the left-hand chart on page 48).¹³ The corresponding results for the Bank of England programme point predominantly to a corridor for GDP of around 1 to 3 percentage points and between around 0.4 and 1.5 percentage points for inflation (see the right-hand chart on page 48).¹⁴

References cited for the charts

M D Bauer and G D Rudebusch (2014), The signaling channel for Federal Reserve bond purchases, *International Journal of Central Banking* 10(3), pp 233-289.

J Bridges and R Thomas (2012), The impact of QE on the UK economy – some supportive monetarist arithmetic, Bank of England Staff Working Papers No 442.

F Breedon, J S Chadha and A Wolters (2012), The financial market impact of UK quantitative easing, *Oxford Review of Economic Policy* 28(4), pp 702-728.

C T Carlstrom, T S Fuerst and M Paustian (2014), Targeting long rates in a model with segmented markets, Federal Reserve Bank of Cleveland Working Paper No 14-19.

H Chen, V Curdia and A Ferrero (2012), The macroeconomic effects of large-scale asset purchase programs, *The Economic Journal* 122(564), pp 289-315.

J H E Christensen and G D Rudebusch (2012), The response of interest rates to US and UK quantitative easing, *The Economic Journal* 122(11), pp 385-414.

H Chung, J-P Laforte, D Reifschneider and J C Williams (2012), Have we underestimated the likelihood and severity of zero lower bound events?, *Journal of Money, Credit and Banking* 44(1), pp 47-82.

S D'Amico, W English, D López-Salido and E Nelson (2012), The Federal Reserve's large-scale asset purchase programmes: rationale and effects, *The Economic Journal* 122, pp 415-446.

S D'Amico and T B King (2013), Flow and stock effects of large-scale Treasury purchases: evi-

dence on the importance of local supply, *Journal of Financial Economics* 108(2), pp 425-448.

M Del Negro, G B Eggertsson, A Ferrero and N Kiyotaki (2011), The great escape? A quantitative evaluation of the Fed's liquidity facilities, Federal Reserve Bank of New York Staff Reports No 520.

J C Fuhrer and G P Olivei (2011), The estimated macroeconomic effects of the Federal Reserve's large-scale Treasury purchase program, Federal Reserve Bank of Boston Public Policy Brief.

J Gagnon, M Raskin, J Remache and B Sack, The financial market effects of the Federal Reserve's large-scale asset purchases, *International Journal of Central Banking* 7(1), pp 3-43.

M Gertler and P Karadi (2013), QE 1 vs. 2 vs. 3 ...: A framework for analyzing large-scale asset purchases as a monetary policy tool, *International Journal of Central Banking* 9(1), pp 5-53.

C A E Goodhart and J P Ashworth (2012), QE: A successful start may be running into diminishing returns, *Oxford Review of Economic Policy* 28(4), pp 640-670.

J D Hamilton and J C Wu (2012), The effectiveness of alternative monetary policy tools in a zero lower bound environment, *Journal of Money, Credit and Banking* 44(1), pp 3-46.

J E Ihrig, E C Klee, C Li, B Schulte and M Wie, Expectations about the Federal Reserve's balance sheet and the term structure of interest rates, Federal Reserve Board Finance and Economics Discussion Series 2012-57.

M Joyce, M Tong and R Woods (2011), The United Kingdom's quantitative easing policy:

¹³ The maximum estimated results (ie the "peak effects") in the various studies are reported for both the Federal Reserve's and the Bank of England's programmes.

¹⁴ It must be noted here that the estimates on the real economic effects of quantitative easing are fraught with considerable uncertainty. As a case in point, the results neglect, for one thing, uncertainty about the individual estimates within the reported studies (which is often considerable); moreover, although the studied purchase programmes are scaled to a uniform size, the comparability of the results is impaired as the results reported here are, in part, based on differing assumptions – especially regarding the path of the monetary policy lending rate while the purchase programme is being implemented.

design, operation and impact, Bank of England Quarterly Bulletin 51(3), pp 200-212.

G Kapetanios, H Mumtaz, I Stevens and K Theodoridis (2012), Assessing the economy-wide effects of quantitative easing, The Economic Journal 122(11), pp 316-347.

