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# Breaking through the zero line The ECB's Negative Interest Rate Policy

**ECB** 

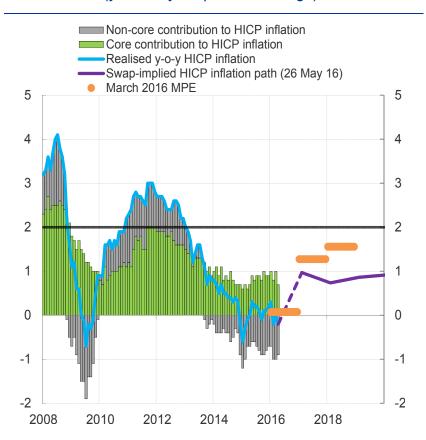
Negative interest rates: Lessons learned...so far Brookings Institution, Washington DC, 6 June 2016

The views expressed in this presentation are those of the authors and do not necessarily reflect those of the ECB or the Eurosystem

## Backdrop: Weak inflation outlook and sluggish recovery

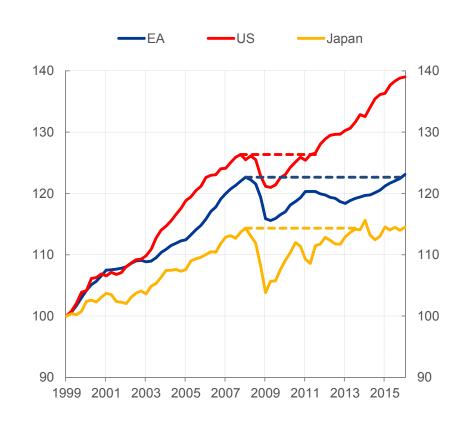
#### **Euro area HICP inflation**

(year-on-year percent change)



Sources: Thomson Reuters, Eurostat, ECB calculations. Latest observation: April 2016 for HICP and 26 May 2016 for swap-implied inflation path.

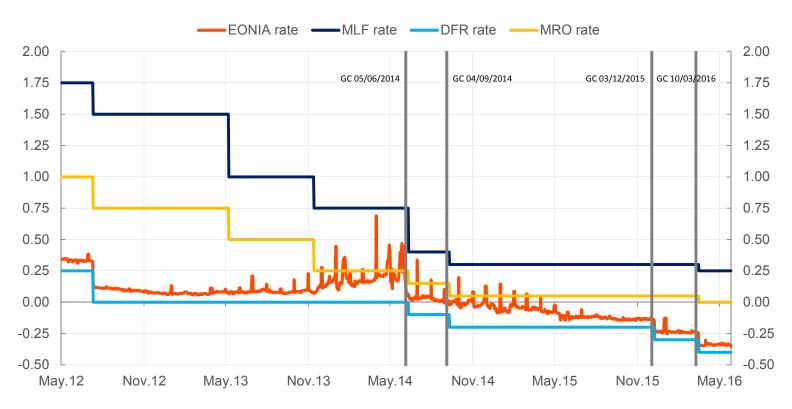
## **Real GDP** (Index, 1999Q1=100)



Sources: Eurostat, BEA, Cabinet Office, ECB calculations. Notes: horizontal dotted lines represent pre-crisis peak real GDP level. Latest observation: 2016 Q1.

## Four small steps into the negative

## ECB policy rates and overnight money market rates May 2012 – May 2016 (percent)



Sources: ECB and Reuters. Latest observation: 26 May 2016.

#### Overview

- A Why? NIRP rehabilitates monetary policy in a low rate world
- B A simple model exercise: NIRP versus ZLB plus forward guidance
- **C** Transmission
- **D** Negative side effects of negative rates?
- E Outlook and open issues

## Why? NIRP rehabilitates monetary policy in low rate world

## Short-term interest rate expectations when the effective lower bound is zero (percent p.a.)

# 

Source: ECB calculations, based on Lemke/Vladu (2016).

20

10

Notes: The chart presents the sequence of risk-neutral predictive distributions of the one-month OIS rate, conditional on term structure information on the indicated date, together with the model-implied one-month forward curve. The results are from a 3-factor arbitrage-free shadow rate term structure model for the euro area EONIA swap curve. The model allows for a shift in the lower bound. Note that for short-term horizons, the model can imply that the risk-neutral probability of the short rate sticking to the lower bound is close to one, so that only high percentiles (or none at all) of the predictive distribution are visible.

30

Horizon in months

50

60

#### A calamitous misadventure?

#### Why a negative interest rate policy

Removes non-negativity restriction on future expected short rates: forward curve becomes flatter than it would be if short rates were expected to be constrained by a zero lower bound

## Why? NIRP rehabilitates monetary policy in low rate world

## Short-term interest rate expectations when the effective lower bound is negative (percent p.a.)

# Conditional (risk-neutral) distribution of future 1-month rates at 30-Sep-2014 EENIIA (OIS 1-month) forward curve Estimated effective lower bound 10 - 90 percentiles of future 1-month rates 1.5 1 O Horizon in months

Source: ECB calculations, based on Lemke/Vladu (2016).

Notes: The chart presents the sequence of risk-neutral predictive distributions of the one-month OIS rate, conditional on term structure information on the indicated date, together with the model-implied one-month forward curve. The results are from a 3-factor arbitrage-free shadow rate term structure model for the euro area EONIA swap curve. The model allows for a shift in the lower bound. Note that for short-term horizons, the model can imply that the risk-neutral probability of the short rate sticking to the lower bound is close to one, so that only high percentiles (or none at all) of the predictive distribution are visible.

#### A calamitous misadventure?

#### Why a negative interest rate policy

Removes non-negativity restriction on future expected short rates: forward curve becomes flatter than it would be if short rates were expected to be constrained by a zero lower bound

## Why? NIRP rehabilitates monetary policy in low rate world

## Short-term interest rate expectations under negative rates and APP (percent p.a.)

## 

Source: ECB calculations, based on Lemke/Vladu (2016).

Notes: The chart presents the sequence of risk-neutral predictive distributions of the one-month OIS rate, conditional on term structure information on the indicated date, together with the model-implied one-month forward curve. The results are from a 3-factor arbitrage-free shadow rate term structure model for the euro area EONIA swap curve. The model allows for a shift in the lower bound. Note that for short-term horizons, the model can imply that the risk-neutral probability of the short rate sticking to the lower bound is close to one, so that only high percentiles (or none at all) of the predictive distribution are visible.

Horizon in months

#### A calamitous misadventure?

- Removes non-negativity restriction on future expected short rates: forward curve becomes flatter than it would be if short rates were expected to be constrained by a zero lower bound
- Charges bank cash hoarding: extra downward pressure on long-term rates via term premium compression and push to portfolio shifts

#### Overview

- A Why? NIRP rehabilitates monetary policy in a low rate world
- B A simple model exercise: NIRP versus ZLB plus forward guidance
- C Transmission via banks and macroecomic impact
- **D** Negative side effects of negative rates?
- E Outlook and open issues

## A simple model: the bond market

- Simple 2-period model with representative investor
- $\triangleright$  Investor allocates time t wealth  $W_t$  into one-period and two-period bonds to maximize next period's expected wealth  $W_{t+1}$  minus variance penalty:

$$max [E(W_{t+1}) - \frac{1}{2} \gamma Var(W_{t+1})]$$

> First-order condition gives demand **B** for long-term bonds:

$$B = [Var(R_{t+1}^1)]^{-1} \cdot [2 R_t^2 - R_t^1 - E(R_{t+1}^1)]$$

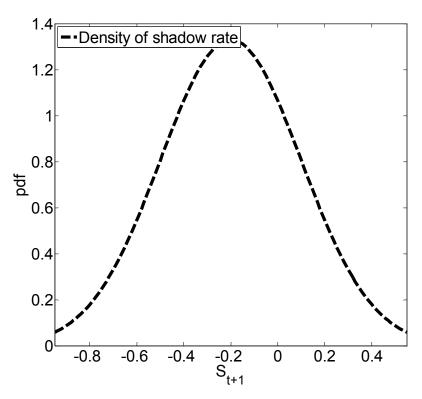
where  $R_t^n$  is the yield to maturity of an n-period bond at time t.

- > Short-term bond is in elastic supply, rate set by the central bank
- > Fixed supply **Q** of long-term bonds: in equilibrium **Q=B**.
- > Two-year yield in equilibrium:

$$R^{2}_{t} = \frac{1}{2} \cdot [R^{1}_{t} + E(R^{1}_{t+1})] + \frac{1}{2} \gamma Q Var(R^{1}_{t+1})$$
Expectations component Term premium

## Simple model: The policy rate in "normal times"

## Distribution of Central Bank's intended (=shadow) policy rate S next period



Sources: ECB calculations.

Notes: Hypothetical and illustrative example with current and intended short rate  $S_t$  equal to -0.2%,  $\beta$  = 1.2 and  $\sigma^2_{\pi}$  = 0.25.

Central bank follows a (simplified and modified) Orphanides/Wieland rule, so that the intended short rate S<sub>t</sub> is

$$S_t = S_{t-1} + \beta \cdot (\pi_t - \pi_{t-1}),$$
  
where  $\pi_t - \pi_{t-1} \sim N(0, \sigma_{-1}^2)$ 

Distribution of next period's intended policy (='shadow') rate is a simple normal:

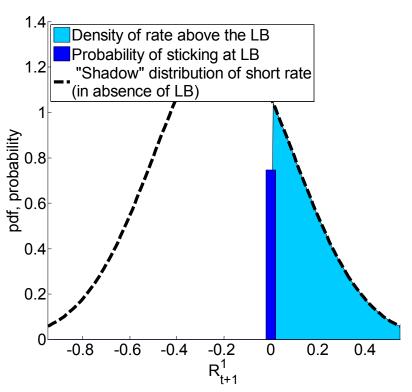
$$S_{t+1} \sim N(S_t, \beta^2 \sigma^2_{\pi})$$

➤ In *normal times*, when lower bound is far away:

$$E(R_{t+1}^1) = E(S_{t+1}) = S_t$$

## Simple model: The policy rate close to the lower bound

#### Distribution of short-term rate R next period



Sources: ECB calculations.

Notes: Hypothetical and illustrative example with current and intended short rate  $S_t$  equal to -0.2%,  $\beta$  = 1.2,  $\sigma^2_{\pi}$  = 0.25, and lower bound LB=0, hence actual current short rate  $R^1_{t}$  = LB = 0. Expected future short rate  $E(R^1_{t+1})$  = 4 bps.

