Annex I – Data definitions and sources

Consumer prices

Harmonised index of consumer prices (HICP), Euro area (changing composition), seasonally adjusted, not working day adjusted, ECB calculation based on Eurostat data.
Alternative for robustness analysis: HICP - All-items excluding energy and food (HICPexEF), Euro area (changing composition), Eurostat, Neither seasonally nor working day adjusted.
Sources: European Central Bank and Eurostat.

Eurocoin

Eurocoin, or €-coin, is a real-time, monthly estimate of area-wide GDP growth. The index gives a monthly "smoothed" estimate of quarter-on-quarter GDP growth in the euro area and highlights the underlying trend by adjusting the growth rate for short-term fluctuations and measurement errors.
Source: Banca d'Italia and CEPR.

Employment

Total number of persons employed (thousands of persons). Derived from unemployment rate (standardised unemployment rate, percentage of civilian workforce, Euro area 19, fixed composition, Seasonally adjusted, not working day adjusted) and total number of persons unemployed (standardised unemployment, thousands of persons, Euro area 19, fixed composition, Seasonally adjusted, not working day adjusted).
Source: Eurostat.

Government bond yields

Benchmark long-term interest rate: Composite Euro Area 10-year Government Benchmark bond yield, aggregated by the ECB, Euro area changing composition, monthly data derived as average of daily data.
Data for yield curve analysis: Yield curve spot rate, 10-year maturity and 1-year maturity - Government bond, nominal, all issuers whose rating is triple A - Euro area (changing composition). Svensson model - continuous compounding - yield error minimisation - Euro, provided by ECB: see
https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html
Alternative data for yield curve robustness analysis: Euro area 10-year and 2-year government benchmark bond yield, percent per annum, Euro area (changing composition, GDP weighted aggregation), monthly data derived as average of daily values, data collected and compiled by the ECB.
Data for country yield curve analysis: 10-year and 1-year (2-year for Spain) government bond yield, percent per annum, monthly data derived as average of daily values, for Germany, France, Italy and Spain, data collected and compiled by the ECB.
Source: European Central Bank.

Eurosystem security purchases

Asset side of the (simplified) Eurosystem balance sheet, monthly data derived as end-of-month daily/weekly outstanding amounts. For the amounts of the Eurosystem public and private security purchases under the APP as well as the previous Eurosystem security purchase programmes for monetary policy purposes see http://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html.
For more details on the Eurosystem balance sheet see the ECB Economic Bulletin article entitled "The role of the central bank balance sheet in monetary policy", issue 4, 2015.
Source: European Central Bank.

Stock prices

Dow Jones Euro Stoxx Broad Stock Exchange Index, historical close, monthly data derived as monthly average of daily data.
Source: European Central Bank.

Exchange rate

Nominal effective exchange rate (NEER) against Euro, monthly data derived as monthly average of daily data, Euro area-19 countries vis-a-vis the EER-38 group of trading partners (AU, CA, DK, HK, JP, NO, SG, KR, SE, CH, GB, US, BG, CZ, HU, PL, RO, CN, DZ, AR, BR, CL, HR, IS, IN, ID, IL, MY, MX, MA, NZ, PH, RU, ZA, TW, TH, TR and VE) excluding the Euro.
Source: European Central Bank.

Credit to the non-financial private sector

Sum of outstanding amounts of MFI loans to non-financial corporations (derived by rescaling indices of notional stocks with base equal to the outstanding amounts for December 2010) and outstanding amounts of securities (corporate bonds and equities) issued by non-financial corporations. Series adjusted to include loan sales and securitisation.
Sources: European Central Bank.

Composite lending rate

Composite lending rate, derived as weighted average of interest rates charged on short-term and long-term loans to non-financial corporations, with weights based on the nominal outstanding amounts of corresponding loans to non-financial corporations.
Sources: European Central Bank.

Inflation expectations

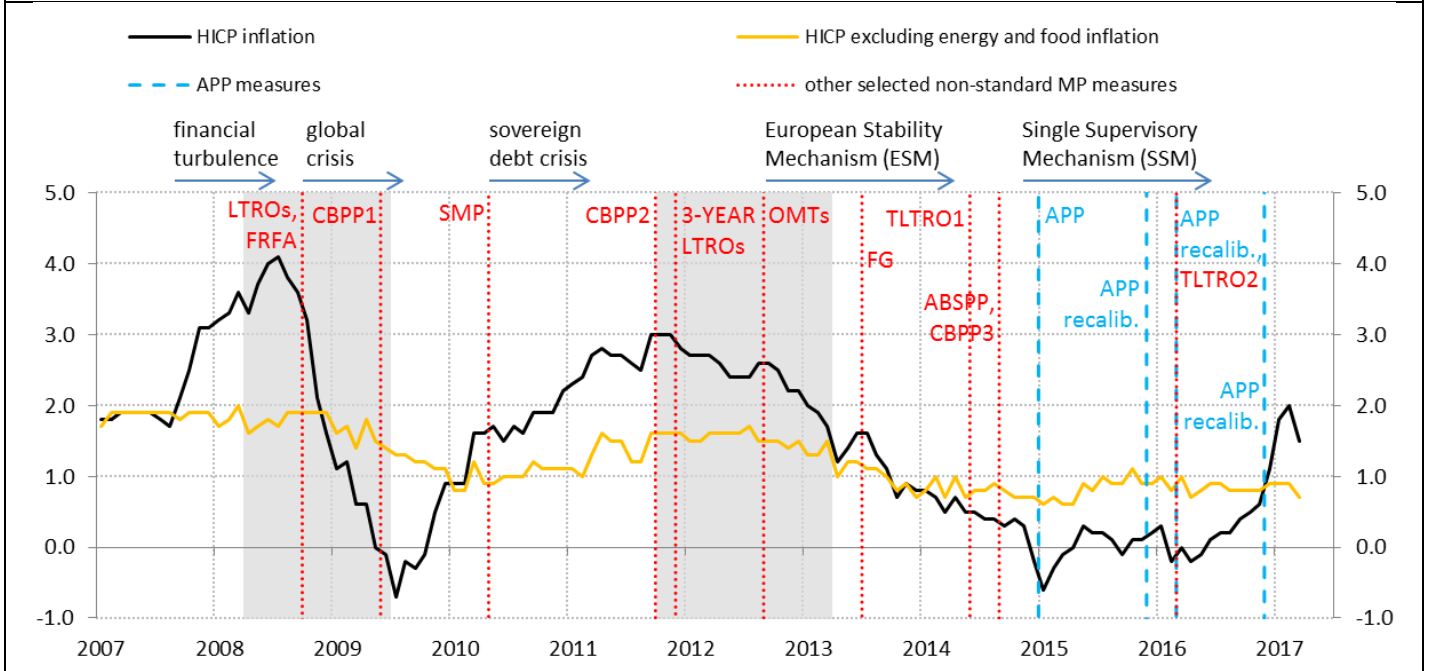Consensus forecast of euro area HICP inflation 6- to 10-years ahead.
Sources: Consensus Economics.

Short-term forward rates

Three months Eonia (OIS) forward rates two years ahead. Monthly data derived as monthly average of daily data.
Sources: European Central Bank.

Chart A – HICP inflation, January 2007 to March 2017
(annual percentage changes)

