EUROPEAN CENTRAL BANK

EUROSYSTEM

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joint work with

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The financial and macroeconomic impact of the ECB's Asset Purchase Programme (APP) announcements

First Annual Workshop of the ESCB Research Cluster 1 on Monetary Economics

Banco de España, Madrid, 9-10 October 2017

Motivation and objective

Motivation

- Assessing the impact of the expanded asset purchase programme (APP) on financial markets and the macro-economy is **essential for the ECB** and more in general **for policy-makers in the Euro Area**

Objective

- Develop an **empirical structural model** allowing to estimate impact of APP announcements (initial and re-calibrations) on financial and macroeconomic variables

Approach

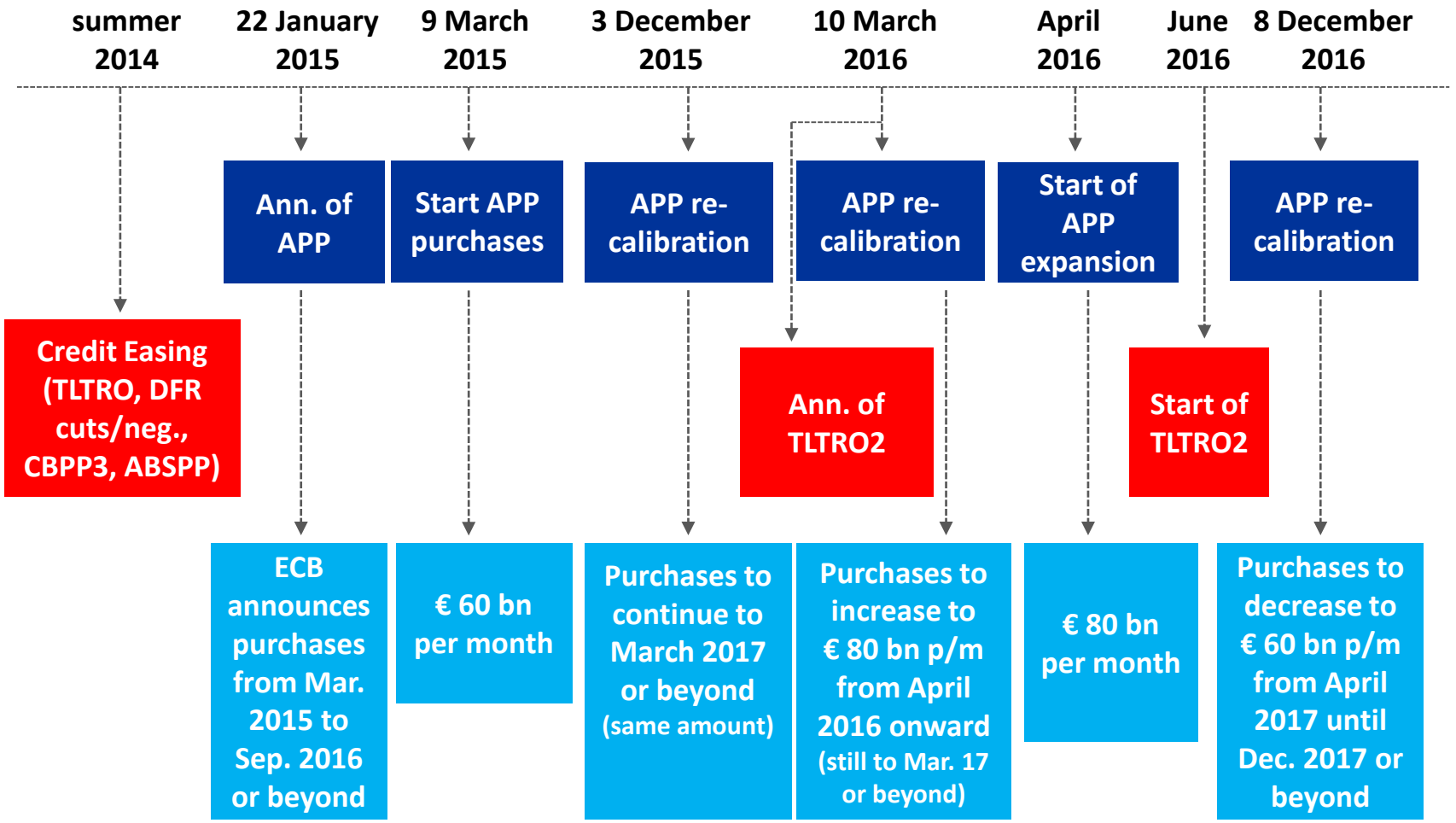
- **Model:** structural VAR with time-varying parameters and stochastic volatility
- **Identification of APP announcement shocks**: novel approach, based on narrative restrictions derived from the specific features of the APP as announced by the ECB

Literature

- Impact of the APP on financial markets
  - Altavilla, Carboni and Motto (2015)
  - De Santis (2016)
  - Andrade, Breckenfelder, De Fiore, Karadi and Tristani (2016)
  - Koijen et al (2016)
  - Albertazzi, Becker and Boucinha (2016)
  - Altavilla, Canova and Ciccarelli (2016)
  - …

- Impact on the macroeconomy
  - Andrade, Breckenfelder, De Fiore, Karadi and Tristani (2016)
  - Altavilla, Canova and Ciccarelli (2016)
  - Wieladeck and Garcia Pascual (2016)
  - Gambetti and Musso (2017)
  - …

APP timing of events



APP: quantitatively not fully anticipated

EUROZONE STIMULUS

Central bank bond-buying proposal beats all expectations

As significant was the vow to keep on purchasing until inflation heads for 2%

CLAIRE JONES — FRANKFURT

It was a long time coming. But in the end, Mario Draghi's bond-buying plan outstripped expectations.