Central bank follows a (simplified and modified) Orphanides/Wieland rule, so that the intended short rate S<sub>t</sub> is

$$S_t = S_{t-1} + \beta \cdot (\pi_t - \pi_{t-1}),$$
  
where  $\pi_t - \pi_{t-1} \sim N(0, \sigma^2_{\pi})$ 

Distribution of next period's intended policy (='shadow') rate is a simple normal:

$$S_{t+1} \sim N(S_t, \beta^2 \sigma^2_{\pi})$$

> But if CB is constrained by lower bound (*LB*):

$$R_t^1 = max \{LB, S_t\}$$

... and the predictive distribution of the actual short rate is a censored normal with

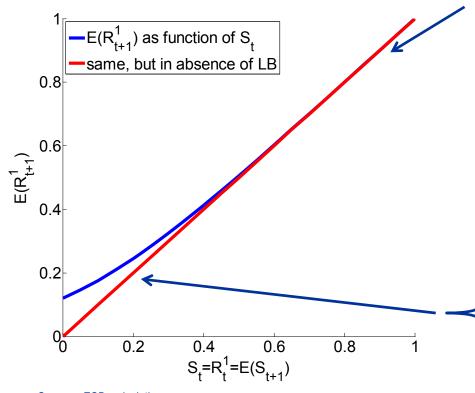
$$E(R^{1}_{t+1}) = LB$$

$$+ (S_{t} - LB) \cdot \Phi[(S_{t} - LB)/(\beta \sigma_{\pi})]$$

$$+ \beta \sigma_{\pi} \Phi[(S_{t} - LB)/(\beta \sigma_{\pi})]$$

## Simple model: ZLB reduces influence on term structure

# Relation between current policy rate S and expected next period's short-term rate R (percent)



Sources: ECB calculations.

Notes: Hypothetical and illustrative example with current and intended short rate  $S_t$  equal to -0.2%,  $\beta$  = 1.2,  $\sigma^2_{\pi}$  = 0.25, and lower bound LB=0.

In *normal times*, when short-term policy rate are is above *LB*:

$$\circ$$
  $E(R_{t+1}^1) = E(S_{t+1})$ 

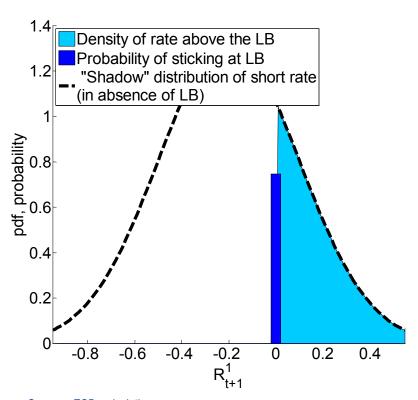
- Relation between current policy rate  $R^{1}_{t} = S_{t} \text{ and expected future short rate}$   $E(R^{1}_{t+1}) \text{ is almost linear}$
- ➤ When short-term rates approach *LB*:
  - $\circ$   $E(R_{t+1}^1) > E(S_{t+1})$
  - Relation between current policy rate  $R^1_t$  and expected future short rate  $E(R^1_{t+1})$  is convex: rate cuts have weaker and weaker impact on  $E(R^1_{t+1})$  and (under certain conditions) on  $R^2_t$

## Simple model: Under ZLB, $E(R_{t+1}^1)$ is biased upwards

$$R_{t}^{2} = \frac{1}{2} \cdot [R_{t}^{1} + E(R_{t+1}^{1})] + \frac{1}{2} Q \ Var(R_{t+1}^{1})$$

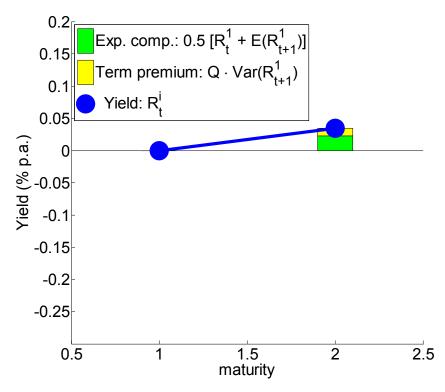
#### Distribution of short-term rate R next period

## Term structure of interest rates (percent p.a.)



Sources: ECB calculations.

Notes: Hypothetical and illustrative example with current and intended short rate  $S_t$  equal to -0.2%,  $\beta$  = 1.2 ,  $\sigma^2_{\pi}$  = 0.25, and lower bound LB=0, hence actual current short rate  $R^1_{t}$  = LB = 0. Expected future short rate  $E(R^1_{t+1})$  = 4 bps.



Sources: ECB calculations.

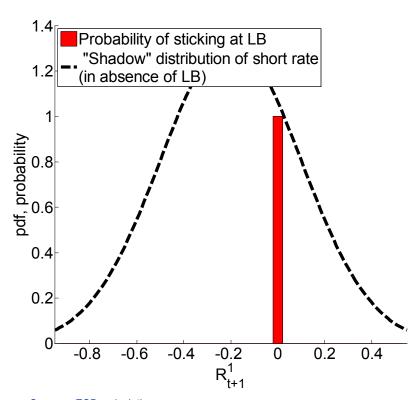
Notes: Yield (=3 bps) decomposition into expectational component (2 bps) and term premium (1 bp), with 'risk aversion' parameter y=2.and Q=1.

## Option 1: ZLB plus credible forward guidance on $R_{t+1}^{1} = 0$

$$R_t^2 = \frac{1}{2} \cdot [0 + 0] + \frac{1}{2} Q(0) = 0$$

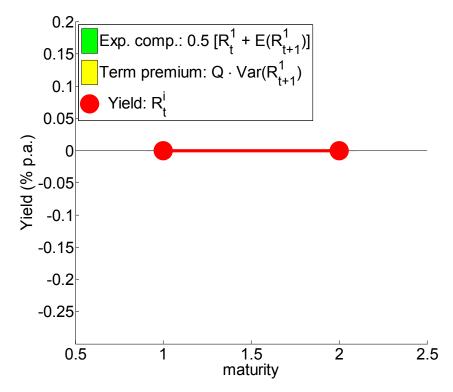
#### Distribution of short-term rate R next period

## Term structure of interest rates (percent p.a.)



Sources: ECB calculations.

Notes: Hypothetical and illustrative example with current short rate  $S_t$  equal to -0.2%,  $\beta$  = 1.2 and  $\sigma^2_{\pi}$  = 0.25, and lower bound LB=0, hence actual current short rate  $R^1_t$  = LB = 0. Unconditional ('Odyssean') forward guidance makes markets expect  $R^1_{t+1}$  = 0 with certainty.



Sources: ECB calculations.

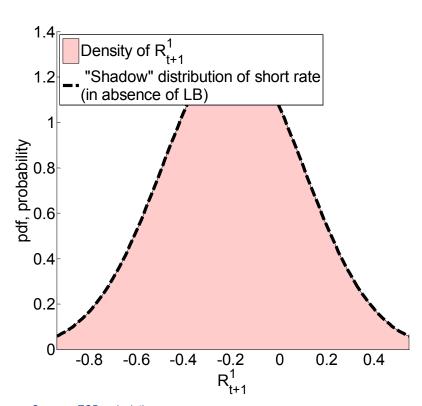
Notes: Yield decomposition into expectational component and term premium, with 'risk aversion' parameter y=2.and Q=1. Term premium vanishes as under the assumed forward guidance, the variance is zero.

## Option 2: NIRP with no forward guidance on $R_{t+1}^{1}$ ...

$$R_{t}^{2} = \frac{1}{2} \cdot [S_{t} + E(S_{t+1})] + \frac{1}{2} Q Var(S_{t+1})$$

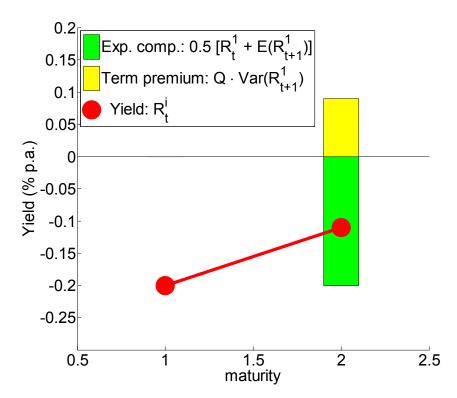
#### Distribution of short-term rate R next period

## Term structure of interest rates (percent p.a.)



Sources: ECB calculations.

Notes: Hypothetical and illustrative example with current short rate  $S_t$  equal to -0.2%,  $\beta$  = 1.2 and  $\sigma^2_{\pi}$  = 0.25, and lower bound removed. Hence actual current and expected short rate  $R^1_{t}$  =  $E(R^1_{t+1})$ =-0.2%. The variance is now maximal. i.e. equal to the variance of the shadow rate distribution.



Sources: ECB calculations.

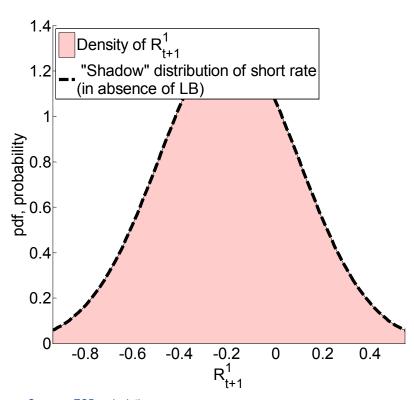
Notes: Yield decomposition into expectational component and term premium, with 'risk aversion' parameter  $\gamma$ =2 and Q=1. Compared to status quo, yield drops from 3 to -11 bps. Expectational component drops from 2 to -20 bps. Term premium is higher than under 'status quo' (9 vs 1 bps) as the variance is higher.

## ... possibly reinforced by QE to compress term premium

$$R_{t}^{2} = \frac{1}{2} \cdot [S_{t} + E(S_{t+1})] + \frac{1}{2} Q' Var(S_{t+1})$$

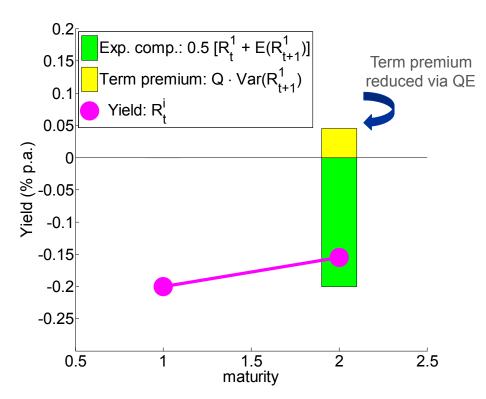
#### Distribution of short-term rate R next period

## Term structure of interest rates (percent p.a.)



Sources: ECB calculations.