Source: CEPR, European Central Bank and Eurostat.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.
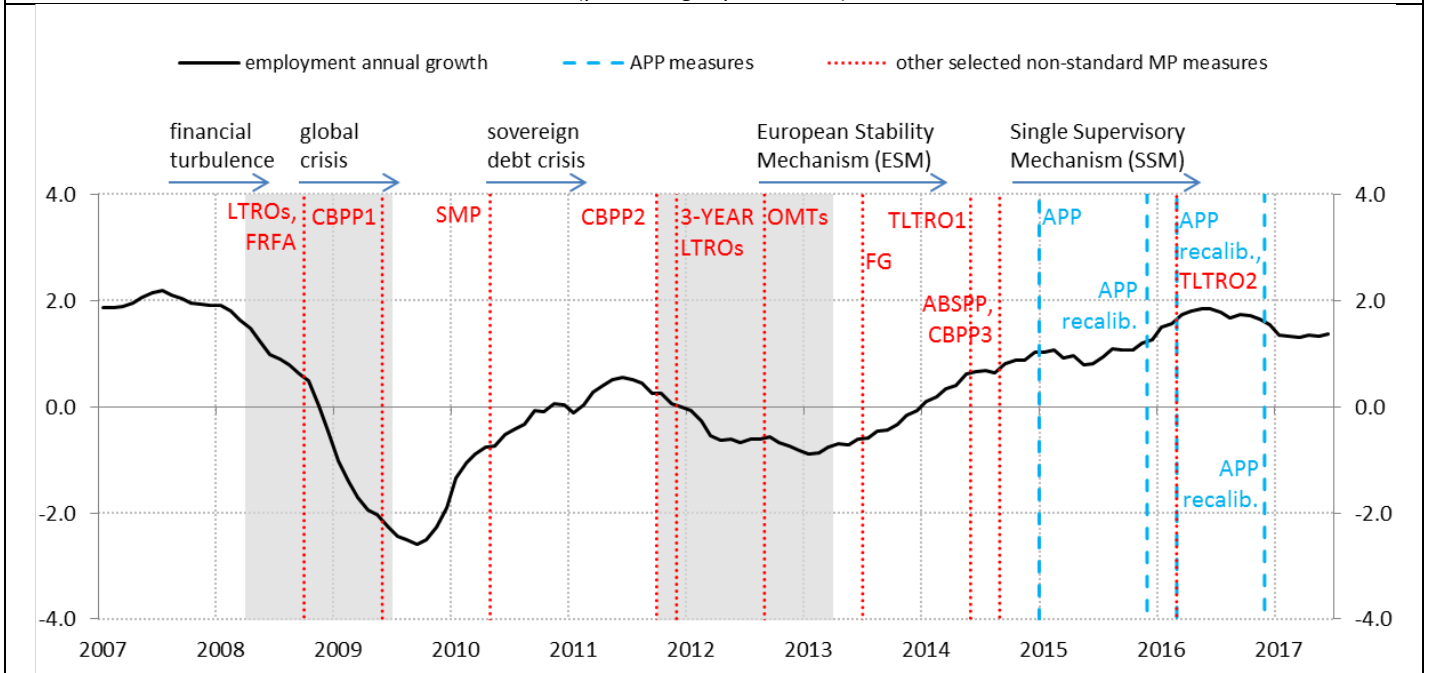
Chart B – Eurocoin and euro area real GDP, January 2007 to March 2017
(percentages, annual percentage changes)
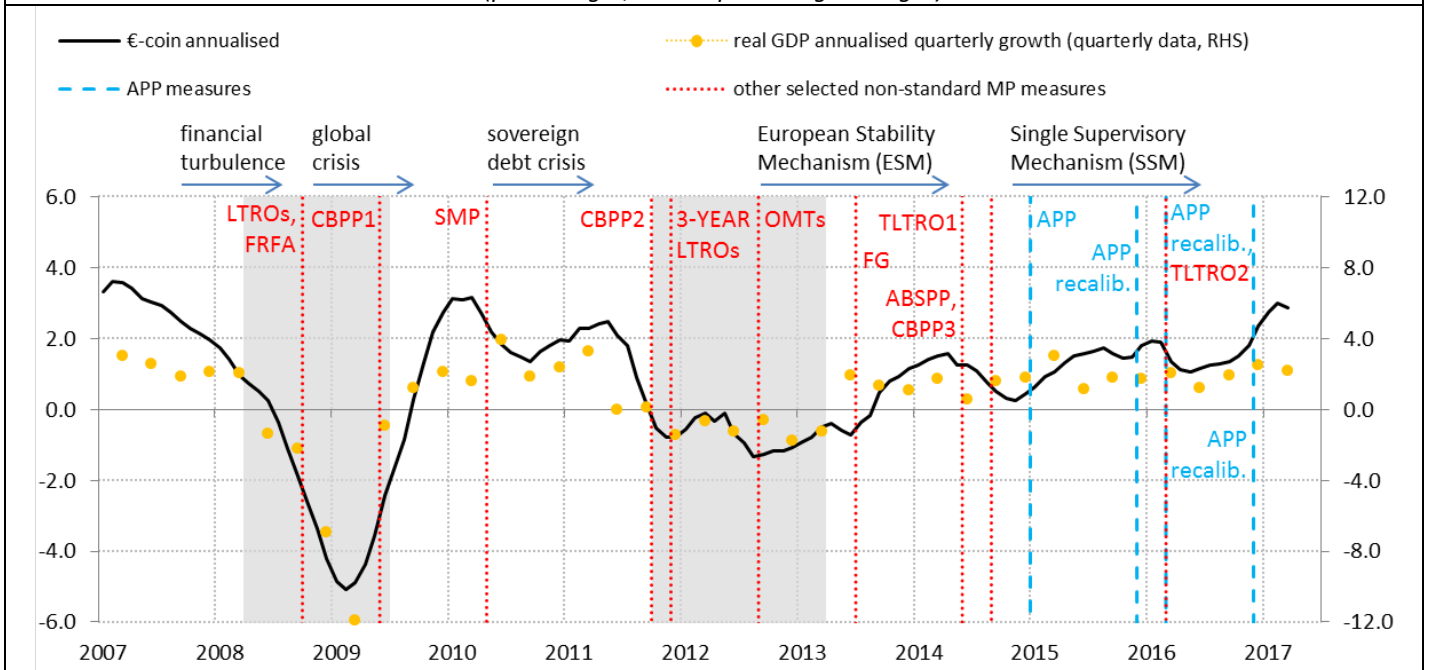
Source: Bank of Italy, CEPR and Eurostat.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.
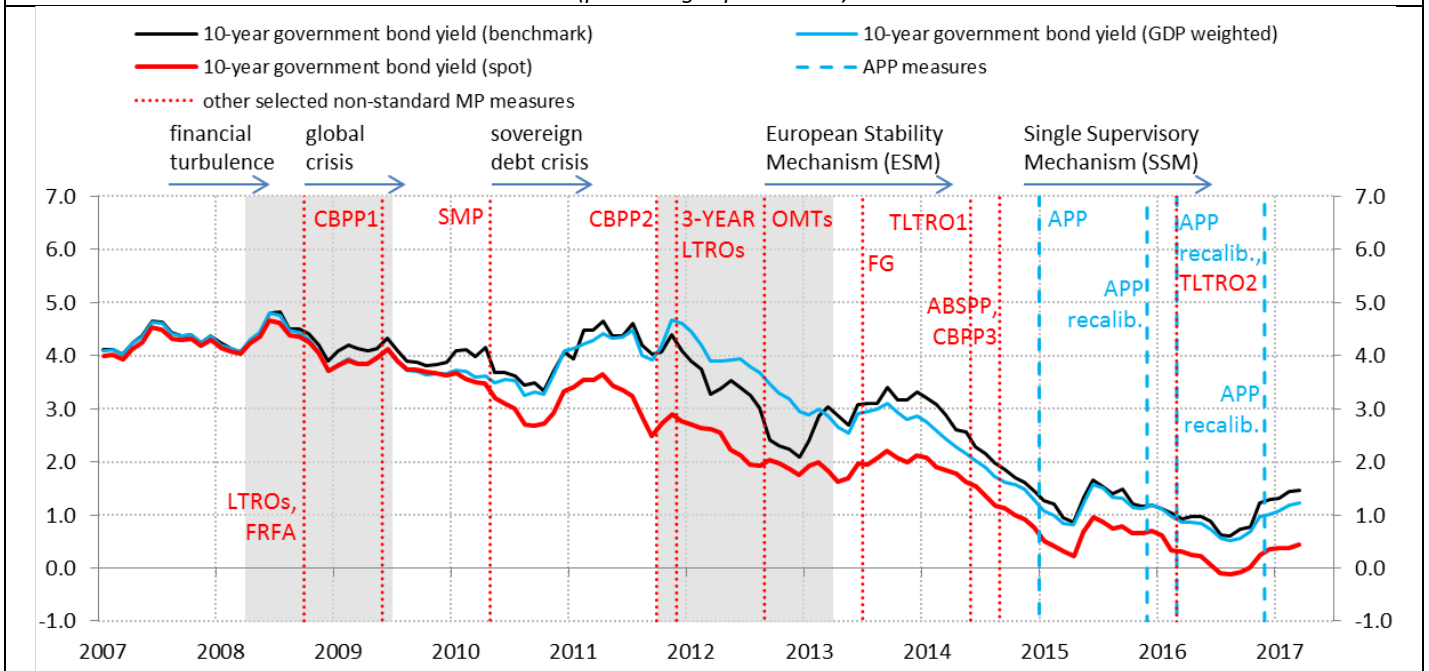
Chart C – Total euro area employment, January 2007 to March 2017
(percentages per annum)

— employment annual growth   – – – APP measures   ········ other selected non-standard MP measures

financial turbulence   global crisis   sovereign debt crisis   European Stability Mechanism (ESM)   Single Supervisory Mechanism (SSM)

LTROs, FRFA   CBPP1   SMP   CBPP2   3-YEAR LTROs   OMTs   TLTRO1 FG   ABSPP, CBPP3   APP   APP recalib.   APP recalib., TLTRO2   APP recalib.

Source: CEPR and Eurostat.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.

Chart D – Composite long-term euro area government bond yields, January 2007 to March 2017
(percentages per annum)

— 10-year government bond yield (benchmark)   — 10-year government bond yield (GDP weighted)
— 10-year government bond yield (spot)   – – – APP measures
········ other selected non-standard MP measures

financial turbulence   global crisis   sovereign debt crisis   European Stability Mechanism (ESM)   Single Supervisory Mechanism (SSM)

CBPP1   SMP   CBPP2   3-YEAR LTROs   OMTs   TLTRO1 FG   ABSPP, CBPP3   APP   APP recalib.   APP recalib., TLTRO2   APP recalib.   LTROs, FRFA