Deep splits on the European Central Bank's 25-member governing council had sparked concerns that Mr Draghi's version of quantitative easing would underwhelm, even as prices in the eurozone had dropped for the first time in five years.

Market analysts polled by Bloomberg earlier this week had expected some €550bn-worth of government bond purchases. The ECB now intends to buy double that amount, launching a €1.1tn bond-buying spree, the vast majority of which will involve purchases of sovereign debt.

Mr Draghi, ECB president, said yesterday that plunging oil prices had raised the threat of a destructive period of falling prices.

The ECB would purchase €60bn-worth of government debt, alongside asset-backed securities and covered bonds, from March until September 2016 to rid the eurozone of deflation that threatens to wipe out any chance of meaningful economic recovery.

Mr Draghi signalled that the central bank's earlier purchases of ABSs and covered bonds could provide some guide to the split between purchases of private and public debt.

The central bank has bought about €35bn of private sector assets over the past three months, indicating it will purchase about €10bn of private sector paper and around €50bn-worth of government bonds from the spring. As important as the size of purchases was the ECB's on buying until inflation returning towards 2 per "medium term".

"The most important today's programme was not but the overall message," Flanders, strategist at JPM markets needed to hear was both willing and insti to pursue its inflation tar tortuous the path to th might be."

"Two cheers for the statement. Though more or urgency would have said Richard Barwell, Royal Bank of Scotland.

However, the ECB's national central banks to s of the responsibility for lo national debt is bound t other eurozone governm

Mr Draghi gave ground to QE's sceptics and fears in Germany and the Netherlands that the policy would put taxpayers in the region's core on the hook for losses in the periphery.

If one of the 19 member states of the eurozone were to force a haircut on all its creditors, their national central bank would take the hit for all but 8 per cent of the national debt bought under QE.

A likely win for the leftwing Syriza party in this weekend's Greek elections had highlighted concerns about burden sharing. Syriza wants an end to austerity

important thing about today's programme was not the details but the overall message'

in QE, at least at the beginning. The ECB's small print means that only countries which are in an EU reform programme which — unlike Greece's — is not under review can take part. Conditions on purchases undertaken as part of the ECB's earlier sovereign bond-buying scheme, the Securities Markets Programme, mean no Greek debt can be bought until June.

The rest of the region will participate according to the ECB's capital key, which roughly replicates member states' contribution to the region's out-

Accounting rules have been set to avoid other buyers falling victim to mark-to-market losses on their debt purchases. Policy makers will buy just over €100bn of debt of other European institutions, mostly European Investment Bank paper. National central banks buy at maturities across the government bond yield curve, from two up to 30 years.

Mr Draghi defended the decision to scrap risk sharing, saying "every monetary policy operation has some fiscal implications" and that policy makers needed to ensure "monetary dominance". While some on the governing council challenged the decision, no strong objections were voiced. A consensus backed the move.

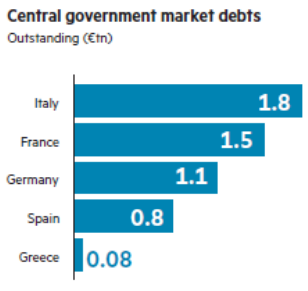
The entire council said that QE was monetary policy — a statement the ECB hopes will counter the threat of legal action in Germany.

More fierce objections were raised to the timing of the programme. Both of the council's German members, Bundesbank president Jens Weidmann and executive board member Sabine Lautenschläger, thought economic conditions did not warrant QE.

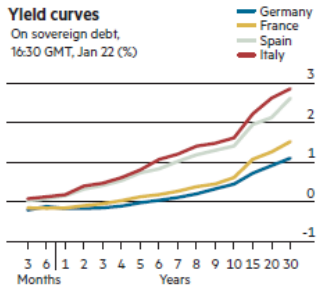
Market analysts polled by Bloomberg earlier this week had expected some €550bn-worth of government bond purchases. The ECB now intends to buy double that amount, launching a €1.1tn bond-buying spree, the vast majority of which will involve purchases of sovereign debt.

Draghi's objectives

Under its QE programme, the ECB will purchase up to one-third of a eurozone country's sovereign debt ...