Notes: Hypothetical and illustrative example with current short rate  $S_t$  equal to -0.2%,  $\beta$  = 1.2 and  $\sigma^2_{\pi}$  = 0.25, and lower bound removed. Hence actual current and expected short rate  $R^1_{t}$  =  $E(R^1_{t+1})$ =-0.2%. The variance is now maximal. i.e. equal to the variance of the shadow rate distribution.



Sources: ECB calculations.

Notes: Yield decomposition into expectational component and term premium, with 'risk aversion' parameter  $\gamma$ =2 and Q=0.5, i.e. reducing private sector bond holdings by one half. Compared to status quo, yield drops from 3 to -16 bps. Expectational component drops from 2 to -20 bps. QE reduces term premium further to below 5 bps.

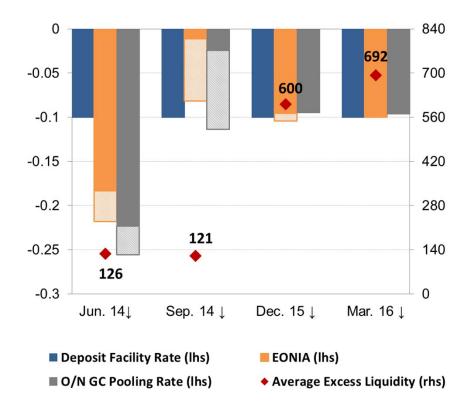
#### Overview

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## Transmission: smooth pass-through with ample liquidity

## Change in deposit rate and money market rates and excess liquidity

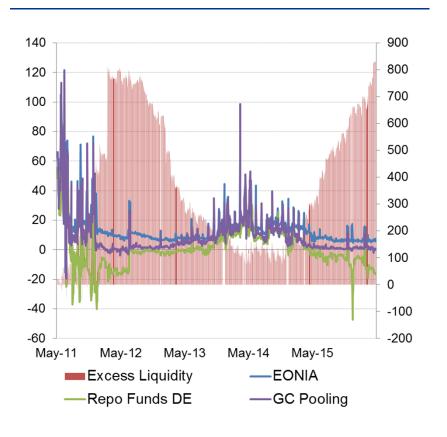
(average rate in the maintenance period (MP) after the rate cut (solid) and as of second MP until next rate change (stripes), in % (lhs) and billion euro (rhs))



## Sources: ECB, EMMI, Eurex repo and Bloomberg

## Spreads of money market rates with deposit rates and excess liquidity

(basis points (lhs) and billion euro (rhs))

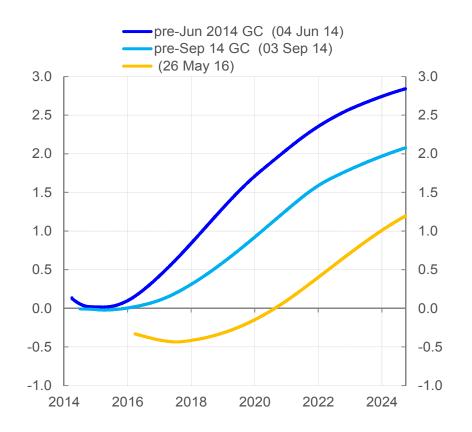


Sources: ECB, EMMI, BrokerTec, Eurex repo and Bloomberg, .

## Transmission: the risk-free yield curve

#### **EONIA Forward Curves since June 2014**

(percentage points)



#### A calamitous misadventure?

#### Why a negative interest rate policy

- Removes non-negativity restriction on future expected short rates: forward curve becomes flatter than it would be if short rates were expected to be constrained by a zero lower bound
- Charges bank cash hoarding: extra downward pressure on long-term rates via term premium compression and push to portfolio shifts
- NIRP has flattened and stabilized the term structure since 2014

Sources: ECB and Reuters

Note: Curve shows instantaneous EONIA forward rates based on OIS.

## Transmission: The bank lending channel

#### Bank lending rates on loans for companies

(percentages per annum; three-month moving averages)

#### —FR — IT — EA — NL Negative rate policy 7 0 7.0 TLTRO APP 6.0 6.0 5.0 5.0 4.0 4.0 3.0 3.0 2.0 2.0 1.0 1.0 0.0 0.0 2008 2009 2010 2011 2012 2013 2014 2015 2016

#### Source: ECB.

Notes: The indicator for the total cost of lending is calculated by aggregating shortand long-term rates using a 24-month moving average of new business volumes. Latest observation: March 2016.

#### A calamitous misadventure?

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- NIRP has flattened and stabilized the term structure since 2014
- NIRP has compressed levels and dispersion of banks' lending rates across euro area ...

## Transmission: The bank lending channel

## Bank reactions to holdings of excess liquidity (coefficient estimates)

#### ■ 90% confidence interval -coefficient estimate 0.06 0.018 0.09 0.04 0.016 0.08 0.02 0.07 0.014 0.00 0.06 0.012 -0.020.010 0.05 -0.040.04 0.008 -0.06 0.006 0.03 -0.08 0.004 0.02 -0.10 0.01 0.002 -0.120.00 0.000 -0.14pre-NIRP NIRP NIRP pre-NIRP pre-NIRP Lending to Acquisitions Wholesale NFCs and funding of households government bonds

Sources: ECB estimates based on S. Demiralp, J. Eisenschmidt and T. Vlassopoulos, (2016), "The impact of negative interest rates on bank balance sheets: Evidence from the euro area", ECB mimeo.

Note: estimates refer to less vulnerable euro area countries (Belgium, Germany, Estonia, France, Latvia, Luxembourg, Malta, the Netherlands, Austria, Slovakia and Finland)

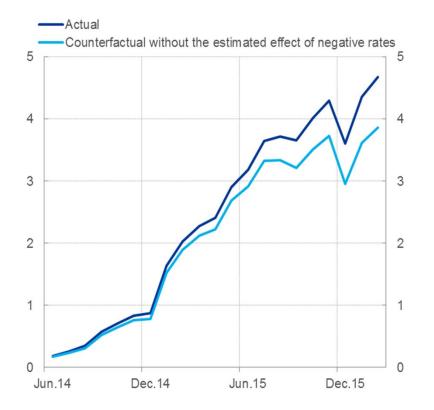
#### A calamitous misadventure?

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- NIRP has flattened and stabilized the term structure since 2014
- NIRP has compressed levels and dispersion of banks' lending rates across euro area ...
- ... as the charge on excess liquidity shifts the risk-reward calculus of bank s' portfolio allocation

## Transmission: The bank lending channel

## Cumulated changes in loans to companies

#### (percentage changes)



## Sources: ECB estimates based on S. Demiralp, J. Eisenschmidt and T. Vlassopoulos, (2016), "The impact of negative interest rates on bank balance sheets: Evidence from the euro area", ECB mimeo.

Note: The chart refers to the sample of banks for which individual bank data is available. Less vulnerable euro area countries are Belgium, Germany, Estonia, France, Latvia, Luxembourg, Malta, the Netherlands, Austria, Slovakia and Finland.

#### A calamitous misadventure?

- Removes non-negativity restriction on future expected short rates: forward curve becomes flatter than it would be if short rates were expected to be constrained by a zero lower bound
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- NIRP has compressed levels and dispersion of banks' lending rates across euro area ...
- ... as the charge on excess liquidity shifts the risk-reward calculus of bank s' portfolio allocation
- > ... and makes loans more attractive

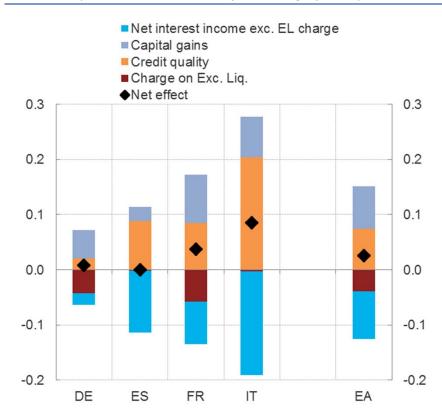
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## Financial stability: A tax on bank intermediation?

#### Bank profitability and monetary policy: 2014-2017

(contribution to ROA, percentage points)



#### Source: EBA, ECB and ECB estimates.

Notes: Deviation from no policy action scenario. Capital gains based on data on a consolidated basis for 68 euro area banking groups under direct ECB supervision and included in the 2014 EU-wide stress test. Euro area figures calculated as the weighted average for the countries included in the sample using Consolidated Banking Data (CBD) information on the weight of each country's banking system on the euro area aggregate. Effect on net interest income based on aggregate BSI data and obtained by simulation of the interest income and interest expenses based on estimates of the effect of APP on bond yields, lending and deposit rates, excess liquidity and economic growth taking into account BMPE projections for interest rates and credit aggregates. Effect on credit quality based on the median of estimates obtained from a suite of empirical studies.