A Krishnamurthy and A Vissing-Jorgensen, The ins and outs of LSAPs, Jackson Hole 2013 Symposium Proceedings, Federal Reserve Bank of Kansas City.

C Li and M Wei (2013), Term structure modeling with supply factors and the Federal Reserve's large-scale asset purchase programs, International Journal of Central Banking 9(1), pp 3-39.

J Meaning and F Zhu, The impact of recent central bank asset purchase programmes, BIS Quarterly Review, December 2011.

N McLaren, R N Banerjee and D Latto (2014), Using changes in auction maturity sectors to help identify the impact of QE on gilt yields, The Economic Journal 124(5), pp 453-479.

M H Pesaran and R P Smith (2016), Counterfactual analysis in macroeconometrics: an empirical investigation into the effects of quantitative easing, Research in Economics, forthcoming.

E T Swanson (2011), Let's twist again: a high-frequency event-study analysis of Operation Twist and its implications for QE2, Brookings Papers on Economic Activity 42(1), pp 151-207.

M Weale and T Wieladek (2016), What are the macroeconomic effects of asset purchases?, Journal of Monetary Economics 79, pp 81-93.

looked at in isolation – ie for given macroeconomic conditions; this means that none of the positive effects of expansionary monetary policy, brought about by increased economic activity as well as all resulting positive effects on banks' profitability, are taken into account. Currently, however, there is little evidence to suggest that the contractionary effects of the present low-interest-rate environment are dominant in terms of the macroeconomic effects. For example, German banks' interest income as a source of earnings did not decline last year, and German credit institutions' risk provisioning is at a very low level.⁵⁰

Results of survey on German credit institutions' profitability

However, the survey conducted in mid-2015 by the Bundesbank and the Federal Financial Supervisory Authority (BaFin) on the profitability and resilience of German credit institutions in a low-interest-rate environment has revealed that the profitability of small and medium-sized German credit institutions will, based on the institutions' own targets and projections, come

under pressure.⁵¹ Participating banks stated that the low-interest-rate environment is forcing them to replace higher-yielding credit and securities transactions, as they mature, with new positions that generate a lower rate of return. As explained above, funding costs are diminishing at the same time, but credit institutions need to keep deposit rates in positive territory for business policy and competitive reasons. Looking ahead, these developments will squeeze margins in banking business considerably, although the currently positive economic

⁵⁰ In 2014, no significantly negative effects of the low-interest-rate environment on profitability could yet be detected for the German banking sector. See Deutsche Bundesbank, Risks in the German banking sector, Financial Stability Review 2015, pp 29-40.

⁵¹ In addition to their target scenario, the banks had to prepare projections on further pre-defined interest rate scenarios. The outlook is poor, especially in the scenarios in which the interest rate level shifts down by 100 basis points, where the banks are expecting net interest income to fall by around 32% over the forecast period to 2019.

situation is shoring up the business performance and plans of German credit institutions.⁵²

Increased risk propensity in low-interest-rate environment?

Expansionary monetary policy stance can contribute to excessive risk-taking

The risk-taking channel describes how an expansionary monetary policy stance – brought about, for example, by quantitative easing – creates an incentive to take on greater risks.⁵³ Here, an expansionary monetary policy leads not only to growth in bank lending – as is generally described in the context of other monetary policy transmission channels – but can also lead to higher-risk lending overall. If, all in all, “too many” risky projects are being funded, the likelihood of a future financial crisis can increase.

This can occur in various ways ...

Thus, the risk-taking channel describes how monetary policy measures, especially a change in the policy rate or the interest rate path, alter perception of risk and/or risk tolerance.⁵⁴ The risk-taking channel therefore encompasses the impact of monetary policy measures on the perceived or measured risk of investment portfolios, asset valuation and funding costs.⁵⁵ Unlike other monetary policy transmission channels, such as the interest rate channel or exchange rate channel, the risk-taking channel is less tightly circumscribed; rather, it comprises a range of mechanisms.⁵⁶ It can exert its influence in various ways.⁵⁷

... via the “search for yield” or ...