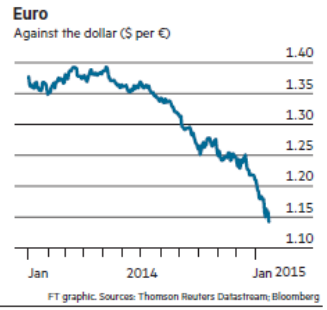


... to bring down yields across all maturities with the aim of pushing investors into riskier financial assets



The objective is to stave off economic stagnation in

... and weaken the euro to give a competitiveness
gion's exporters



FT graphic. Sources: Thomson Reuters Datastream; Bloomberg

FT

Video
Will Mario Draghi's QE plan be enough to revive the eurozone economy?
ft.com/ecbqe

APP announcement proxy

APP announcements

$$a_t = E_{t-1}a_t + b_t$$

where

$a_t = announcement\ of\ APP\ and\ APP\ recalibrations$

$E_{t-1}a_t = anticipated\ component\ of\ the\ announcement$

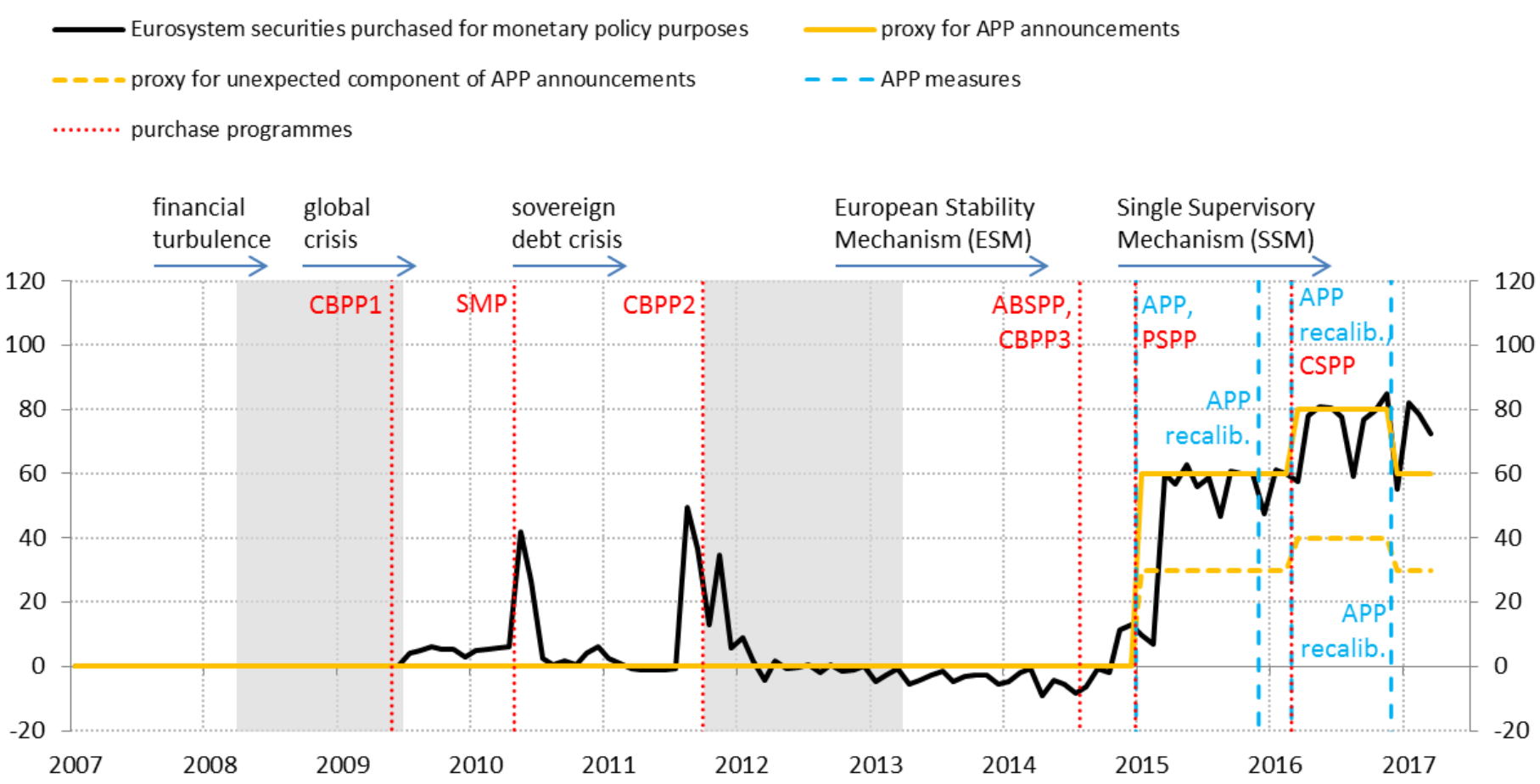
$b_t = unexpected\ component\ of\ the\ announcement,\ i.e.\ the\ \mathbf{announcement shock}$

$t = month\ of\ the\ announcement, i.e.\ January\ 2015, December\ 2015, March\ 2016, December\ 2016$