#### A calamitous misadventure?

#### Why a negative interest rate policy

- Removes non-negativity restriction on future expected short rates: forward curve becomes flatter than it would be if short rates were expected to be constrained by a zero lower bound
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- > ... as the charge on excess liquidity shifts the risk-reward calculus of bank s' portfolio allocation
- > ... and makes loans more attractive

#### **Multiple channels**

- Charge on bank cash is a tax on core banks
- Falling Euribor pressures margins in periphery
- But there are several offsetting factors ...
- ... and net impact is muted over next few years

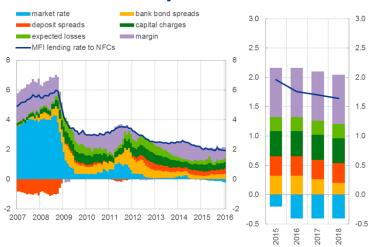
## Financial stability: The TLTRO safeguard

#### Banks' lending costs and lending margins

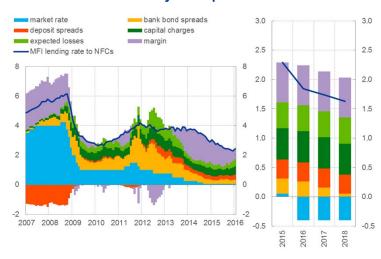
(annual percent change)

#### **ECB Constrained optimisation**





#### **Italy and Spain**



- > Preserve downward pressure on borrowing costs
- But avoid that a tax on banks' cash hoarding turn into a tax on bank intermediation

#### **TLTRO-2**

- Announce series of 4-year lending operations with reward for banks outperforming lending benchmark
- The TLTRO reward calibrated so as to give banks some room for recovering lending margins (purple bars on the left) while keeping lending rates on a declining trend
- In practice: index ex post TLTRO-2 borrowing rate for outperformers to deposit facility rate ...
- ... and thereby pull down the base rate (light blue bars on the left) off which banks price loans

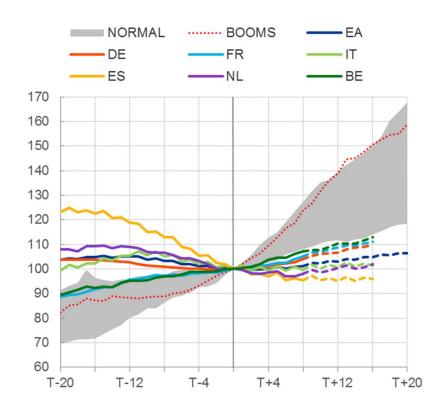
## Financial stability: No property price bubble in sight

## Real household loans around starting period of house price booms

(indices, normalised to 100 at T=trough; T=2013Q4)

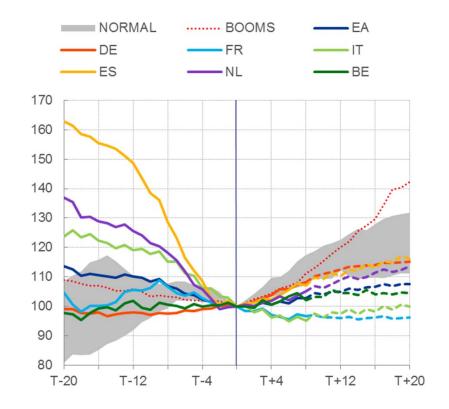
## Real house prices around starting period of house price booms

(indices, normalised to 100 at T=trough; T=2013Q4)



Sources: BIS, ECB and ECB calculations.

Notes: Based on data from 1970Q1 to 2015Q4 for euro area countries. All indicators are deflated by HICP. Projections for euro area are June 2016 BMPE Projections while for countries are December 2015 BMPE projections. Trough (starting point of house price normal increases or booms) identified via quarterly version of Bry-Boschan algorithm by Harding and Pagan, 2002. Dotted line refers to median during house price booms. Grey range refers to interquartile range during normal house price increases.



Sources: BIS, ECB, Fed Dallas, OECD and ECB calculations.

Notes: Based on data from 1975Q1 to 2015Q4 for euro area countries. All indicators are deflated by HICP. Projections for euro area are June 2016 BMPE projections. Trough (starting point of house price normal increases or booms) identified via quarterly version of Bry-Boschan algorithm by Harding and Pagan, 2002. Dotted line refers to median during house price booms. Grey range refers to interquartile range during normal house price increases.

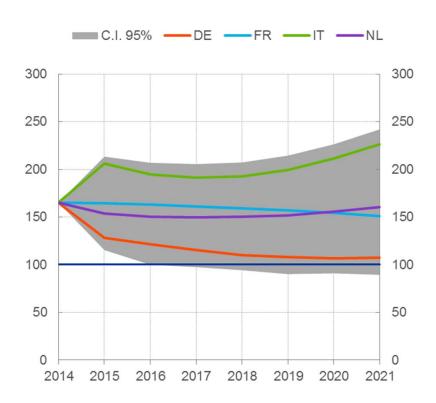
## Financial stability: Insurance industry slowly adapting

## Projection of solvency ratios under the "adverse" scenario

(2014-2021; SCR ratio)

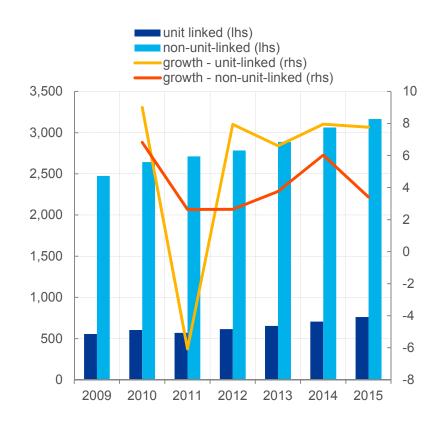
## Net equity of households in unit-linked and non-unit-linked life insurance

(2009-2015; EUR billions; percentages)



Source: ECB-DGMF/FSS calculations.

Note: The solid lines represent the median solvency ratios defined as Own Funds over Solvency Capital Requirements. C.I. is the confidence interval containing the 95% of the simulated solvency ratios for the considered countries.



Source: ECB.

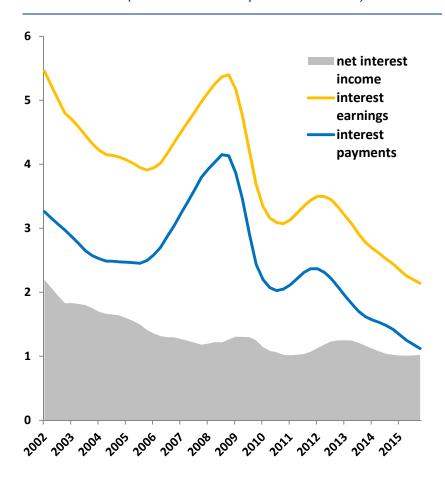
## Financial stability: No expropriation of savers in aggregate

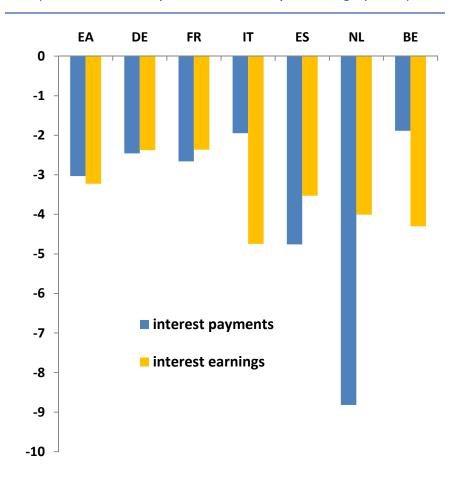
## Euro area household interest payments/earnings

(as a share of disposable income)

# Change in household interest payments/earnings since 2008Q3

(as a share of disposable income, percentage points)





Sources: Eurostat and ECB calculations.

Note: The change has been computed for the period 2008Q3-2015Q4. Interest payments/earnings after FISIM allocation (Financial Intermediation Services Indirectly Measured). Latest observation: 2015Q4

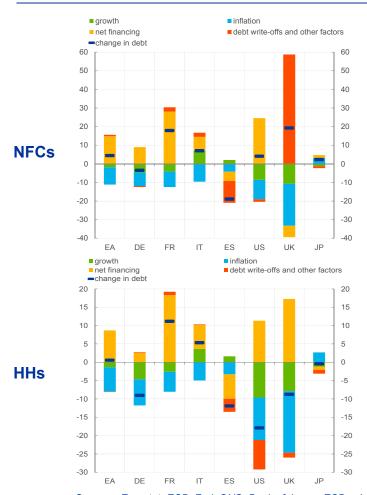
## Financial stability: Policy helps deleveraging

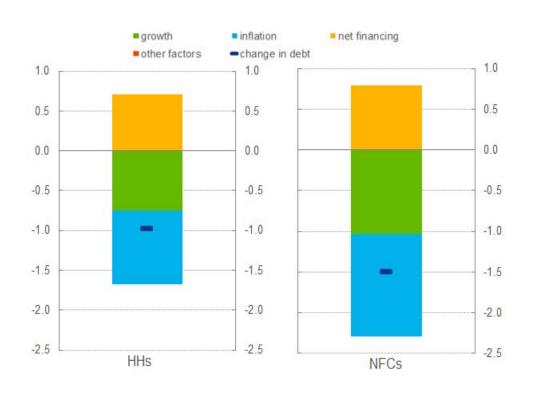
#### Change in private debt since mid-2007

(as a percent of nominal GDP; percentage point contributions)

# The estimated cumulative impact of ECB measures on the euro area private debt in 2015-18

(percentage points)





Sources: Eurostat, ECB, Fed, ONS, Bank of Japan, ECB calculations.

Notes: Corporate debt is defined as the sum of total loans granted to NFCs net of inter-company loans, debt securities issued and pension liabilities. Household debt includes total loans granted to households. Other factors include possible valuation effects and reclassifications. Latest observation: 2015 Q4 for EA, US and JP and 2015 Q3 for DE, FR, IT, ES and UK. The impact of APP on NFCs and HHs debt (RHS) excludes the March 2016 package.

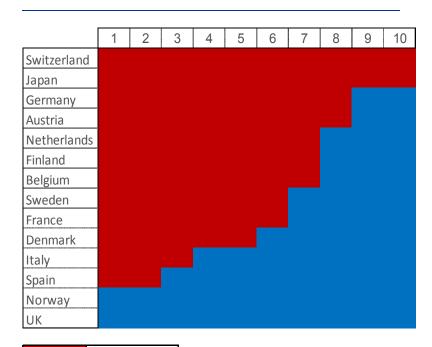
#### Overview

- A Why? NIRP rehabilitates monetary policy in a low rate world
- B A simple model exercise: NIRP versus ZLB plus forward guidance
- **C** Transmission
- D Financial stability
- E Outlook and open issues

## Outlook and open issues

#### Government bonds with negative rates

(yields by maturity)



## Negative yield Positive yield

Source: Deutsche Bank and ECB calculations

Note: Maturities are shown on the horizontal axis. For NL, SE, FR and IT the 1 year maturity refers to T-Bills. The last observation available for NL 1y T-Bill is 18/01/2015 and for SE is 20/01/2016. The last observation for the 2y Government Bond for NO is 18/02/2016. The last observation available for the 3y Government Bond for DK is 12/01/2016 and for SE is 05/02/2015. The last observation available for the 4y Government Bond for DK is 01/2/2013 and for NO is 18/02/2016. The last observation available for the 6y Government Bond for DK is 22/10/2015 and for NO is the 18/02/2016. No observations are available for 6, 8 and 9 years maturity for SE; for 1, 7, 8 and 9 years for DK, and 9 years maturity for the UK. The maturity without observation obtains the same colour as of one maturity below and above, in case these have the same colour or the colour following the yield curve. Latest observation: 26 May 2016.