Source: CEPR and European Central Bank.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.
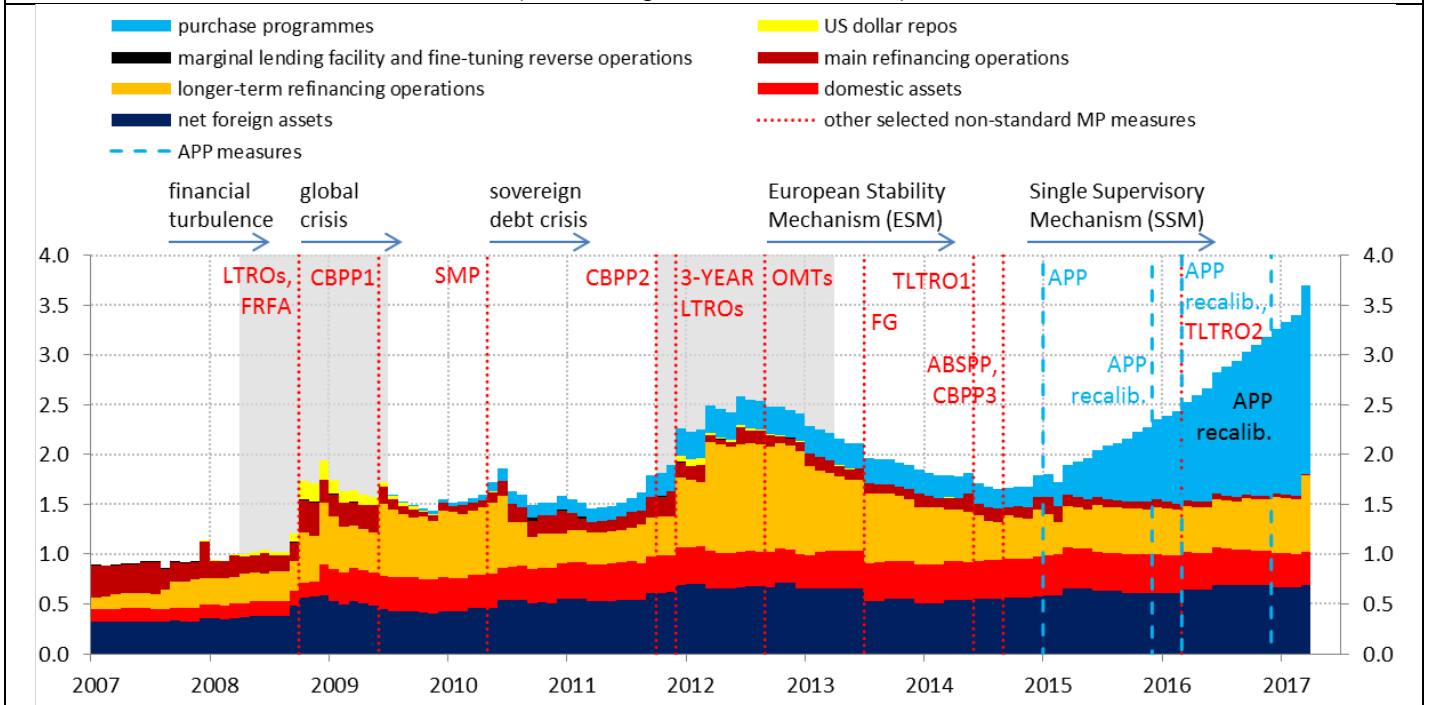
Chart E – Composite short-term euro area government bond yields, January 2007 to March 2017
(percentages per annum)
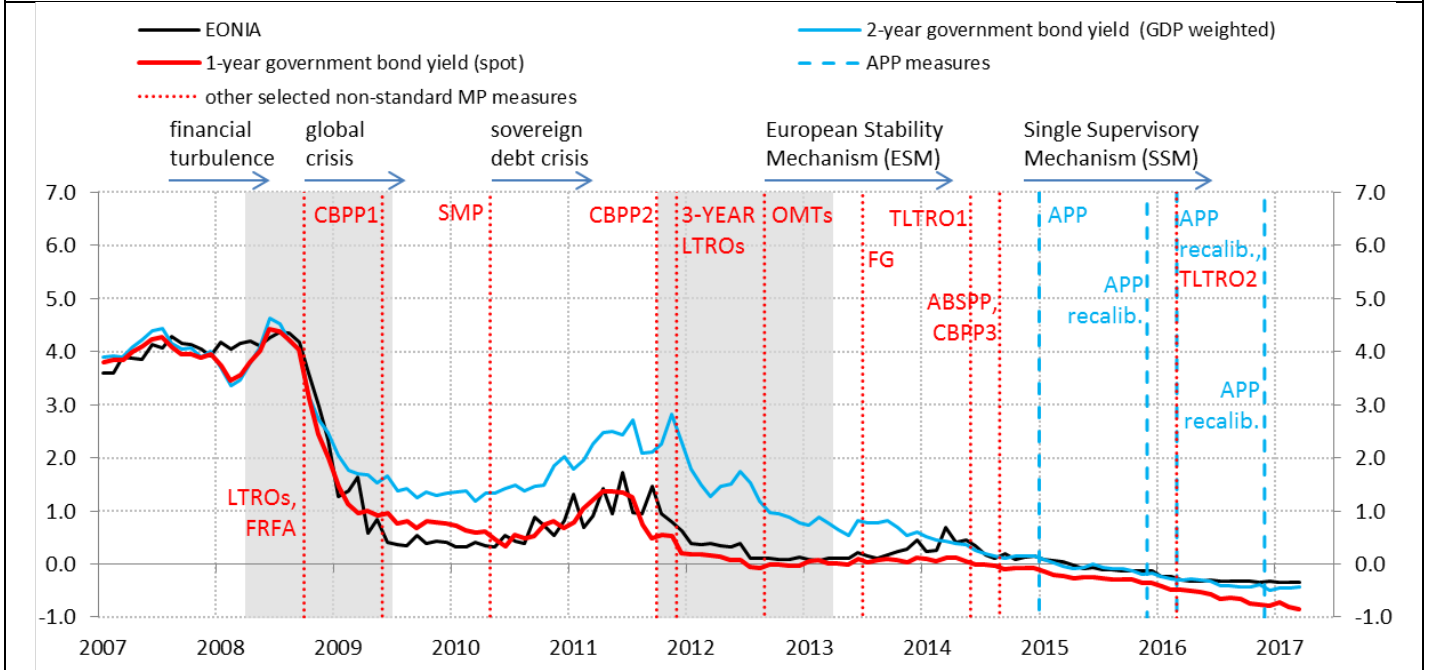
Source: CEPR and European Central Bank.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.
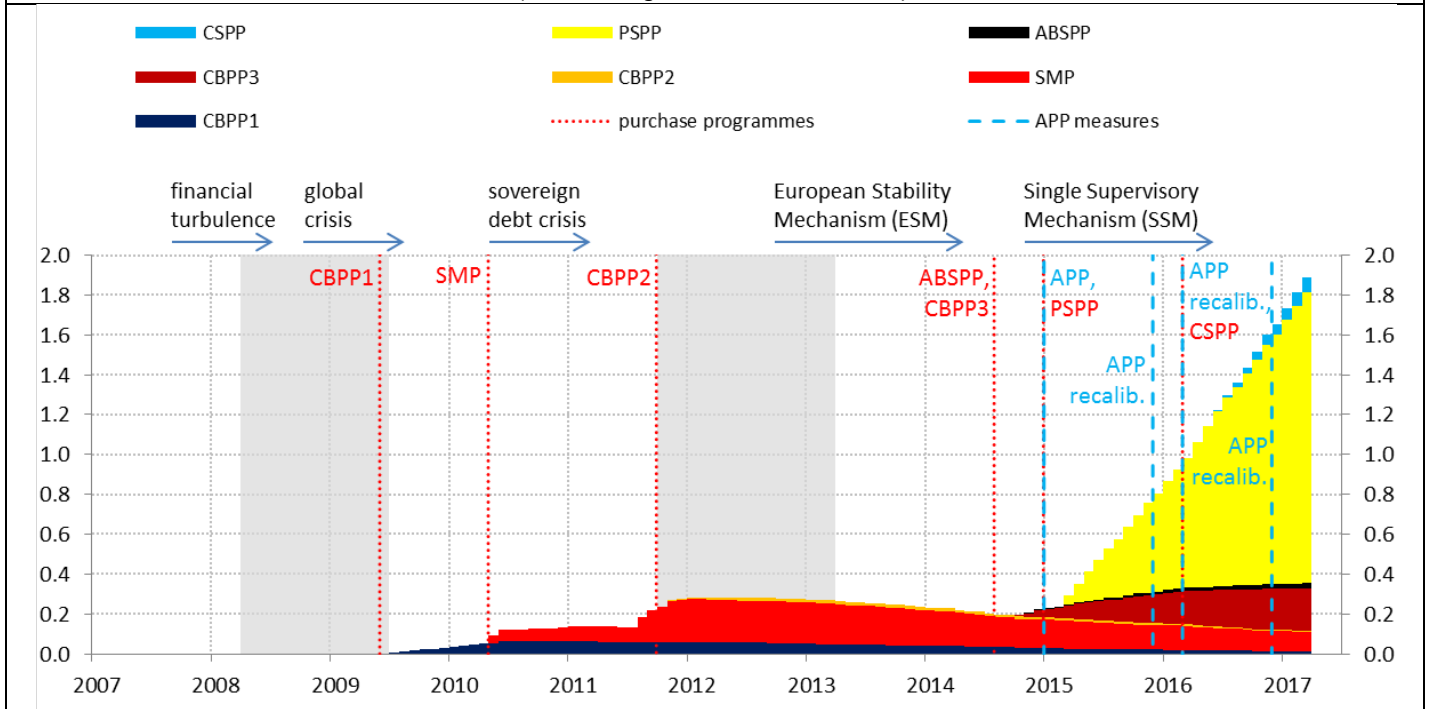
Chart F – Simplified Eurosystem balance sheet asset composition, January 2007 to March 2017
(outstanding amounts, EUR trillions)

Source: CEPR and European Central Bank.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.
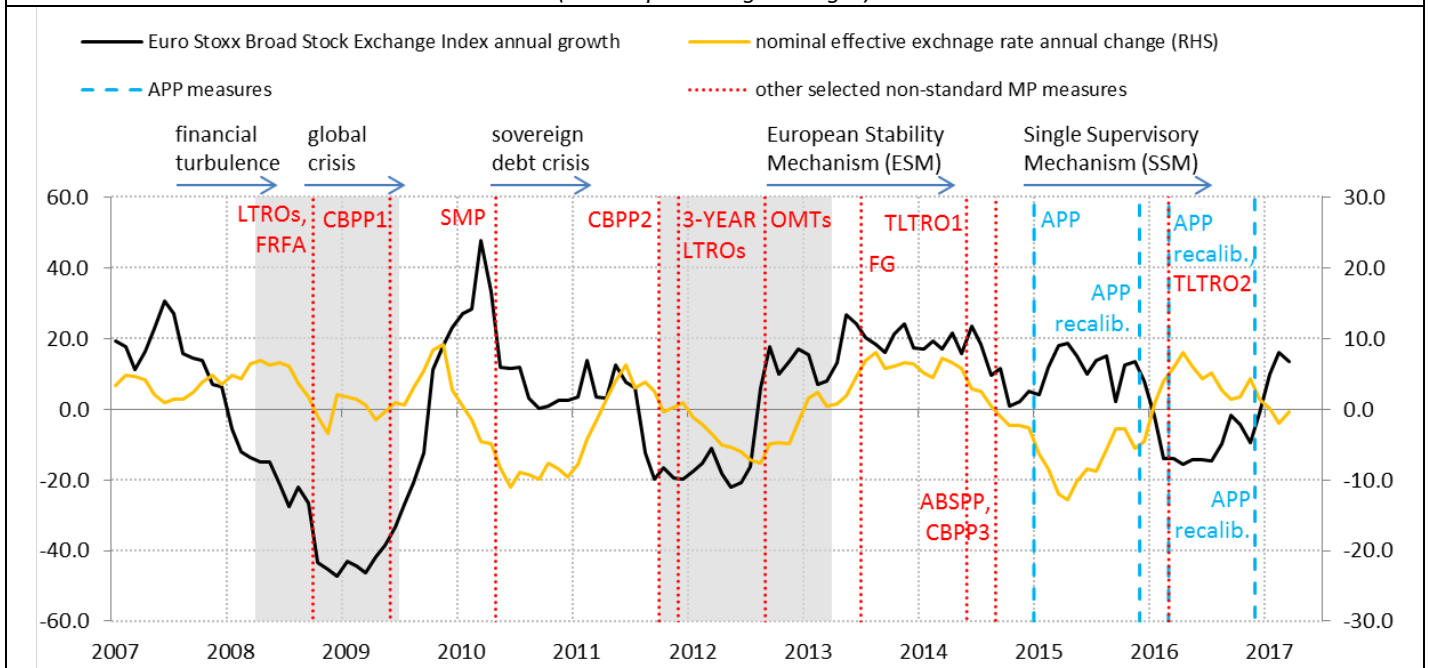
Chart G – Eurosystem security purchases for monetary policy purposes, January 2007 to March 2017
(outstanding amounts, EUR trillions)

CSPP   PSPP   ABSPP
CBPP3   CBPP2   SMP
CBPP1   .... purchase programmes   – – APP measures

financial turbulence   global crisis   sovereign debt crisis   European Stability Mechanism (ESM)   Single Supervisory Mechanism (SSM)

CBPP1   SMP   CBPP2   ABSPP, CBPP3   APP, PSPP   APP recalib.   CSPP   APP recalib.   APP recalib.

Source: CEPR and European Central Bank.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB (see Annex I for details). Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP) (see Annex II for more details). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.
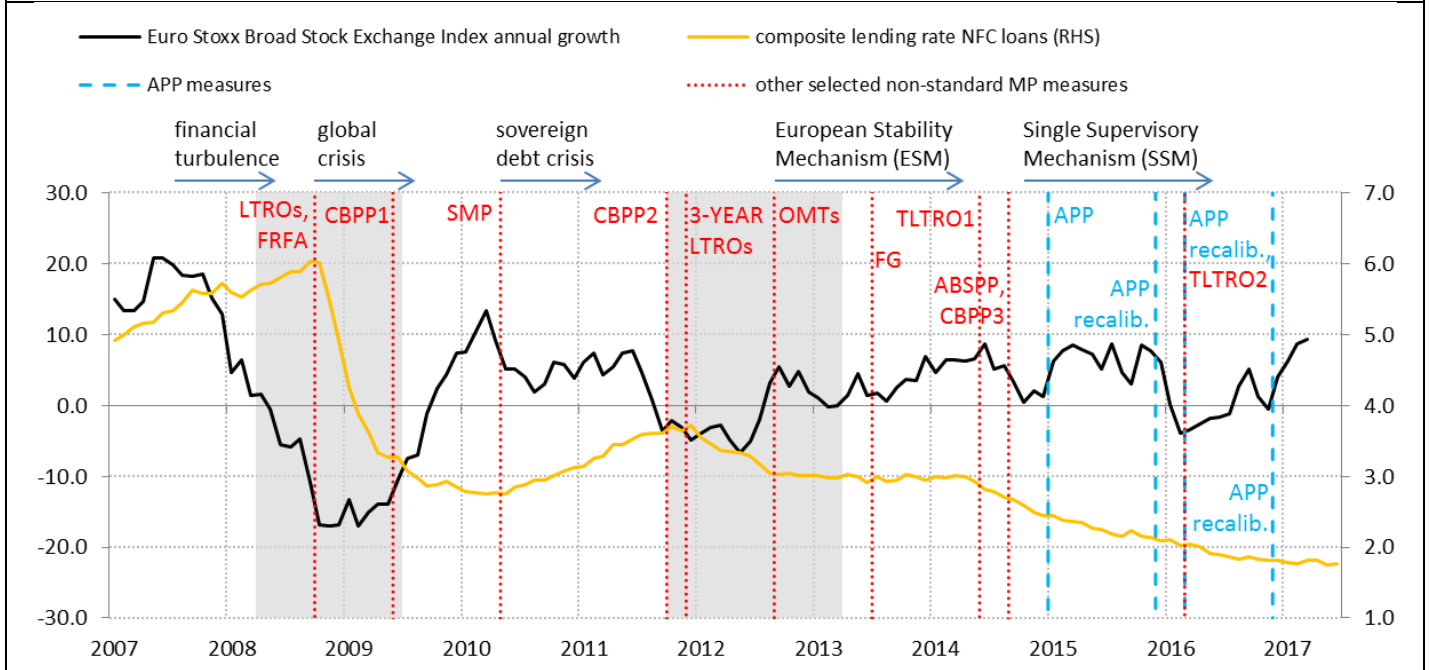
Chart H – Stock prices and nominal effective exchange rate, January 2007 to March 2017
(annual percentage changes)