First of all, a search for yield can increase the propensity to run risks. An expansionary monetary policy stance – brought about, for example, by quantitative easing – normally leads to a reduction in nominal yields. Those financial market participants whose long-term liabilities are nominally fixed owing to contractual or statutory obligations are then potentially prepared to make riskier investment decisions with higher expected returns in order to meet their profit targets. For example, instead of comparatively safe government bonds, financial market participants could invest in higher-

interest-bearing securities which, however, typically come with higher risks.⁵⁸

In addition, an expansionary monetary policy normally has the effect of raising asset prices, which lead to increased lending via the balance sheet channel and are ultimately reflected in higher aggregate income streams. An economic stimulus induced in this way, however, is likely to influence financial market participants’

... through rising asset prices and income streams

⁵² Given the improvement in their capital base over the past few years, the resilience of the German banks is nevertheless considered strong overall. See A Dombret (2015), The impact of low interest rates – results of a survey among German banks, Statement for a media briefing on the low-interest-rate survey conducted by the Bundesbank and BaFin, 18 September 2015.

⁵³ It should be remembered here that a low policy rate in itself does not necessarily imply an expansionary monetary policy stance. That depends in decisive measure on the level of the “natural rate of interest”, ie on the interest rate which is compatible with price stability.

⁵⁴ See C Borio and H Zhu (2012), Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism?, *Journal of Financial Stability* 8(4), pp 236-251.

⁵⁵ G Dell’Ariccia, L Laeven and R Marquez (2014), Real interest rates, leverage, and bank risk-taking, *Journal of Economic Theory* 149, pp 65-99 develop a microeconomic partial equilibrium model for which two assumptions essentially suffice for the existence of a risk-taking channel. The first of these is the assumption of limited liability and commercial banks’ possibility to choose the riskiness of their portfolios by themselves. However, since the portfolio’s risk is not directly observable to creditors, the commercial bank’s capital structure plays a decisive role. The second assumption is that commercial banks’ financing costs are a function of the level of a risk-free reference rate. On the basis of these assumptions, risk-taking is determined largely by three partly conflicting forces or aspects: a pass-through effect, a risk-shifting effect and the degree of leverage. The authors find that a reduction in the risk-free interest rate generally leads to increased risk-taking. See also I Angeloni and E Faia (2013), Capital regulation and monetary policy with fragile banks, *Journal of Monetary Economics* 60, pp 311-324; and A Abbate and D Thaler (2015), Monetary policy and the asset risk-taking channel, Deutsche Bundesbank Discussion Paper No 48/2015.

⁵⁶ See M Apel and C Claussen (2012), Monetary policy, interest rates and risk-taking, *Sveriges Riksbank Economic Review* 2, pp 68-83.

⁵⁷ See L Gambacorta, Monetary policy and the risk-taking channel, *BIS Quarterly Review*, December 2009, pp 43-53.

⁵⁸ See R Rajan (2005), Has financial development made the world riskier? *Economic Policy Symposium Proceedings – Jackson Hole*, Federal Reserve Bank of Kansas City; and P Abbassi, R Iyer, J-L Peydró and F R Tous, Securities trading by banks and credit supply: micro-evidence from the crisis, *Journal of Financial Economics*, forthcoming.

risk perception.⁵⁹ For example, with rising asset prices and higher income streams, financial market participants will typically reckon with fewer defaults and sinking asset price volatility, which could, in turn, encourage them to take on additional risks.

Quantitative significance of risk-taking channel unclear, ...

Empirical studies confirm the existence of the risk-taking channel. For instance, in both Europe and the United States, there is evidence of a positive correlation between falling short-term interest rates and the granting of bank loans to borrowers with lower credit ratings.⁶⁰ Indications of this can also be seen outside of the banking sector. For the United States, for example, it could be shown that both money market funds and pension funds added riskier assets to their portfolios during periods of low interest and following the implementation of non-standard monetary policy measures; in other words, they intensified their “search for yield”.^{61, 62} However, the results of these studies differ with respect to the strength of the risk-taking channel, meaning that no reliable assessment can currently be made to quantify the significance of this channel for monetary policy.

... potentially depends on interest rate environment

Finally, it should be noted that the specific form of the risk-taking channel is likely to depend on the monetary policy regime. If the central bank is operating in a “normal” interest rate environment, a monetary policy-induced interest rate cut is usually associated with a steepening of the yield curve, since short-term interest rates typically have a stronger reaction to rate cuts than long-term interest rates. This tends to have a positive effect on expected earnings and thus on banks’ perceived resilience.