#### A calamitous misadventure?

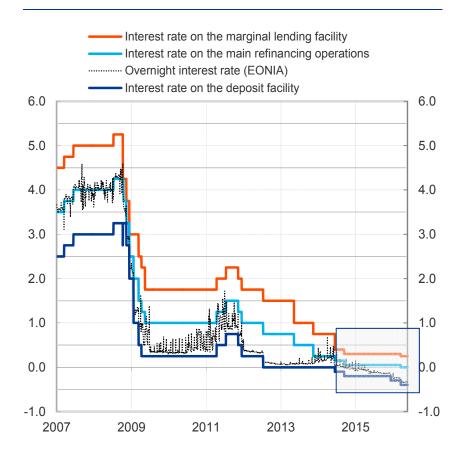
- No. NIRP is a symptom: incidence of negative rates attests to the global nature of the phenomenon
- Safe assets have been decimated during the crisis (especially in Europe), their price has surged
- > Two ways to curb excess demand for safety: Let incomes fall or make safe assets very expensive
- NIRP is an efficient way to accomplish the latter
- In the short term, NIRP re-empowers monetary policy, conventional and unconventional
- But, if reflation is retarded, transmission could change in unknown directions:
  - Protracted period of low rates is fertile ground for asset price bubbles
  - o Bank disintermediation could proceed faster
  - Insurers could become asset managers
  - Savers could feel more exposed to risk than desired, and de-risk more aggressively
- Fast return of inflation to objective is key to avoiding these risks

# Thank you

## Goodbye ZLB: Four rate cuts into negative since June 2014

#### **Key ECB policy rates since 2014**

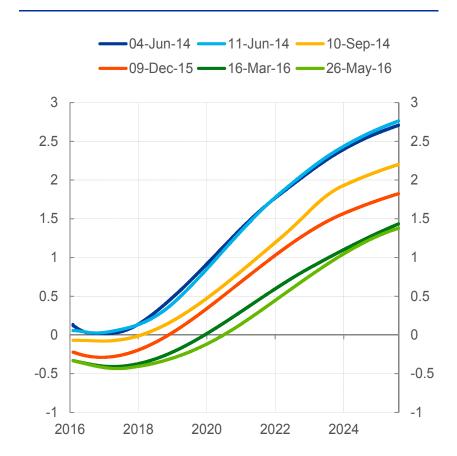
(percent p.a.)



Sources: ECB, Thomson Reuters. Latest observation: 26 May 2016.

#### Money market forward curves

(percent p.a.)

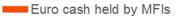


Sources: Reuters and ECB calculations.

Notes: 26 May 2016.

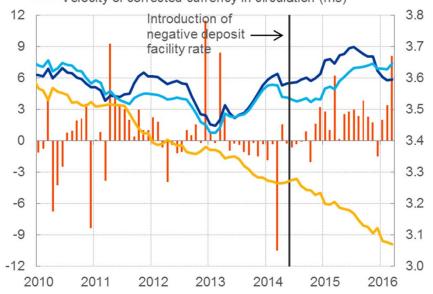
## Negative DFR, banknotes and the physical lower bound

# Currency in circulation and income velocity of currency (annual percentage changes (left); multiples of currency in circulation (right))



——Currency in circulation

Currency in circulation for external demand and exeptional developments in Greece
 Velocity of corrected currency in circulation (rhs)



#### Sources: ECB, ECB estimates.

Notes: Velocity of currency in circulation is defined as nominal GDP over currency in circulation. Nominal GDP is converted to monthly frequency using a cubic spline interpolation.

Latest observation: March 2016.

## Estimated negative rate threshold based on cost of cash storage

	Largest Denomination	Value of 1 Unit of Currency in USD		Implied Minimum Rate
Switzerland	1000	1.03	0.2%	-0.5%
Euro area (DEU)	500	1.11	0.4%	-0.7%
Denmark	1000	0.15	1.2%	-1.5%
Sweden	1000	0.12	1.3%	-1.6%

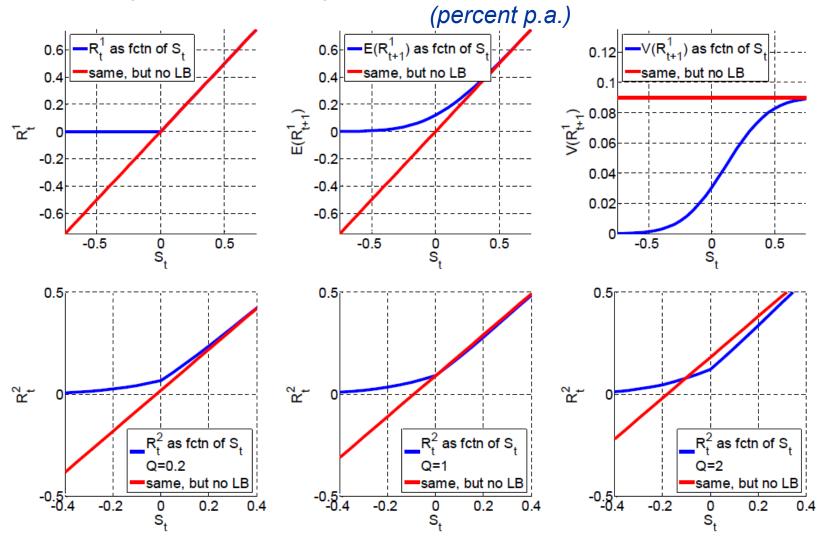
Sources Prince et al. (2016).

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Notes: Policy rates could likely dip a bit below the storage cost of cash, given factors like the inconveninence of transacting in cash and the spread between policy and deposit rates.

## ZLB: Rate cut has less impact on $E(R_{t+1}^1)$ , reduces $Var(R_{t+1}^1)$

### $R_t^2$ as function of $S_t$ : decomposition (top) and relevance of Q (bottom)



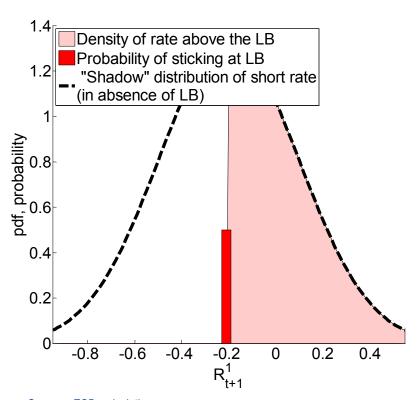
Sources: ECB computations

Notes: Hypothetical and illustrative example with  $\beta$  = 1.2 and  $\sigma^2_{\pi}$  = 0.25, and LB=0. Recall that the long-term rate is given as  $R^2_t$  = 0.5  $R^1_t$  + 0.5  $E(R^1_{t+1})$  + Q  $Var(R^1_{t+1})$ . The first row, from left to right, shows the constituting elements as a function of  $S_t$ :  $R^1_t$ ,  $E(R^1_{t+1})$ ,  $Var(R^1_{t+1})$ . The second row shows the full  $R^2_t$ , as a function of  $S_t$  for different levels of  $Q_t$ .

## Option 3: Shifting the LB from 0 to -20 bps

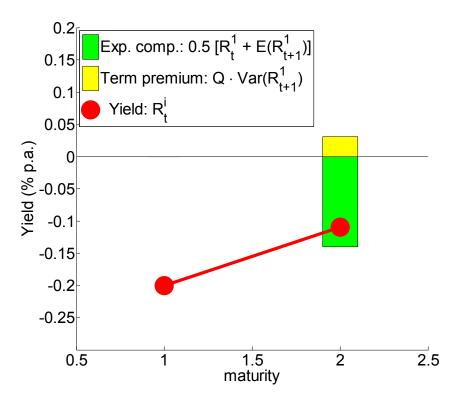
#### Distribution of short-term rate R next period

## Term structure of interest rates (percent p.a.)



Sources: ECB calculations.

Notes: Hypothetical and illustrative example with current short rate  $S_t$  equal to 0.2%,  $\beta$  = 1.2 and  $\sigma^2_{\pi}$  = 0.25, and new lower bound LB=-0.2%, hence actual current short rate  $R^1_t$ = LB = -0.2%. Expected future short rate  $E(R^1_{t+1})$  = -8 bps. Note that the variance is higher than under 'status quo' as the distribution is again censored, but less asymmetric (as shadow rate distribution unchanged). It is still lower than under the shadow rate distribution.



Sources: ECB calculations.

Notes: Yield decomposition into expectational component and term premium, with 'risk aversion' parameter  $\gamma$ =2 and Q=1. Compared to status quo, yield drops from 3 to -11 bps. Expectational component drops from 2 to around -14 bps (=0.5\*(-20-8) bps). Term premium is a bit higher than under 'status quo' (3 vs 1 bps) as the variance is the same.

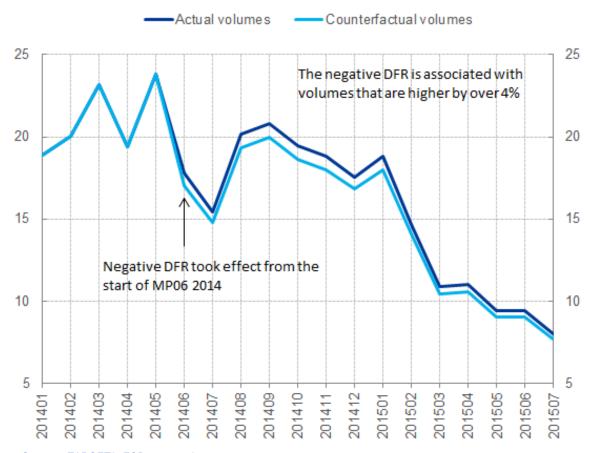
## Summary: Policy options to reduce the LB-induced bias

Impact on:	Status quo: LB=0 binding, S <sub>t</sub> = E(S <sub>t+1</sub> ) = - 20bps	Forward guidance	Reduce LB to negative (say -20 bps)	Drop LB (almost) completely
Current rate R <sub>t</sub>	Zero	Zero	-20 bps	-20 bps
Expected short rate E(R <sup>1</sup> <sub>t</sub> )	Above zero (due to probability mass above LB)	Zero (by construction)	Above -20 bps (due to probability mass above new LB)	- 20 bps
Term premium (TP) Q Var(R <sup>1</sup> <sub>t+1</sub> )	Small (due to low variance of future rates)	Zero (by construction)	A bit higher than in status quo, but lower than under complete LB drop	Higher than in status quo due to higher variance
Overall long-term rate R <sup>2</sup> <sub>t</sub> = average expected short rate +TP	Higher than zero and intended rate	Zero	Lower - if expectations decrease not outweighed by term premium	Lower - if expectations decrease not outweighed by term premium
Deviate from rule?	No	Yes	No	No
QE effective?	A bit	No	Yes	Yes

## Negative DFR spurred interbank lending

#### **Overnight interbank lending**

(average daily volumes per reserve maintenance period, EUR bn)



Sources: TARGET2, ECB computations

Notes: The counterfactual volumes illustrate how overnight interbank lending volumes would have evolved if the negative DFR was not significantly associated with higher volumes. These counterfactual volumes are derived from a panel analysis of overnight lending volumes as identified in TARGET2. The panel includes daily observations for 14 euro area countries from 1 August 2011 until 8 December 2015. The results of the panel analysis indicate that after controlling for excess liquidity, the width of the standing facilities corridor and country risk, the period during which the DFR was either -10bps or -20bps is associated with overnight lending volumes that are higher on average by 4.1%.