—— Euro Stoxx Broad Stock Exchange Index annual growth   —— nominal effective exchnage rate annual change (RHS)
– – APP measures   .... other selected non-standard MP measures

financial turbulence   global crisis   sovereign debt crisis   European Stability Mechanism (ESM)   Single Supervisory Mechanism (SSM)

LTROs, FRFA   CBPP1   SMP   CBPP2   3-YEAR LTROs   OMTs   TLTRO1   FG   APP   APP recalib.   APP recalib.   TLTRO2   ABSPP, CBPP3   APP recalib.

Source: CEPR and European Central Bank.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.
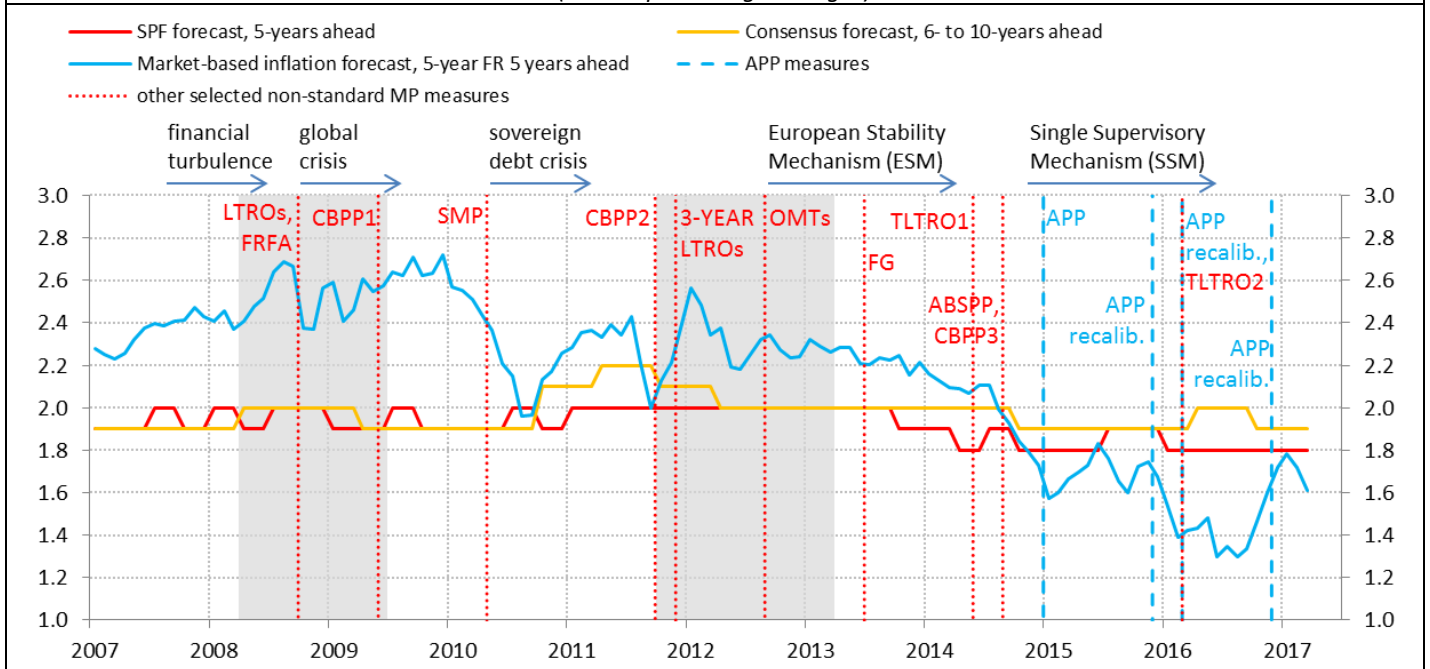
Chart I – NFC credit and composite bank lending rates, January 2007 to March 2017
(annual percentage changes, percentages per annum)

Euro Stoxx Broad Stock Exchange Index annual growth ——— composite lending rate NFC loans (RHS)
APP measures – – – other selected non-standard MP measures ⋯⋯

financial turbulence | global crisis | sovereign debt crisis | European Stability Mechanism (ESM) | Single Supervisory Mechanism (SSM)

LTROs, FRFA | CBPP1 | SMP | CBPP2 | 3-YEAR LTROs | OMTs | TLTRO1 | FG | ABSPP, CBPP3 | APP | APP recalib. | APP recalib., TLTRO2 | APP recalib.

Source: CEPR and European Central Bank.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.

Chart J – HICP inflation longer term expectations, January 2007 to March 2017
(annual percentage changes)

SPF forecast, 5-years ahead ——— Consensus forecast, 6- to 10-years ahead ———
Market-based inflation forecast, 5-year FR 5 years ahead ——— APP measures – – –
other selected non-standard MP measures ⋯⋯

financial turbulence | global crisis | sovereign debt crisis | European Stability Mechanism (ESM) | Single Supervisory Mechanism (SSM)

LTROs, FRFA | CBPP1 | SMP | CBPP2 | 3-YEAR LTROs | OMTs | TLTRO1 | FG | ABSPP, CBPP3 | APP | APP recalib. | APP recalib., TLTRO2 | APP recalib.
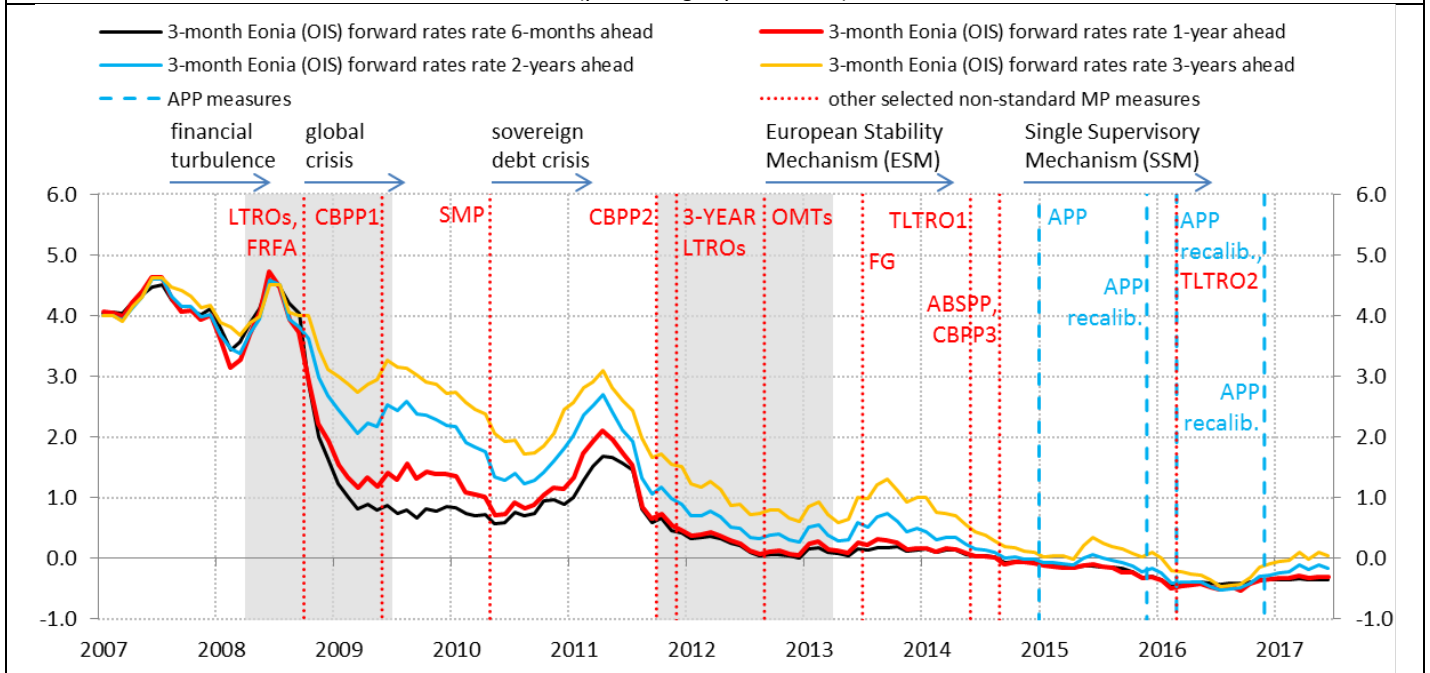
Source: CEPR, Consensus Economics and European Central Bank.
Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.