Data: Eurosystem security purchases and APP ann. proxy

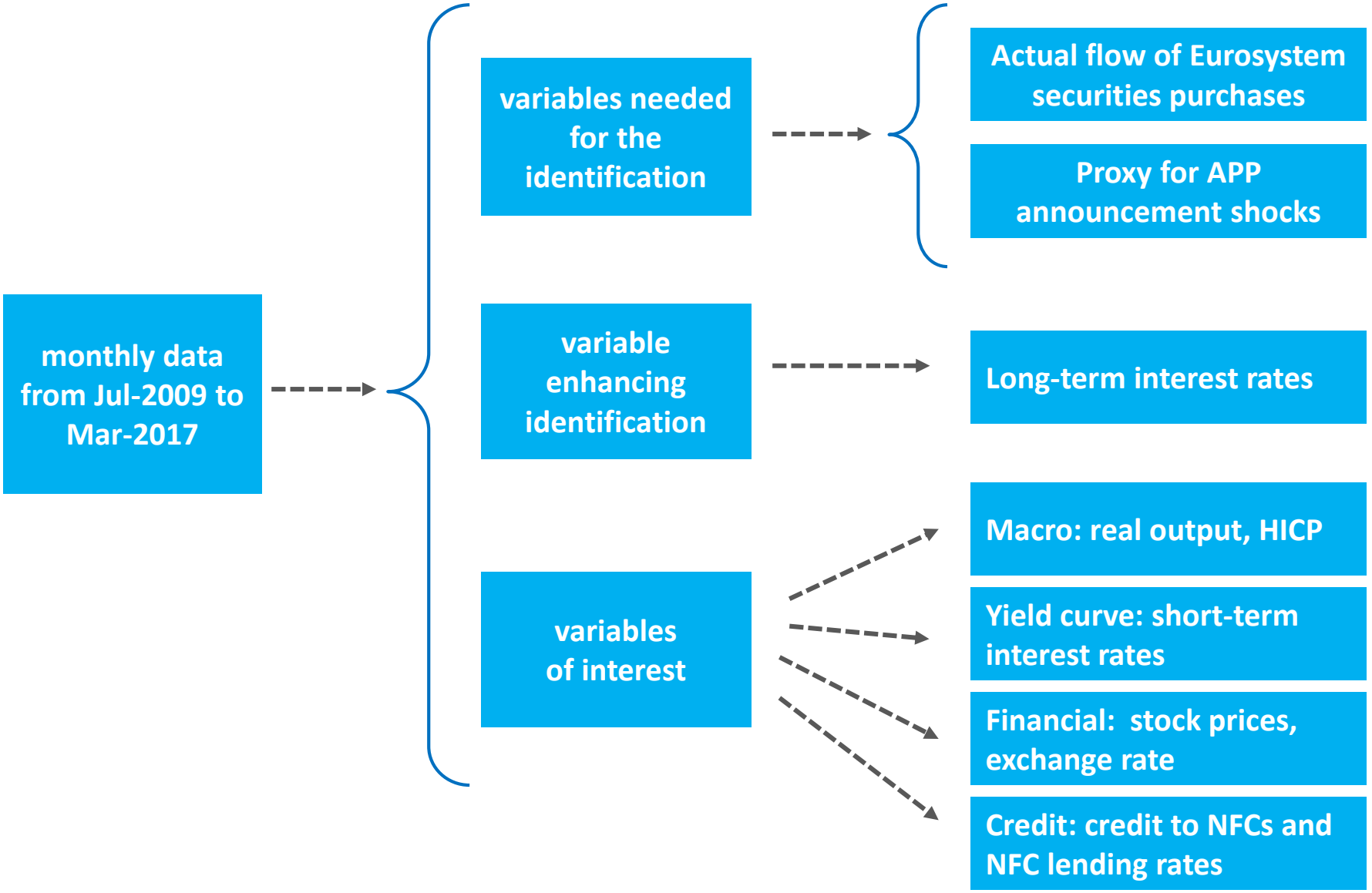
Eurosystem security purchases and APP announcement proxy

(outstanding amounts, EUR billions)