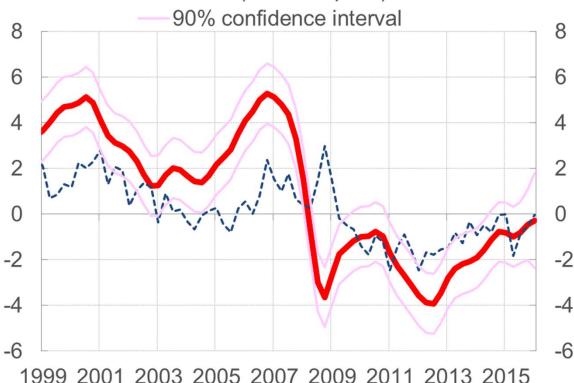
#### Setting negative policy rates to follow natural rate

#### **Estimated Natural Real Rate of Interest**

(percent p.a.)

Natural Real Interest Rate

----Actual (model-implied) 3M Real Rate



Sources: ECB computations

Notes: The underlying model is an update and modification of Mesonnier and Renne (2007) "A time-varying natural rate of interest for the euro area", European Economic Review: a small semi-structural macro model with IS curve and Phillips curve and latent processes for NRI and potential growth. The estimated equilibrium real rate is based on a two-sided filtered ('Kalman smoothed') series. The actual real rate is the model-implied variable, i.e. short-term nominal rate minus model-implied q-on-q expected inflation. Other approaches to compute (ex ante) real rates may lead to different results. Quarterly data, last observation 2016 Q1.

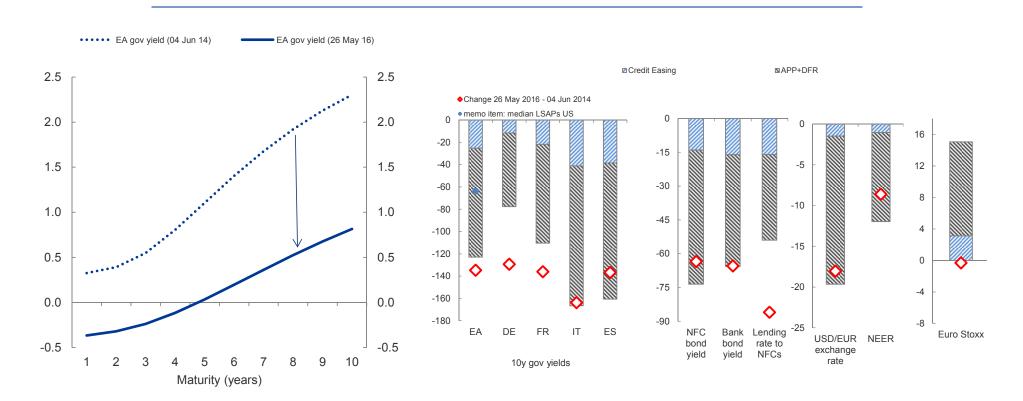
# The 2014-16 measures

		Jun. 2014	Sep. 2014	Jan. 2015	Dec. 2015	Mar. 2016
	Negative rates	MRO: 0.15%: MLF: 0.40%; DRF: -0.10%	MRO: 0.05%: MLF: 0.30%; DRF: -0.20%		MRO: 0.05%: MLF: 0.30%; DRF: -0.30%	MRO: 0.00%: MLF: 0.25%; DRF: -0.40%
	TLTRO I & II	Fixed rate (MRO) Max. maturity: Sep. 2018 Uptake depends on net lending Mandatory early repayment				Fixed rate At MRO or below if lending > benchmark (min. DFR) No mandatory early repayment
APP	Private asset purchases		Broad portfolio of simple & transparent ABS and CBs		APP recalibration	Purchase of inv grade NFC bonds with high pass- through to real economy
	Public asset purchases		4	Purchases of EA sovereign bonds €60bn of monthly purchases "until end-September 2016 and in any case until we see a sustained adjustment in the path of inflation which is consistent with our aim of achieving inflation rates below, but close to, 2% over the medium term."	•Adjusted date- based leg (to Mar. 2017) •Reinvestment of principal payments	APP recalibration •€80bn monthly purchases •Higher issue share limit for certain issuers

#### Borrowing conditions eased across markets

#### Term structure, yields and financial prices since 4 June 2014

(exchange rates and Eurostoxx in percent; else in basis points)

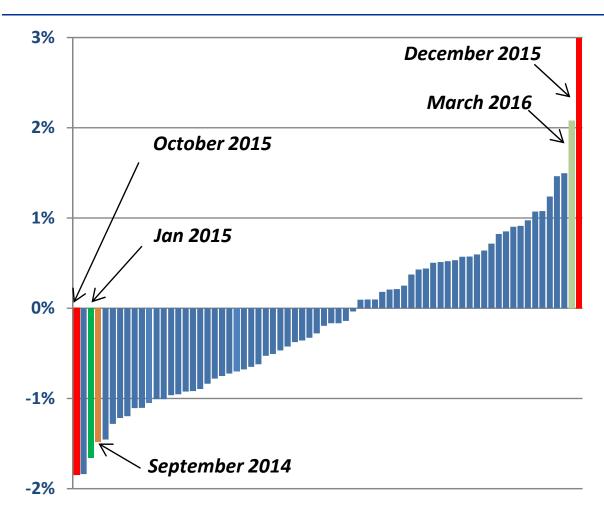


Sources: Bloomberg, ECB, ECB calculations.

Notes: The impact of credit easing is estimated on the basis of an event-study methodology which focuses on the announcement effects of the June-September package; see the EB article "The transmission of the ECB's recent non-standard monetary policy measures" (Issue 7 / 2015). The impact of the DFR cut rests on the announcement effects of the September 2014 DFR cut. APP encompasses the effects of both January 2015 and December 2015 measures. The January 2015 APP impact is estimated on the basis of two event-studies exercises by considering a broad set of events that, starting from September 2014, have affected market expectations about the programme; see Altavilla, Carboni, and Motto (2015) "Asset purchase programmes and financial markets: lessons from the euro area" ECB WP No 1864, and De Santis (2015) mimeo. The quantification of the impact of the December 2015 policy package on asset prices rests on a broad-based assessment comprising event studies and model-based counterfactual exercises. The impact of the March 2016 measures is assessed via model-based counterfactual exercises. Latest observation: 26 May 2016.

## NIRP: Not an instrument of exchange rate manipulation

#### **EURUSD** changes following ECB GovC decisions since 2010



Source: Bloomberg, ECB staff calculations.

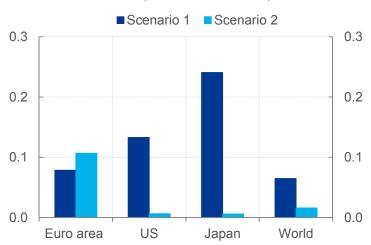
Note: 1-day percentage change on the day of the Governing Council based on New York closing time.

#### NIRP: Not an instrument of exchange rate manipulation

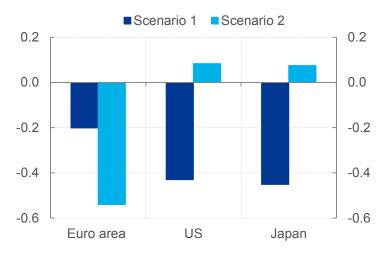
#### G-3 vs ECB-only rate cut to negative levels

(daily; basis points and dollars per euro)

#### Real GDP (% diff. from baseline)



#### Nominal effective exchange rate (% diff. from baseline)



#### A calamitous misadventure?

#### Why a negative interest rate policy

- Removes non-negativity restriction on future expected short rates: forward curve becomes flatter than it would be if short rates were expected to be constrained by a zero lower bound
- Charges bank cash hoarding: extra downward pressure on long-term rates via term premium compression and push to portfolio shifts
- NIRP has flattened and stabilized the term structure since 2014
- NIRP has compressed levels and dispersion of banks' lending rates across euro area ...
- ... as the charge on excess liquidity shifts the risk-reward calculus of bank s' portfolio allocation
- > ... and makes loans more attractive

# Zero-sum redistribution of world scarce demand?

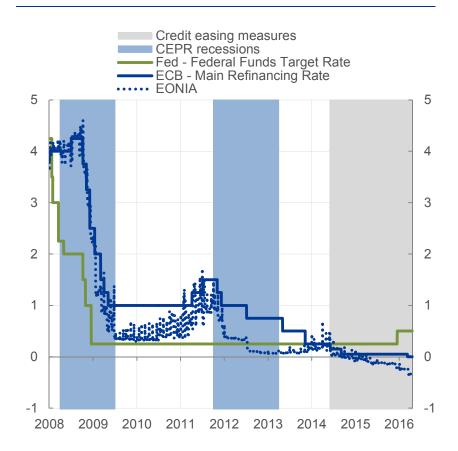
Multilateral easing creates global demand

Sources: National Institute Global Econometric Model (NiGEM), ECB staff calculations.