Chart K – Selected market interest rates, January 2007 to March 2017
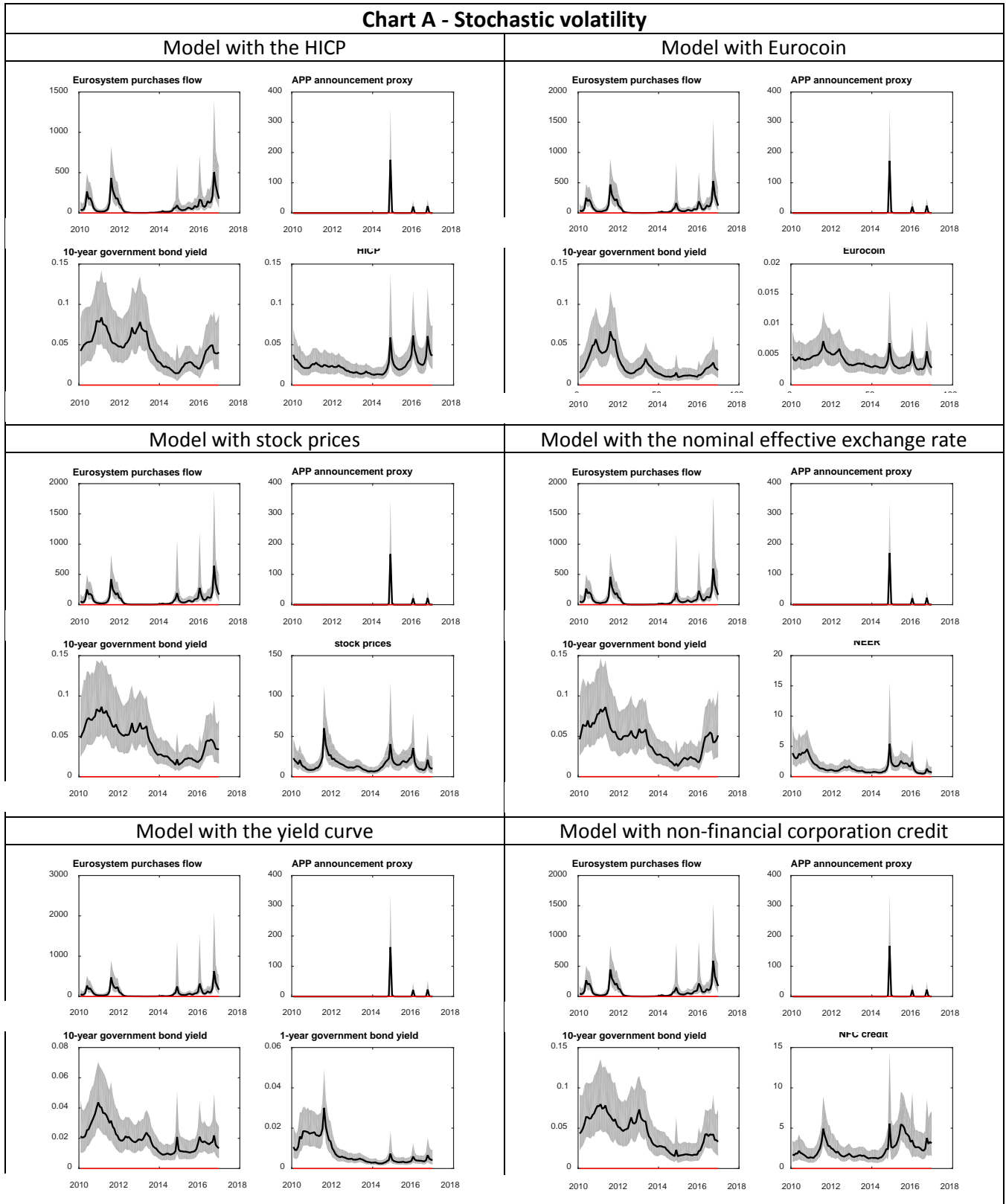*(percentages per annum)*

Source: CEPR and European Central Bank.

Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.

Annex II – Further results

Chart A - Stochastic volatility

Model with the HICP

Model with Eurocoin

Model with stock prices

Model with the nominal effective exchange rate

Model with the yield curve

Model with non-financial corporation credit

Note: Residual time-varying variances. Black full lines: posterior medians. Grey areas: areas delimited by the 16th and 84th percentiles.

Table A – Trace tests

model	16th perc.	50th perc.	84th perc.	trace(Q0)
model with the HICP	0.112	0.154	0.215	0.008
model with Eurocoin	0.995	1.465	2.274	0.083
model with stock prices	0.037	0.052	0.075	0.003
model with the NEER	0.034	0.045	0.067	0.003
model with the yield curve	0.359	0.489	0.686	0.027
model with NFC credit	0.032	0.045	0.066	0.002

Note: The first three columns with figures show the 16th, 50th and 84th percentiles of the posterior of the trace of the variance-covariance matrix of the error term of the law of motion of the parameters of the VAR, while the fourth column shows the trace of the prior variance-covariance matrix. Following Cogley and Sargent (2005), since the value of the trace of the prior variance-covariance matrix is smaller than even the 16th percentile, this can be interpreted as evidence pointing to the presence of time variation in the parameters of the VAR (i.e. the sample points towards greater time variation in the parameters than that of the prior selected).

Chart B - Responses of the slope of the yield curve to the January 2015 and March 2016 APP announcement/recalibration shocks in the largest euro area countries
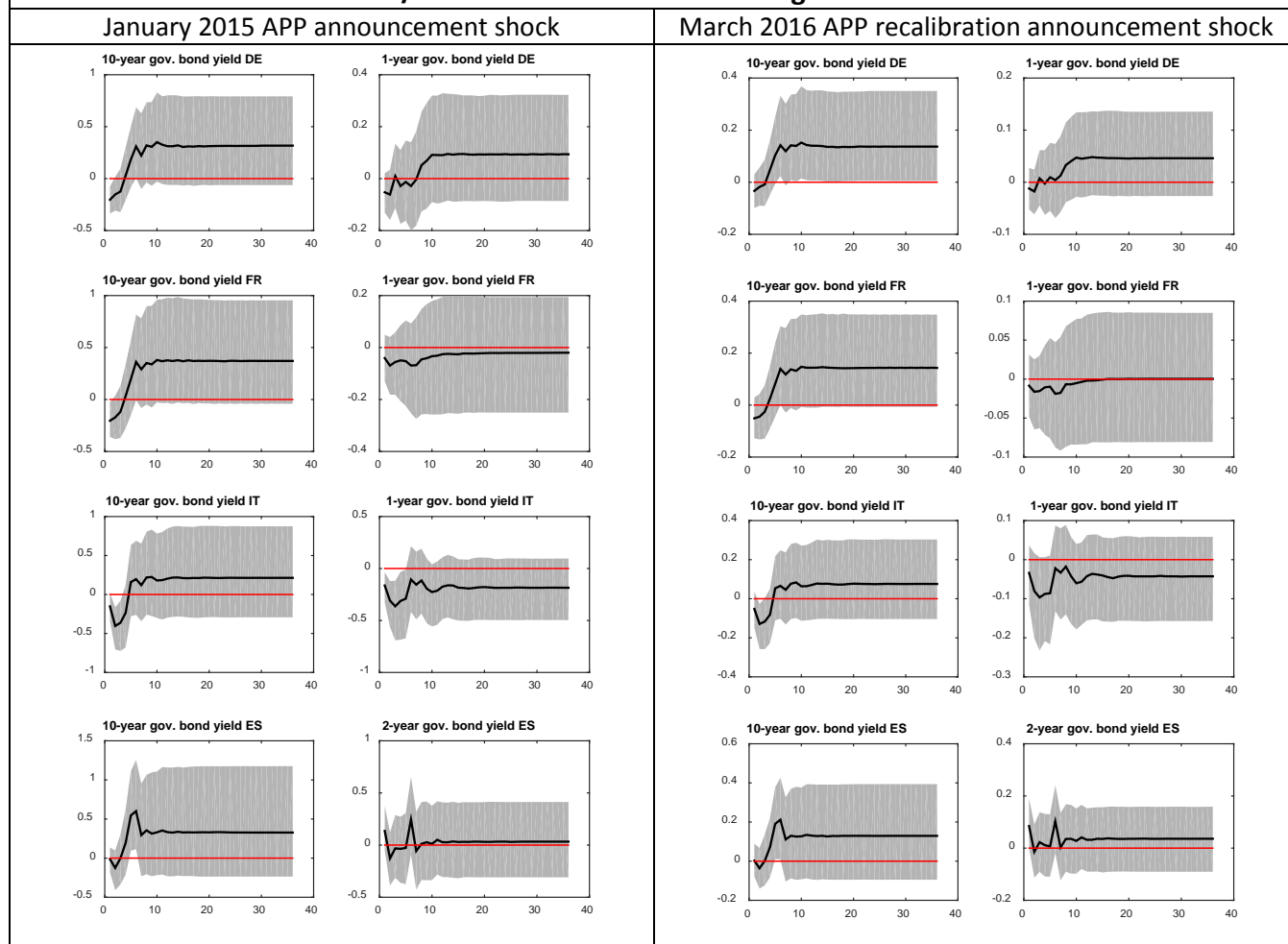
January 2015 APP announcement shock	March 2016 APP recalibration announcement shock

Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to percentage points.

Chart C - Responses of long-term inflation expectations and short-term forward rates to the January 2015 and March 2016 APP announcement/recalibration shocks
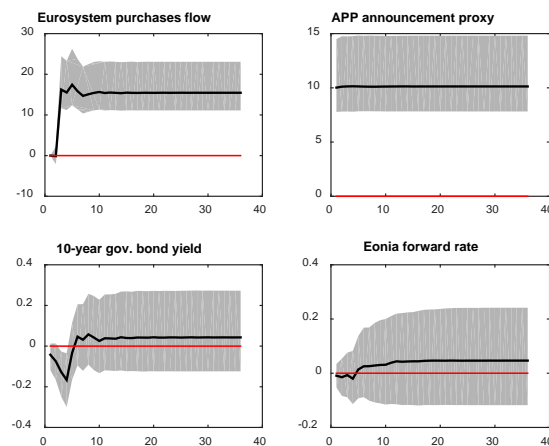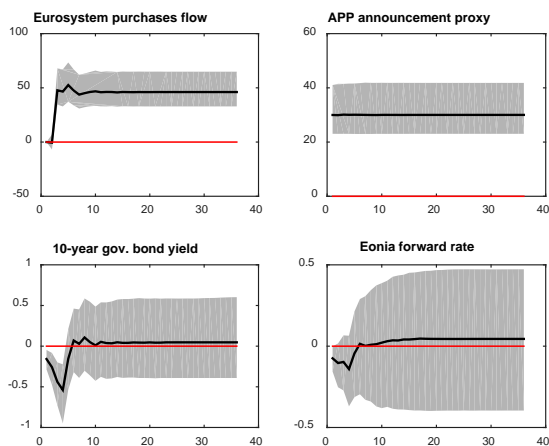
January 2015 APP announcement shock	March 2016 APP recalibration announcement shock