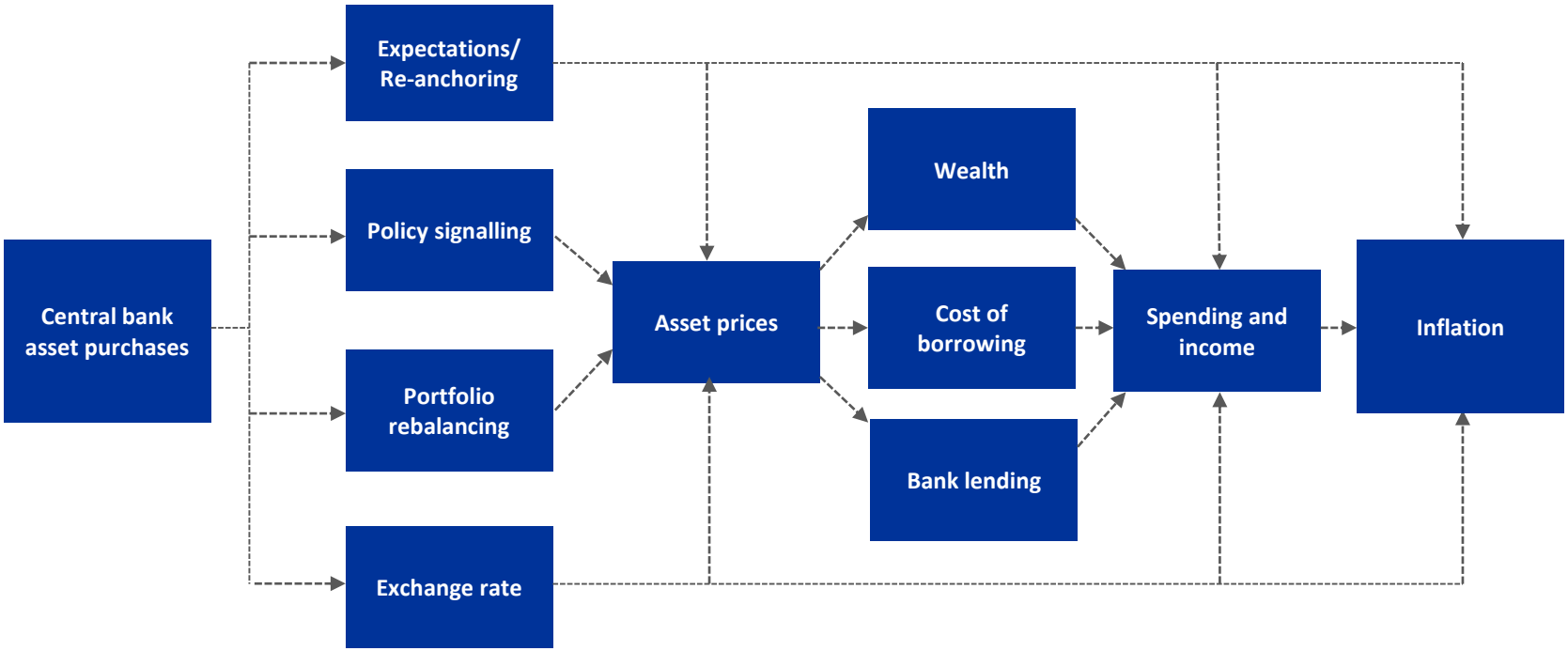


Source: ECB.

Data set



APP channels of transmission



Model

- **Model**: structural VAR with time-varying parameters and stochastic volatility (TV-VAR) a la Primiceri (2005), Cogley and Sargent (2005), Galí and Gambetti (2009, 2015)

- VARs with four variables

- Estimation via Bayesian methods, specifically use Gibbs Sampler algorithm as in Galí and Gambetti (2015) to draw from the joint posterior distribution of model parameters

- Priors:
  - Priors for initial states are assumed to be normally distributed
  - Priors for hyperparameters are assumed to be distributed as independent inverse-Wishart
  - Small degree of variation

Model

Why a structural VAR with time-varying parameters and stochastic volatility?

- To account for structural change, changes in transmission (ZLB, non-standard MP measures), changes in volatility, etc.
- Empirical evidence: estimates of time-varying variances and test for parameter time-variation
- Time-varying parameter and volatility estimates allows to accurately estimate IRFs to announcement shocks in specific months

Identification

Impose minimal set of restrictions to identify the announcement shock

A) restrictions

- On impact, the effect of the announcement shock on the actual flow of purchases is zero
- All other effects to the announcement shock of interest are unrestricted

B) announcement shocks

- Only the announcement shocks of January 2015 and March 2016 are identified
- Role of time-variation in parameters and stochastic volatility essential

Identification: expected effects of Jan. 2015 ann. shock

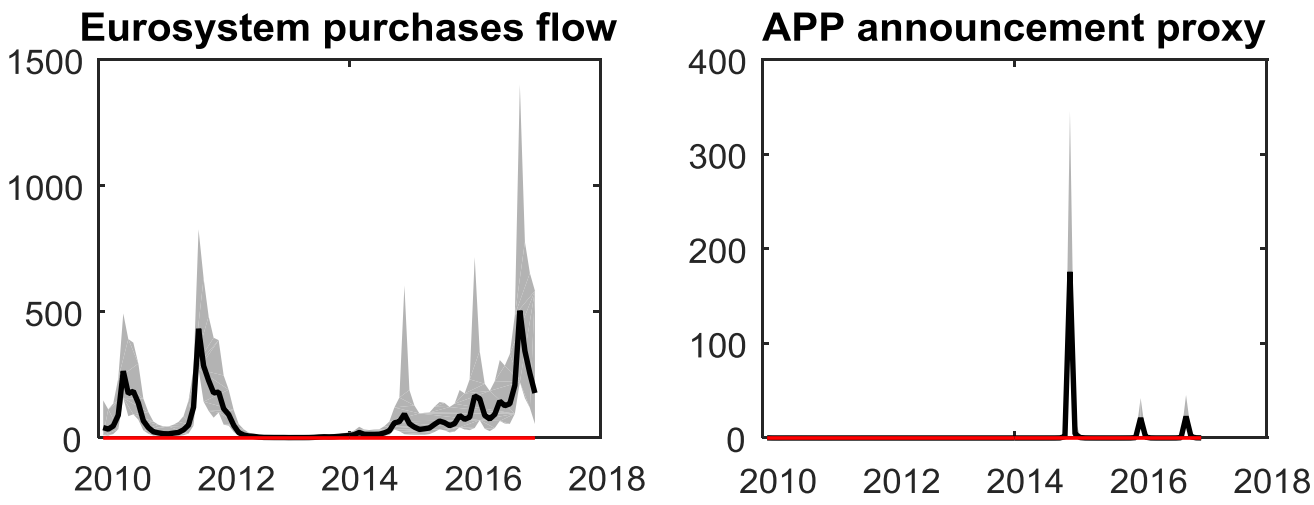
	on impact	lagged effects		
	0 Jan-15 (APP announced)	1 Feb-15	2 Mar-15 (purchases start)	3 Apr-15
Eurosystem security purchases APP announcement proxy	0 + & 0<X≤30bn	0	+ & 0<X≤30bn	
consumer price inflation				+
real economic activity				+
long-term interest rate	-			
short-term interest rate	-			
stock prices	+			
exchange rate	-			
NFC credit volumes				+
bank lending rate to NFCs				-