Notes: Scenario 1 ("G3 rate cut"): EA cut to -0.5%, US cut to -0.1%, Japan cut to -0.5%. Scenario 2 ("EA rate cut"): EA cut to -0.5%, US and Japan unchanged. A decrease in the nominal effective exchange rate indicates a depreciation of the currency, while an increase indicates an appreciation. Peak impact over three years.

## Policy paths since June 2014

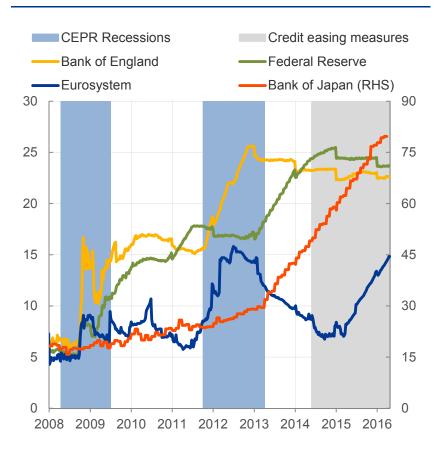
# ECB and FED key interest rates and EONIA (percent)



Source: ECB, Federal Reserve.

Notes: Main Refinancing Rate (ECB), Federal Funds Target Rate (Fed), EONIA (ECB).

# Central bank balance sheets (percent of GDP)



Source: ECB, Federal Reserve, Bank of England, Bank of Japan, Eurostat, BIS. Notes: The ECB balance sheet only comprises assets related to monetary policy.

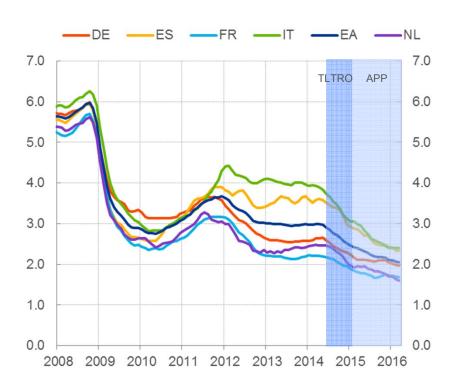
## Exceptional pass-through via bank lending channel

# Bank lending rates on loans for non-financial corporations

(percentages per annum; three-month moving averages)

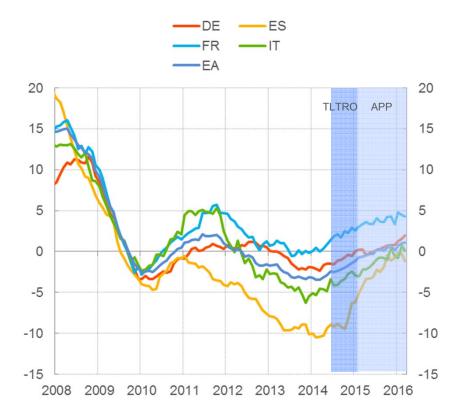
# MFI loans to non-financial corporations in selected euro area countries

(annual percentage changes)



Source: ECB.

Notes: The indicator for the total cost of lending is calculated by aggregating shortand long-term rates using a 24-month moving average of new business volumes. Latest observation: March 2016.



Source: ECB.

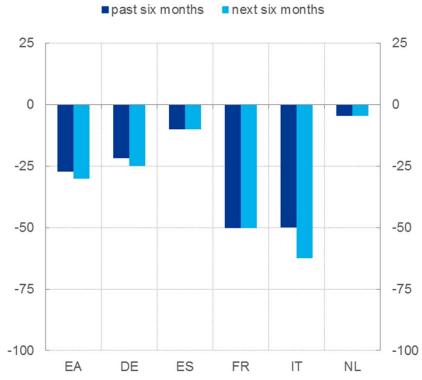
Notes: Adjusted for loan sales and securitisation.

Latest observation: February 2016.

#### Negative rate policy period associated margin compression

# Impact of negative DFR on margins on loans to enterprises

(net percentage of respondents indicating an increase)



Source: ECB (BLS).

Notes: The net percentages are defined as the difference between the sum of the percentages for "increased considerably" and "increased somewhat" and the sum of the percentages for "decreased somewhat" and "decreased considerably". The results shown are calculated as a percentage of the number of banks which did not reply "not applicable". "EA" denotes euro area.

# Model-based decomposition of change in median loan-deposit margin for June 2014 to February 2016 (percentage points)



■ Negative rate and other monetary policy measures (APP, TLTRO)

■ Pure negative rate effect



Sources: ECB. ECB estimates.

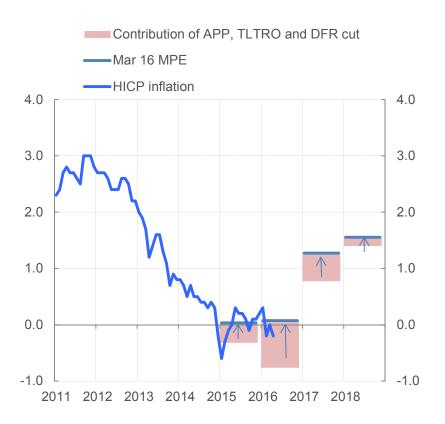
#### Transmission: the macro economy

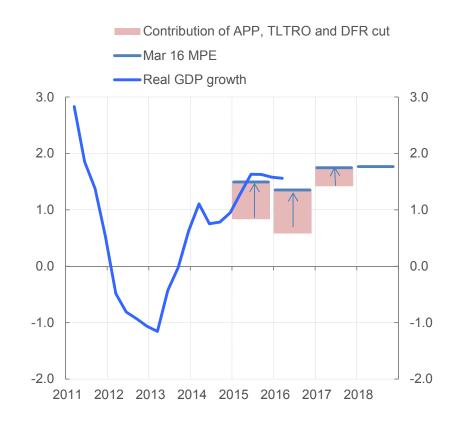
# HICP Inflation, inflation projections and APP/TLTRO contribution

(year-on-year percent change)

# GDP growth, growth projections and APP/TLTRO contribution

(year-on-year percent change)





Source: ECB computations, March 2016 MPE.

Note: The contribution of APP, TLTRO and DFR cut does not include the impact of the measures taken at the March 2016 Governing Council. Latest observation: April 2016 for HICP inflation and 2016 Q1 for real GDP growth.

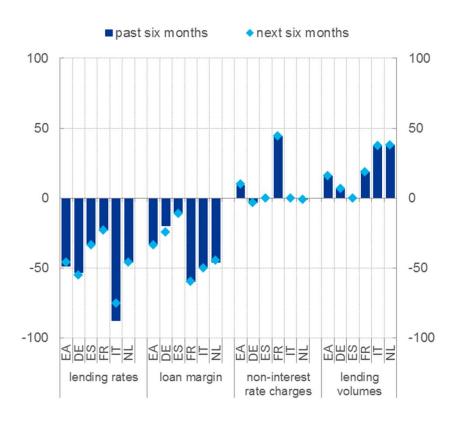
## Impact of the NIRP on bank lending conditions

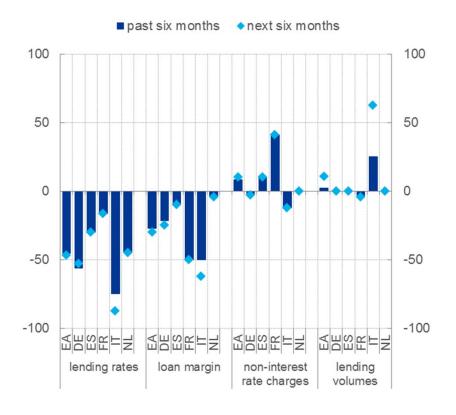
# Impact of the negative DFR on bank lending to households for house purchase

(net percentage of respondents indicating an increase; over the past and next six months)

# Impact of the negative DFR on rates on bank lending to enterprises

(net percentage of respondents indicating an increase; over the past and next six months)





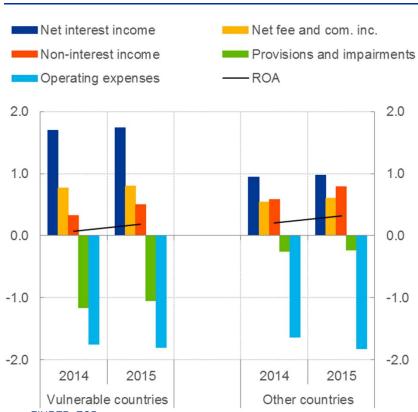
Source: ECB (BLS).

Notes: The net percentages are defined as the difference between the sum of the percentages for "increased considerably" and "increased somewhat" and the sum of the percentages for "decreased somewhat" and "decreased considerably". The results shown are calculated as a percentage of the number of banks which did not reply "not applicable". "EA" denotes euro

#### Transmission: bank lending channel

#### Bank profitability and contributing factors

(percentages of total assets)

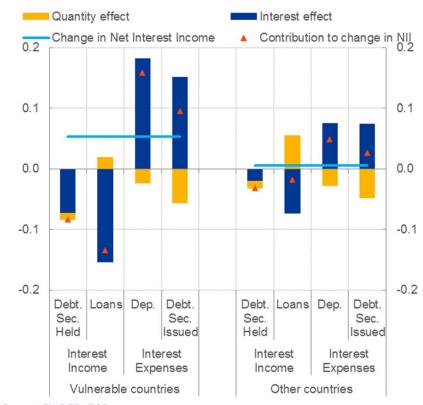


Source: FINREP, ECB.

Notes: Based on data for all institutions under the supervision of the ECB reporting accounting data on a consolidated basis (121 Significant institutions and 168 Less Significant Institutions). These account for around 98 per cent of loans to the non-financial private sector reported for euro area banks in 2015 in the Consolidated Banking Data database. According to this database, banks reporting FINREP data (IFRS and GAAP) account for 90 per cent of total assets reported by euro area banks.

## Contributions to the change in net interest income between 2014 and 2015

(percentages of total assets)



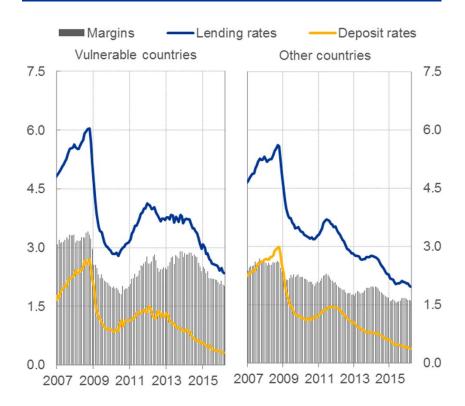
Source: FINREP, ECB.