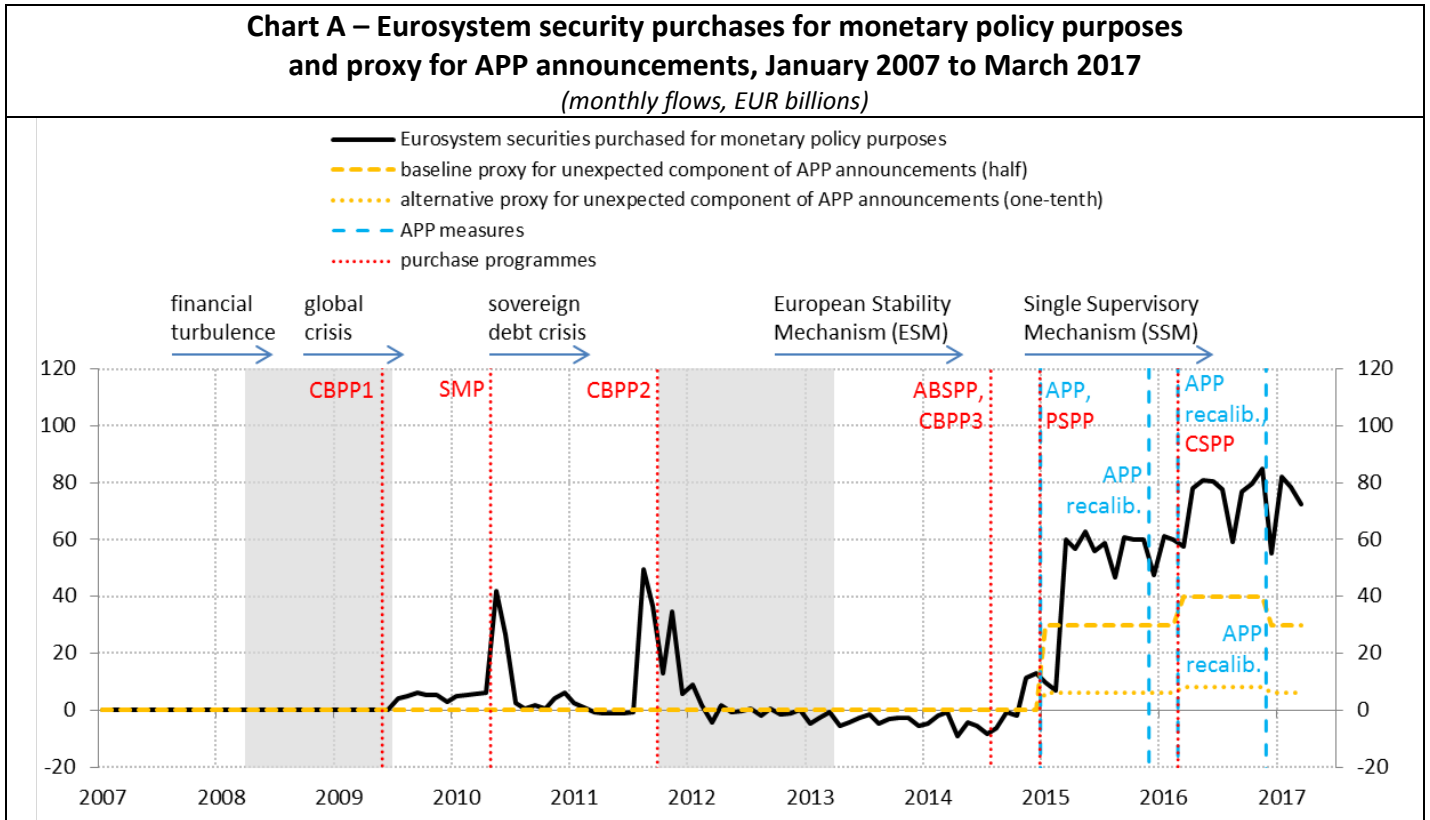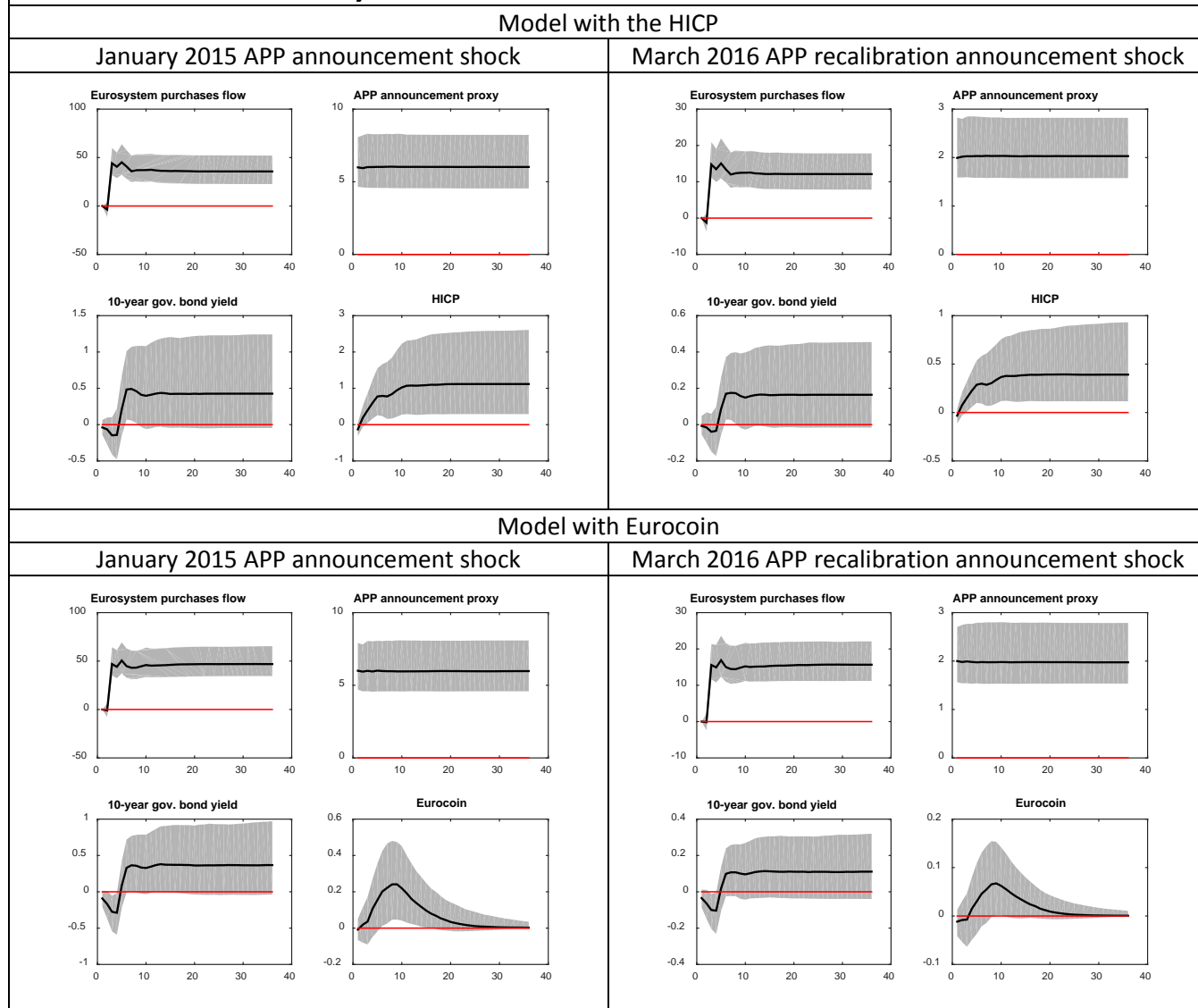Model with long-term inflation expectations (Consensus forecast, 6- to 10-years ahead)
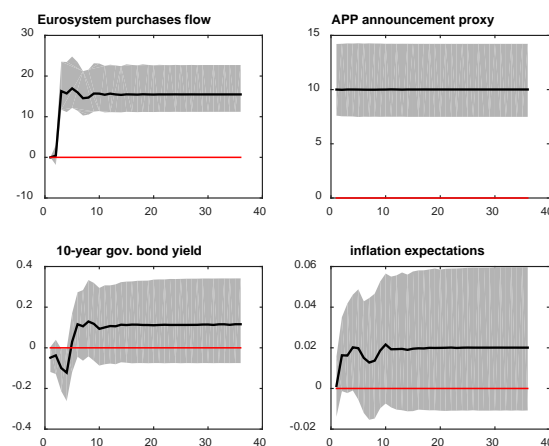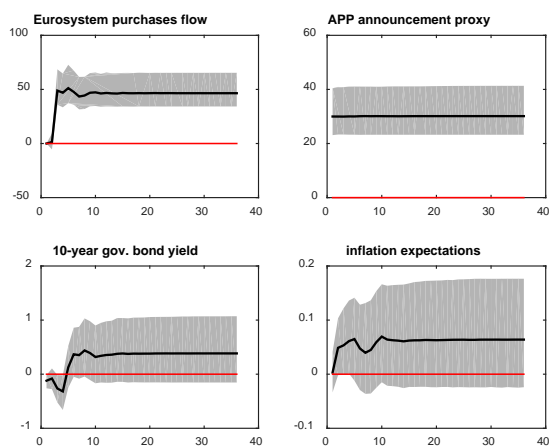
Model with three month Eonia (OIS) forward rates (3-month forward rate 2-year ahead)

Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to percentage points.

1. Alternative APP announcement proxy

Chart A – Eurosystem security purchases for monetary policy purposes and proxy for APP announcements, January 2007 to March 2017
(monthly flows, EUR billions)


Source: CEPR and European Central Bank.

Note: The arrows and associated text refer to major events or phases. Vertical red dotted lines and associated acronyms refer to major non-standard monetary policy measures adopted by the ECB. Vertical dashed blue lines and associated text delimit the dates of the introduction and subsequent re-calibrations of the expanded asset purchase programme (APP). Shaded areas delimit Euro Area recessions as dated by the CEPR Euro Area Business Cycle Dating Committee.

Chart B - Impulse response functions of macroeconomic variables to the January 2015 and the March 2016 announcement shocks

Model with the HICP

January 2015 APP announcement shock
March 2016 APP recalibration announcement shock

Model with Eurocoin

January 2015 APP announcement shock
March 2016 APP recalibration announcement shock

Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to billions of euros (for Eurosystem purchase flow and APP announcement proxy), percentages (for the HICP) or percentage points (for long-term interest rates and Eurocoin).

Chart C - Impulse response functions of financial variables to the January 2015 and the March 2016 announcement shocks
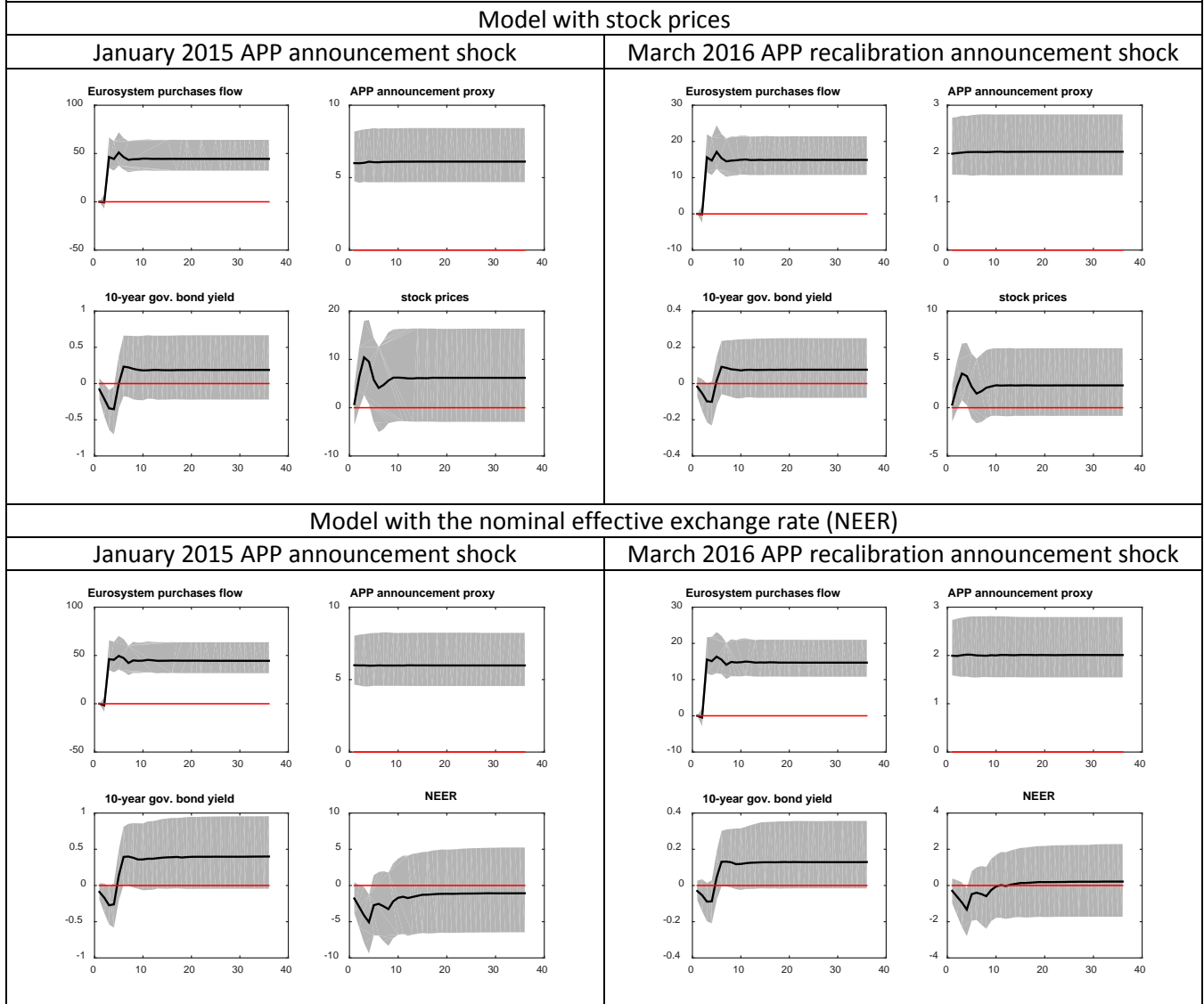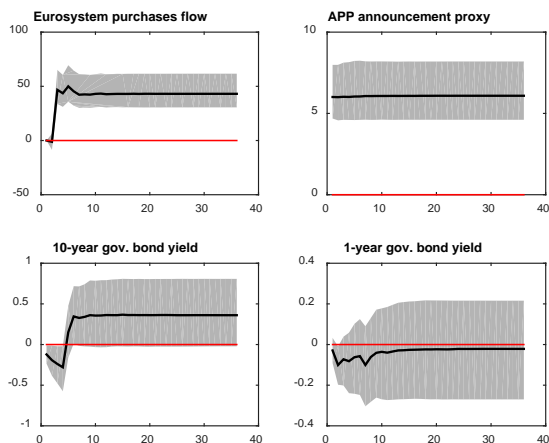
Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to billions of euros (for Eurosystem purchase flow and APP announcement proxy) or percentages (for stock prices and exchange rates).