Identification: imposed effects of Jan. 2015 ann. shock

	on impact	lagged effects		
	0 Jan-15 (APP announced)	1 Feb-15	2 Mar-15 (purchases start)	3 Apr-15
Eurosystem security purchases APP announcement proxy	0			
consumer price inflation real economic activity long-term interest rate short-term interest rate stock prices exchange rate NFC credit volumes bank lending rate to NFCs				

Time variation

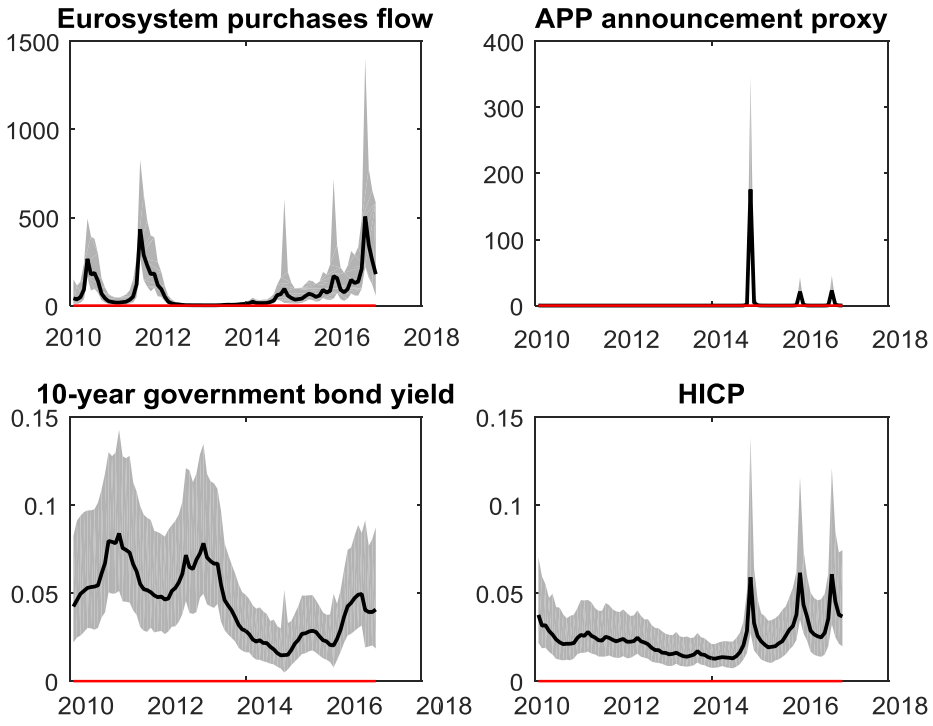
Stochastic volatility



Note: Posterior medians, 16th and 84th percentiles of the residual time-varying variances.

Time variation

Stochastic volatility



Note: Posterior medians, 16th and 84th percentiles of the residual time-varying variances.

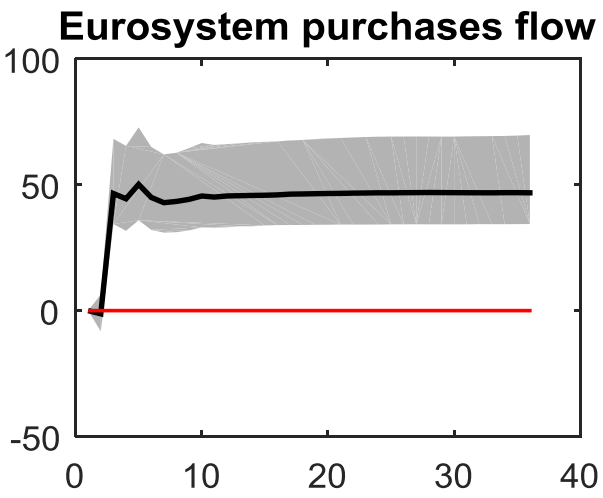
Trace test

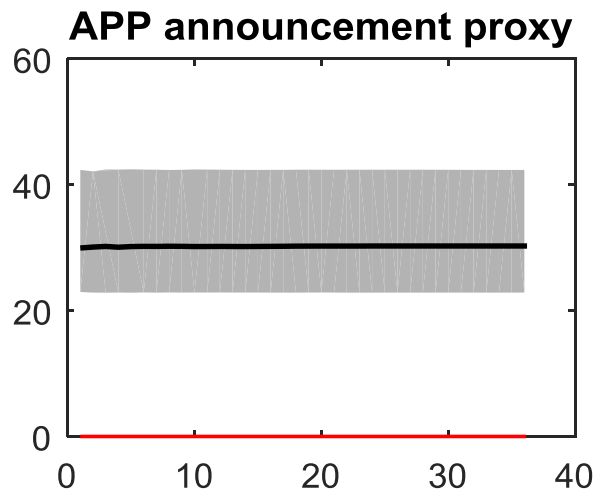
model	16th perc.	50th perc.	84th perc.	trace(Q0)
model with the HICP	0.112	0.154	0.215	0.008
model with Eurocoin	0.995	1.465	2.274	0.083
model with stock prices	0.037	0.052	0.075	0.003
model with the NEER	0.034	0.045	0.067	0.003
model with the yield curve	0.359	0.489	0.686	0.027
model with NFC credit	0.032	0.045	0.066	0.002
model with NFC lending rates	0.487	0.677	1.009	0.040
model with inflation expectations	1.170	1.647	2.367	0.092
model with short-term forward rates	0.158	0.221	0.331	0.012