By contrast, if the central bank wants to make its monetary policy more expansionary at the zero lower bound and, for example, wishes to reduce long-term interest rates through bond purchases, this tends to have a flattening effect on the yield curve. A “search for yield” is then more likely to contribute to the risk-taking channel. Amongst other things, this could be reflected in investors not only opting for riskier

financial instruments but also switching to other forms of investment such as property. This potential dependence on the interest rate environment makes it even more difficult to gauge the current significance of the risk-taking channel, since the end of the observation period of many empirical studies was either prior to or coincided with the onset of the financial crisis in 2007-08. Thus, these studies do not cover the period after the zero lower bound on interest rates was reached and the asset purchase programmes were launched.

■ Summary and outlook

Against the backdrop of subdued inflation prospects and falling market-based inflation expectations at the zero lower bound on interest rates, quantitative easing measures were introduced in the euro area with the objective of bringing about a sustained adjustment to the

Model-based analyses indicate positive impact of APP, ...

⁵⁹ This aspect of the risk-taking channel bears a certain resemblance to the “financial accelerator” in that, due to credit market imperfections, a reduction in the monetary policy rate will ultimately lead to an increase in borrowing and in aggregate demand, therefore amplifying the original monetary policy stimulus through feedback effects. See B Bernanke et al (1999), op cit.

⁶⁰ See G Jiménez, S Ongena, J-L Peydró and J Saurina (2015), Hazardous times for monetary policy: what do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking?, *Econometrica* 82(2), pp 463-505 for Spain; G Dell’Ariccia, L Laeven and G Suarez (2016), Bank leverage and monetary policy’s risk-taking channel: evidence from the United States, CEPR Discussion Paper 11230 and C M Buch, S Eickmeier and E Prieto (2014), In search for yield? Survey-based evidence on bank risk taking, *Journal of Economic Dynamics and Control* 43, pp 12-30 for the United States; and Y Altunbas, L Gambacorta and D Marques-Ibanez (2014), Does monetary policy affect bank risk?, *International Journal of Central Banking* 10(1), pp 95-135 for several European countries and the United States.

⁶¹ See G Chodorow-Reich (2014), Effects of unconventional monetary policy on financial institutions, *Brookings Papers on Economic Activity* 48(1), pp 155-204 for money market funds and pension funds; and M Di Maggio and M T Kacperczyk (2016), The unintended consequences of the zero lower bound policy, *Journal of Financial Economics*, forthcoming, for money market funds.

⁶² German households showed signs of “searching for yield” for the first time in 2015 inasmuch as portfolios shifted towards higher-yielding forms of investment. Previously, this pattern had only been identified in the financial corporations sector; see Deutsche Bundesbank, Indications of portfolio shifts into higher-yielding assets in Germany, *Monthly Report*, May 2016, pp 34-37.

path of inflation in line with the goal of achieving inflation rates below, but close to, 2% over the medium term. As the euro area has had no experience with quantitative easing to date, model-based analyses play a major role in evaluating these non-standard monetary policy measures. The estimates presented in this article show, in particular, that the various model approaches differ considerably in terms of how they evaluate the effectiveness of quantitative easing on macroeconomic developments and inflation, and that there is great uncertainty surrounding its effects. These models demonstrate, all other things being equal, that quantitative easing can have an expansionary effect on aggregate demand and inflation.

In addition to the risk of an increasing nexus between monetary and fiscal policy, possible side effects of quantitative easing in a low-

interest-rate environment include risks to financial institutions' profitability and a heightened propensity to run risks. These side effects and the realisation of the risks associated with the ultra-expansionary monetary policy may, in turn, affect price behaviour and monetary policymakers' ability to maintain price stability. Monetary policymakers should therefore not lose sight of these effects of their policies. The longer the highly accommodative stance remains in place, the more likely its side effects are to deepen. This is why monetary policy, which is currently using expansionary measures in a bid to lift inflation from its very depressed level, must usher in the normalisation of monetary policy once it reaches a price path that is compatible with the Eurosystem's stability target – irrespective of the state of public finances or financial stability.

... but quantitative easing can also entail risks and unwanted side effects