Chart D - Impulse response functions of credit market variables to the January 2015 and the March 2016 announcement shocks

Model with the yield curve
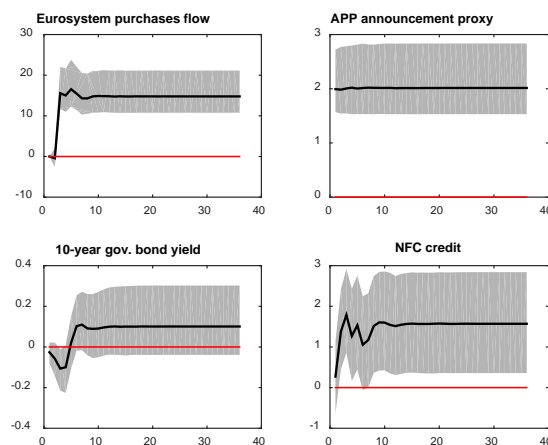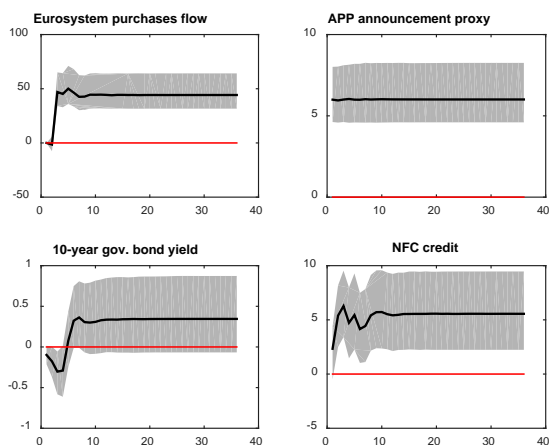
January 2015 APP announcement shock | March 2016 APP recalibration announcement shock
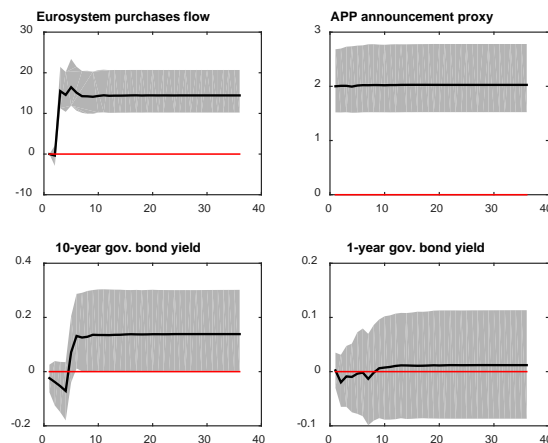
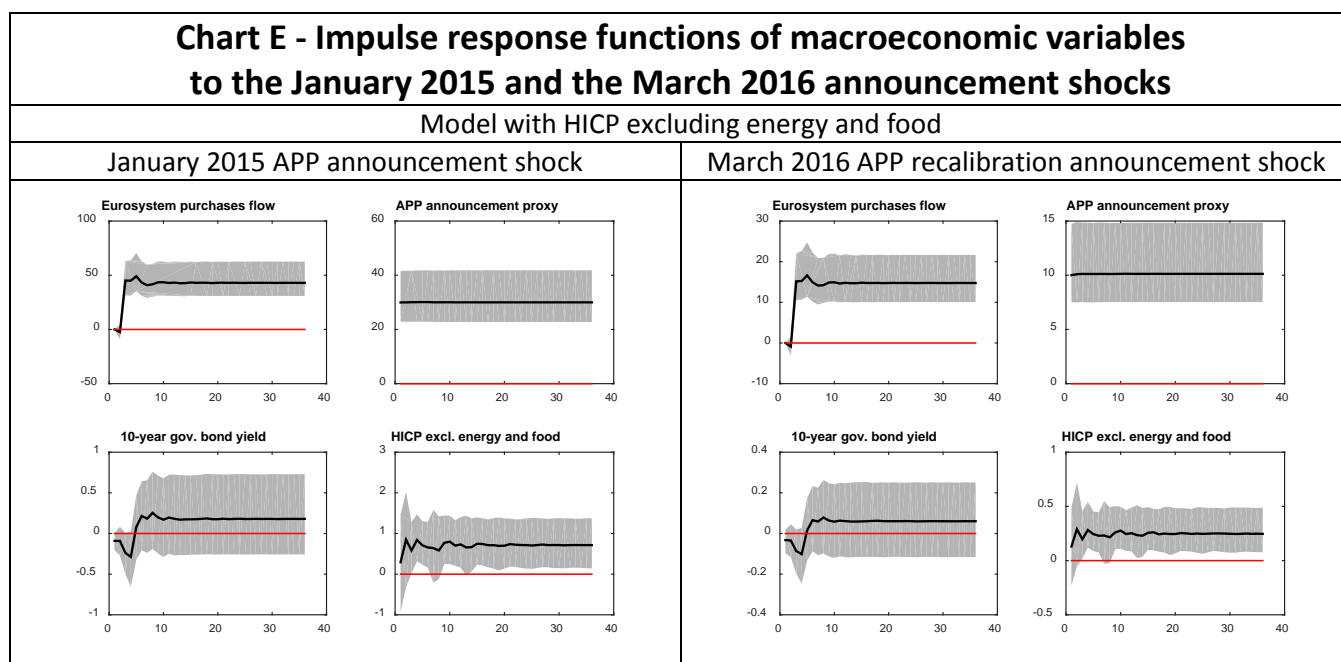## Model with credit to non-financial corporations (NFCs)

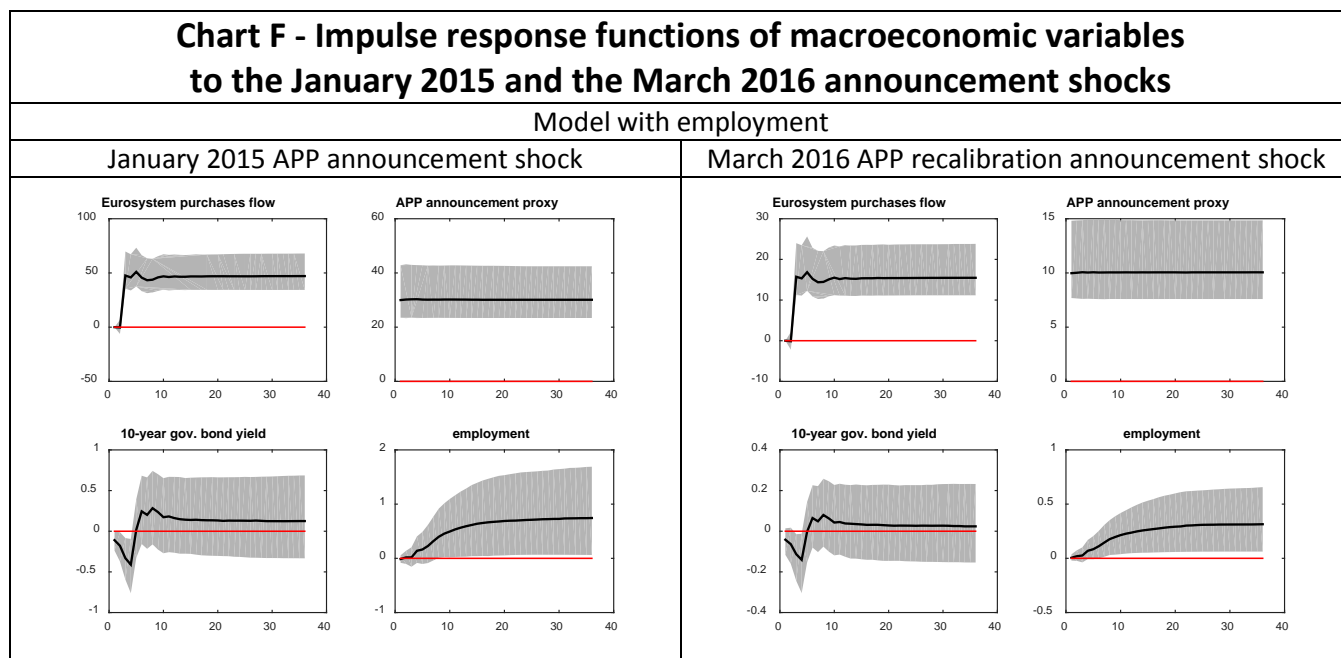### January 2015 APP announcement shock | March 2016 APP recalibration announcement shock

Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to billions of euros (for Eurosystem purchase flow and APP announcement proxy), percentage points (for lending rates) or percentages (for credit). NFC stands for non-financial corporations.

2. Alternative variables

Chart E - Impulse response functions of macroeconomic variables to the January 2015 and the March 2016 announcement shocks

Model with HICP excluding energy and food

January 2015 APP announcement shock	March 2016 APP recalibration announcement shock

Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to billions of euros (for Eurosystem purchase flow and APP announcement proxy), percentages (for the HICP) or percentage points (for long-term interest rates and Eurocoin).