Notes: Interest expenses are inverted, so that a decrease in costs is shown as a positive contribution to net interest income. Based on data for all institutions under the supervision of the ECB reporting accounting data on a consolidated basis (121 Significant institutions and 168 Less Significant Institutions). Interest expenses are inverted, so that a decrease in costs is shown as a positive contribution to net interest income.

#### Interest rates on loans and deposits

## Loan and deposit interest rates and margins on new business

(percentages per annum)

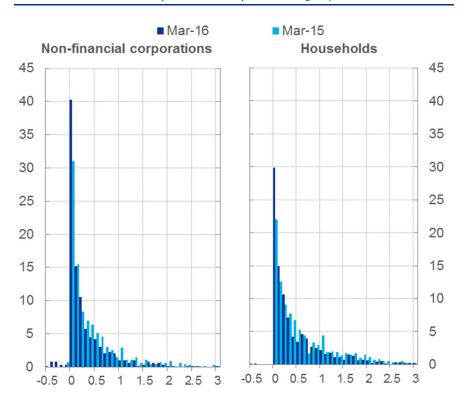


Source: ECB.

Notes: Loan and deposit composite rates are calculated using the corresponding outstanding amount volumes as weights. Latest observation: March 2016.

## Distributions of deposit rates to households and NFCs across individual MFIs

(x-axis: deposit rates in percentages per annum, y-axis: frequencies in percentages)



Source: ECB.

#### Low interest rates and banks' business models

# Loan to deposit ratio and level of interest expense (end 2015 Q4)

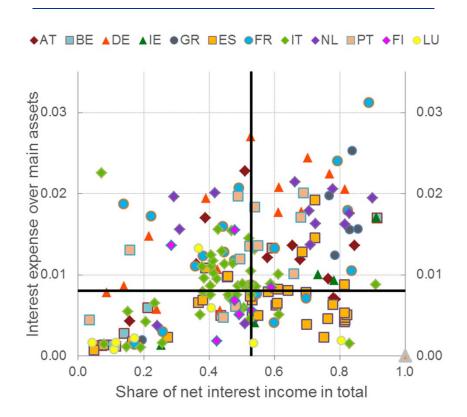
#### ◆AT ■BE ADE AIE ●GR ■ES ●FR ◆IT ◆NL ■PT ◆FI ●LU 1.30 1.30 Loan-deposit ratio 1.05 1.05 0.80 0.55 0.55 0.30 0.30 0.01 0.00 0.02 0.03 Interest expense

#### Sources: ECB. ECB calculations.

Notes: FINREP data for all SI and LSI using IFRS reporting on a consolidated basis. Loan deposit ratios include total loans and deposits to all sectors. Interest expense is as a share of total assets. Horizontal and vertical lines represent median of loan-deposit ratio (0.85) and share of interest expenses in total assets (0.00827) across all euro area institutions. Chart shows banks from 12 of 19 countries.

# Share of interest expenses in assets and share of net interest income in total income

(end 2015Q4)



#### Sources: ECB, ECB calculations.

Notes: FINREP data for all SI and LSI using IFRS reporting on a consolidated basis. Share of net interest income in total net operating income and interest expense over total assets. Vertical and horizontal lines represent median share of net interest income in total net operating income (0.53) and of interest expense over total assets (0.008) across all euro area institutions. Chart shows banks from 12 of 19 countries.

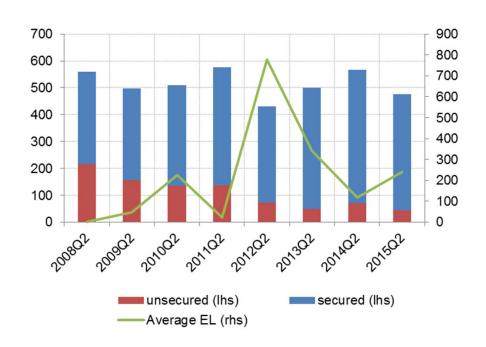
## Reducing incentives for money market activity?

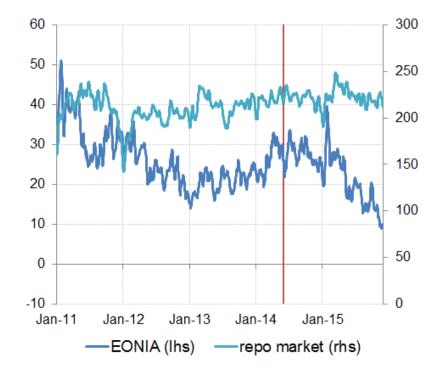
# Euro money market turnover and excess liquidity

(cumulative quarterly turnover, billion euro)

#### Volumes in unsecured EONIA and repo market

(overnight outstanding amounts, billion euro)

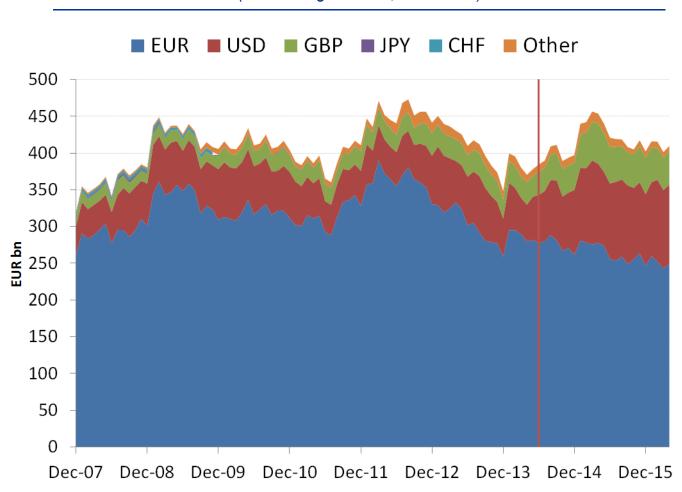




## Banks' short-term issuance with negative rates

#### **STEP volumes by currency**

(outstanding amounts, billion euro)



Sources: ECB, STEP.

## Hurting the Money Market Fund industry?

#### Euro area money market funds – major items

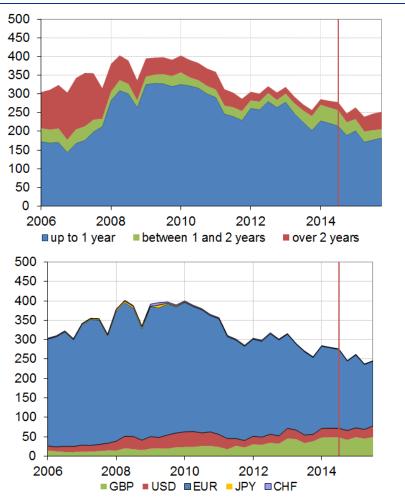
(outstanding amounts, billion euro)

# 1200 1000 800 400 200 2006Q1 2007Q1 2008Q1 2009Q1 2010Q1 2011Q1 2012Q1 2013Q1 2014Q1 2015Q1 Securities issued by non-residents Holdings of MMF s/u Loans to non-residents Securities issued by euro area non-MFI MMF s/u issued

#### Sources: ECB, BSI data.

# MMF holdings of euro area MFI securities by maturity and currency

(outstanding amounts, billion euro)



Sources: ECB. BSI data. .

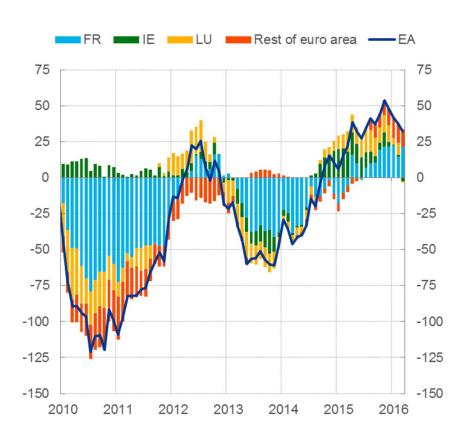
## Money Market Fund industry in the euro area

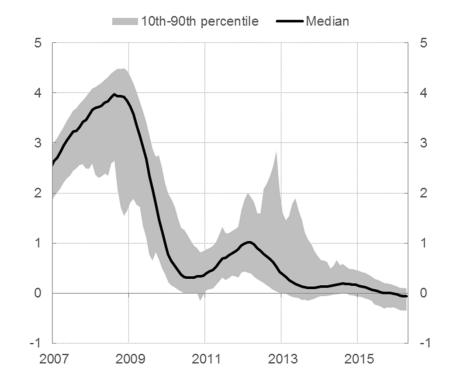
#### Sales of money market fund shares/units

(12-month flows in EUR bn)

# Total returns of money market funds in the euro area

(year-on-year total return in percent)





Source: ECB. Latest observation: March 2016. Sources: Bloomberg, ECB calculations. Notes: monthly data, latest observation: April 2016.

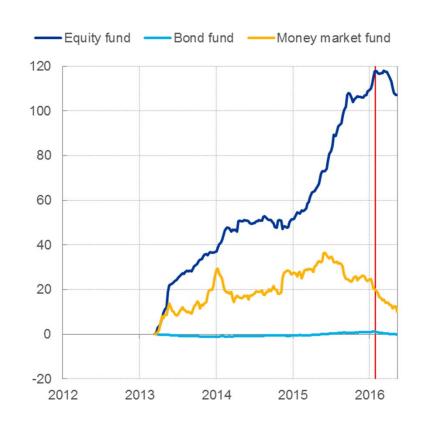
## Money Market Fund industry in other economies: Flow

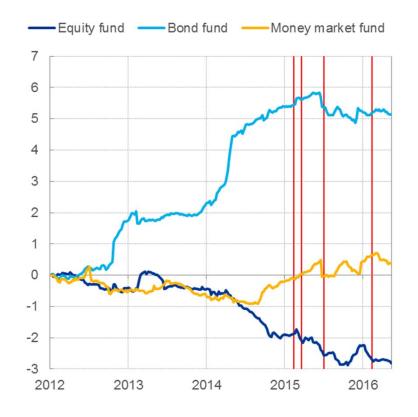
# Inflow and outflow of respective funds to Japan

(billion US\$, cumulative flow, 13 March 2013= 0)

# Inflow and outflow of respective funds to Sweden

(billion US\$, cumulative flow, 4 January 2012= 0)





Source: EPFR

Notes: The data is on a weekly basis. The vertical line indicate the introduction of negative interest rate policy or rate changes into the negative territory.