Chart F - Impulse response functions of macroeconomic variables to the January 2015 and the March 2016 announcement shocks

Model with employment

January 2015 APP announcement shock	March 2016 APP recalibration announcement shock

Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to billions of euros (for Eurosystem purchase flow and APP announcement proxy), percentages (for the HICP) or percentage points (for long-term interest rates and Eurocoin).

Chart G - Impulse response functions of the yield curve to the January 2015 and the March 2016 announcement shocks
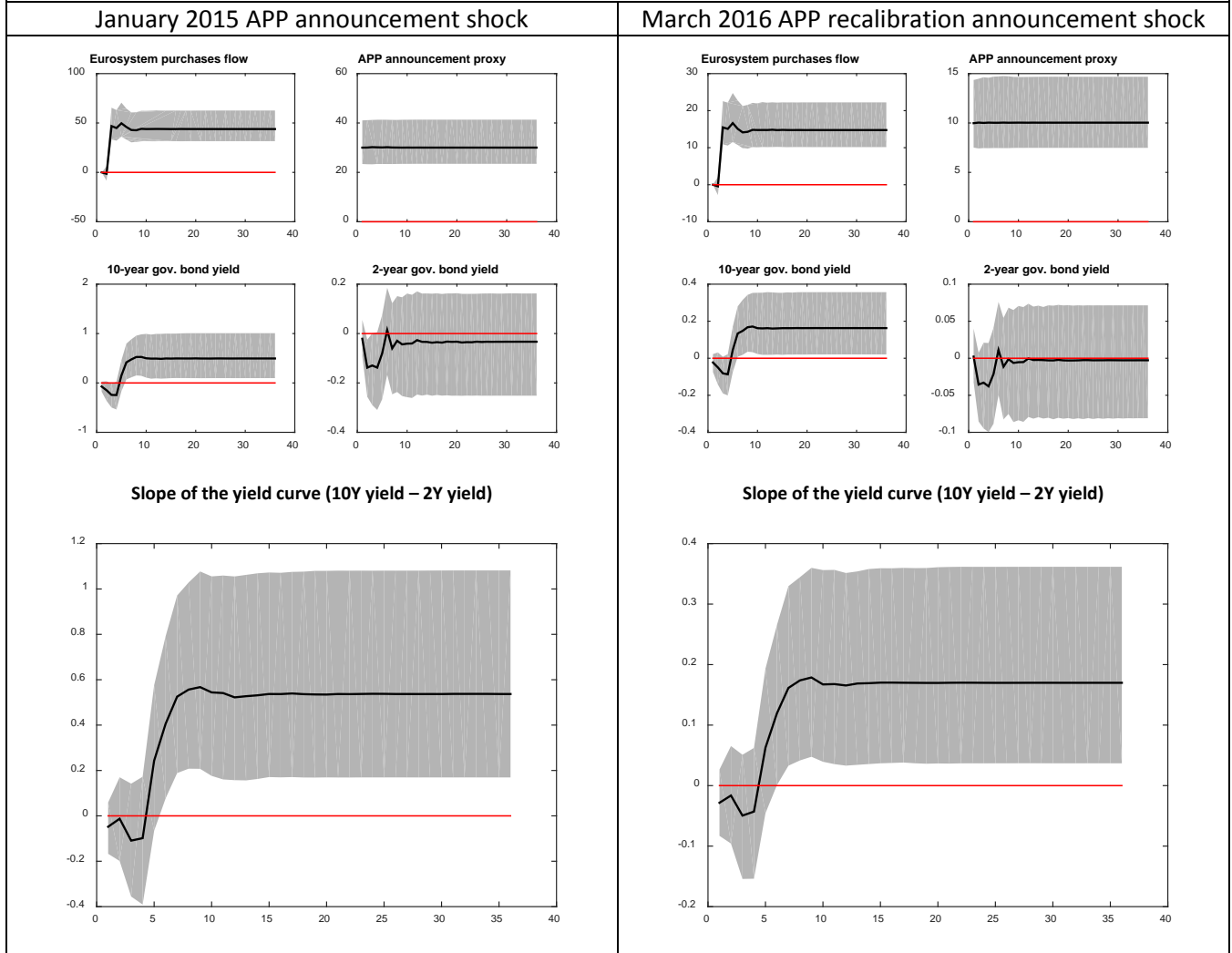
January 2015 APP announcement shock	March 2016 APP recalibration announcement shock

Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to billions of euros (for Eurosystem purchase flow and APP announcement proxy) or to percentage points (for interest rates).

3. Alternative identification scheme

**Table A – Alternative identification restrictions**

	on impact	lagged effects		
	0 Jan-15 (APP announced)	1 Feb-15	2 Mar-15 (purchases start)	3 Apr-15
Eurosystem security purchases	0		+	
APP announcement proxy	+			
10-year government bond yield	-	-		
Eurocoin				+
A) HICP				+
B) stock prices				+
C) exchange rate				-
D) 1-year yield				-
E) NFC credit volumes				+
F) bank lending rate to NFCs				-

Chart H - Impulse response functions of variables in models with five variables to the January 2015 announcement shock
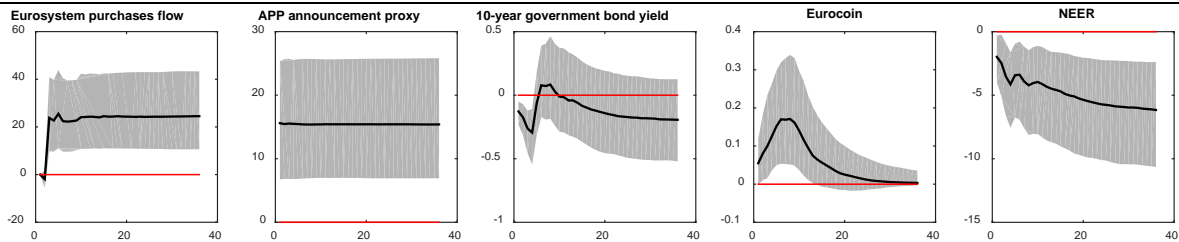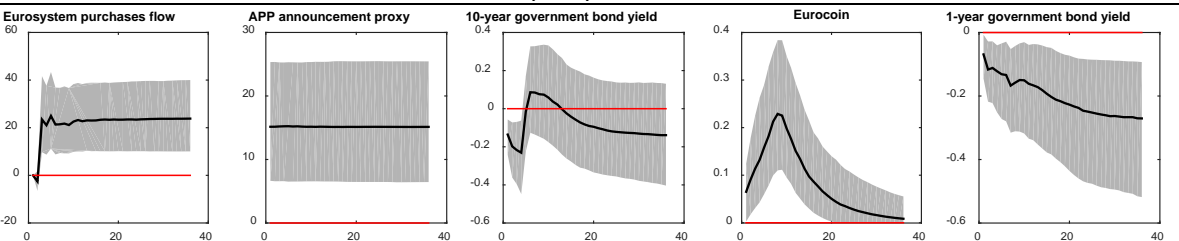
Model with HICP as fifth variable
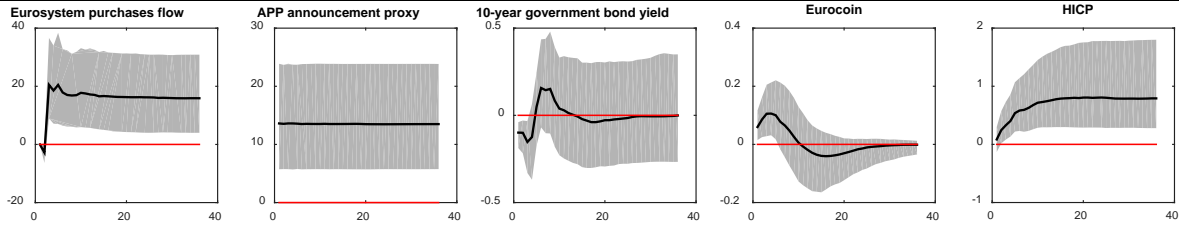
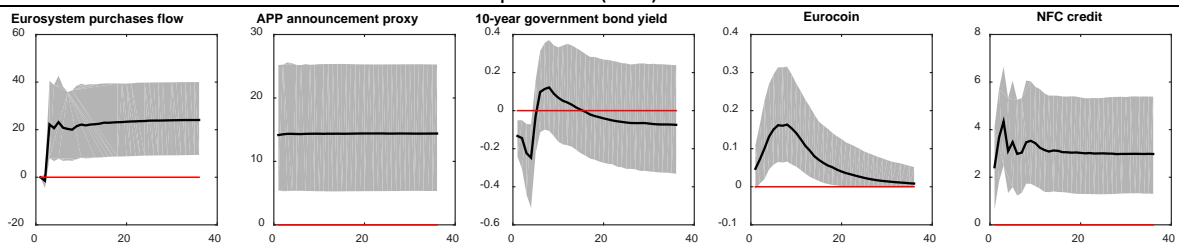## Model with stock prices as fifth variable
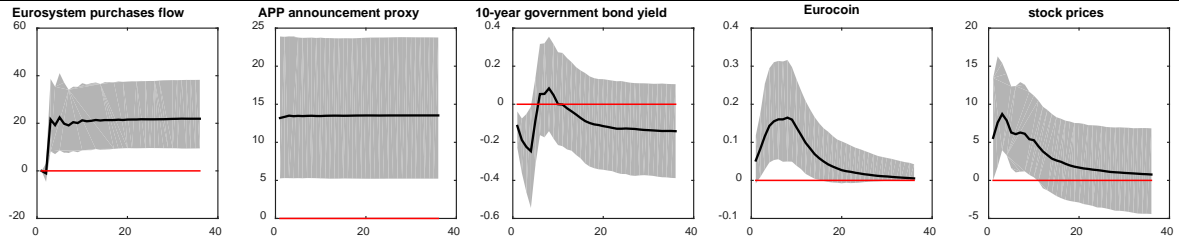
Model with the nominal effective exchange rate (NEER) as fifth variable
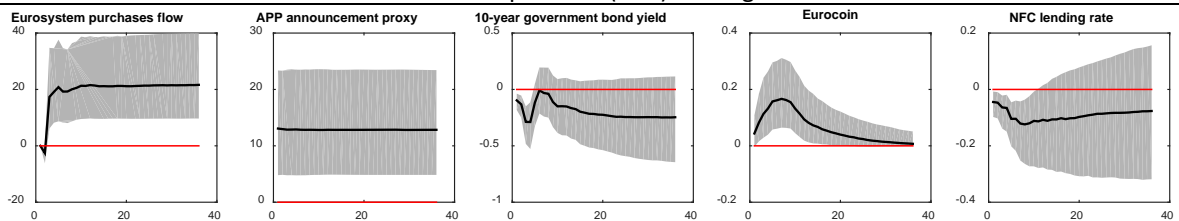

Model with 1-year yield as fifth variable

Model with non-financial corporation (NFC) credit volumes as fifth variable

Model with non-financial corporation (NFC) lending rates as fifth variable

Note: Full black lines are the median impulse response functions, grey areas delimit the space between the 16th and 84th percentiles of impulse response functions. Median responses and percentiles multiplied by the estimated size of the shock in the respective month. Horizontal axes refer to number of months, while vertical axes refer to billions of euros (for Eurosystem purchase flow and APP announcement proxy), percentage points (for interest rates, lending rates and Eurocoin) or percentages (for the HICP, stock prices, the exchange rate and NFC credit).