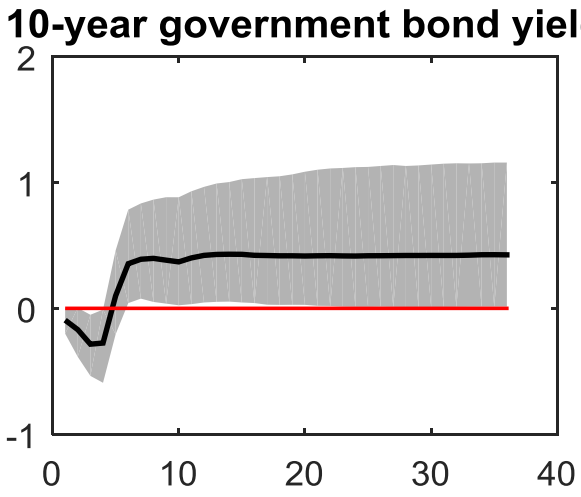
Note: The first three columns show the 16%, 50% and 84% percentiles of the posterior of the trace of the variance-covariance matrix of the error term of the law of motion of the parameters of the VAR, while the fourth column shows the trace of the prior variance-covariance matrix.

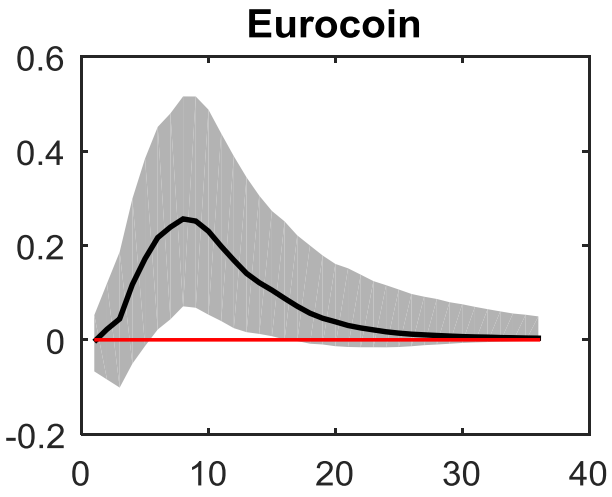
Macroeconomic impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock



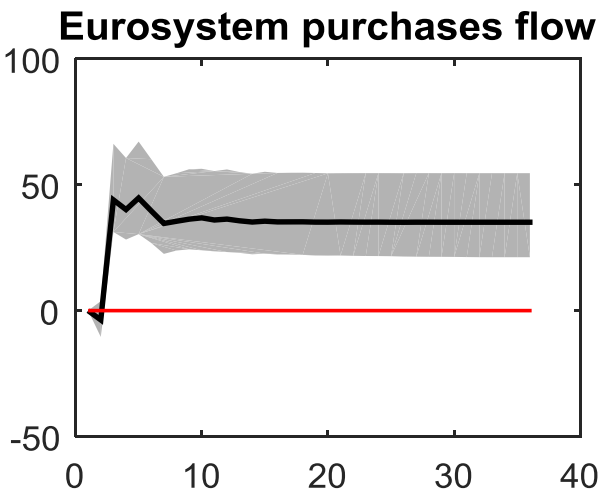


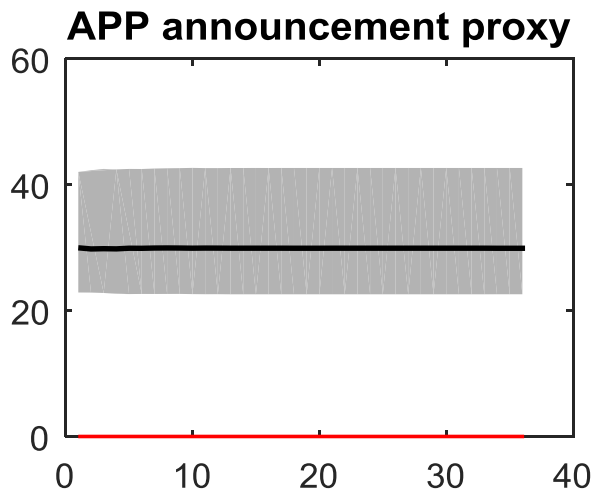


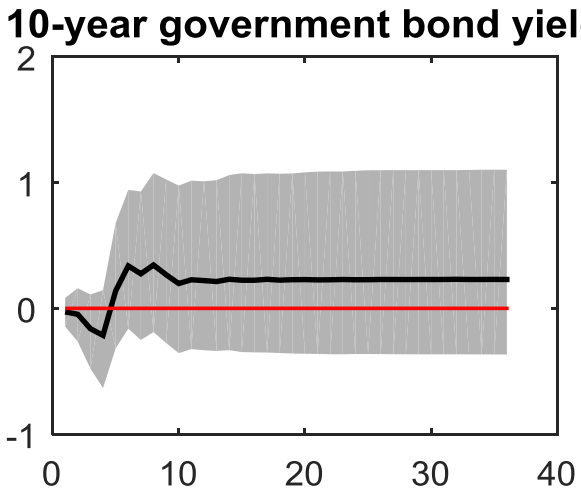


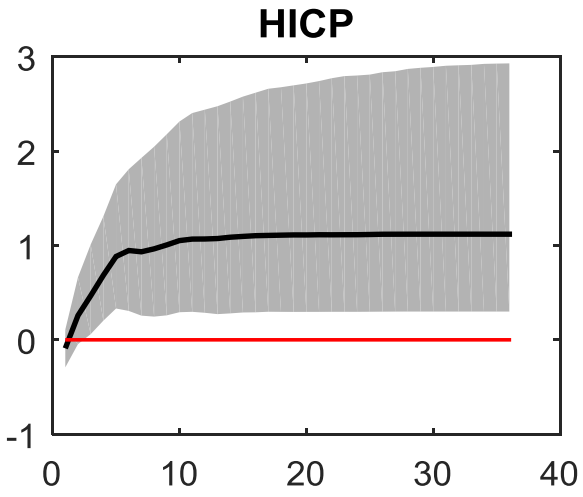
Macroeconomic impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock



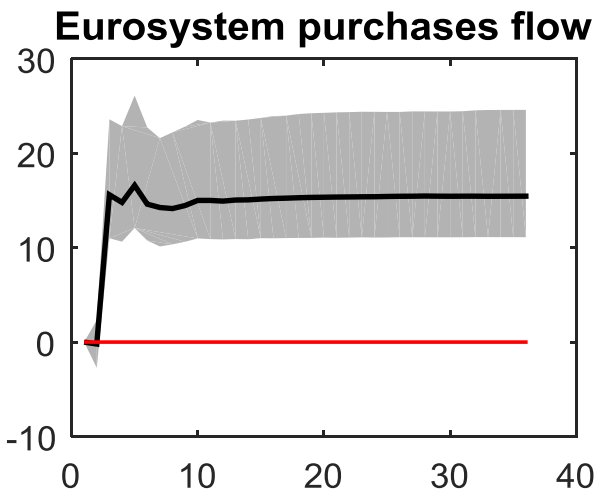


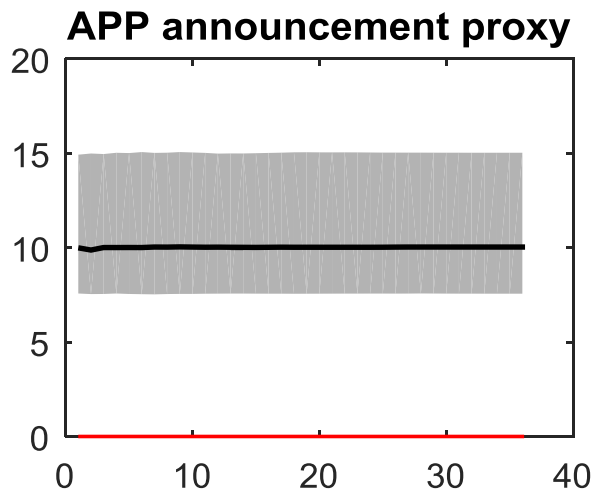


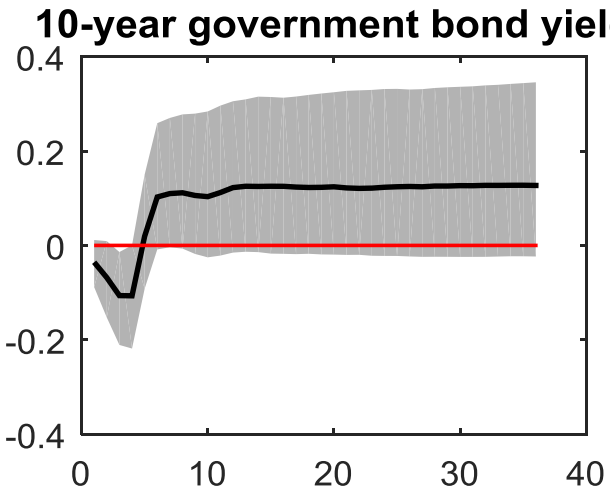


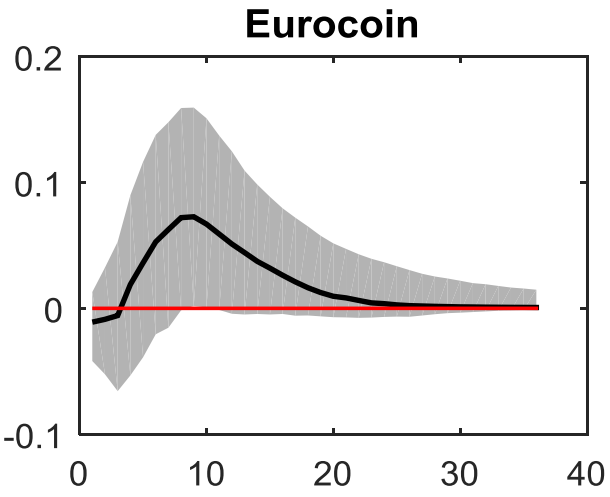
Macroeconomic impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the March 2016 APP announcement shock



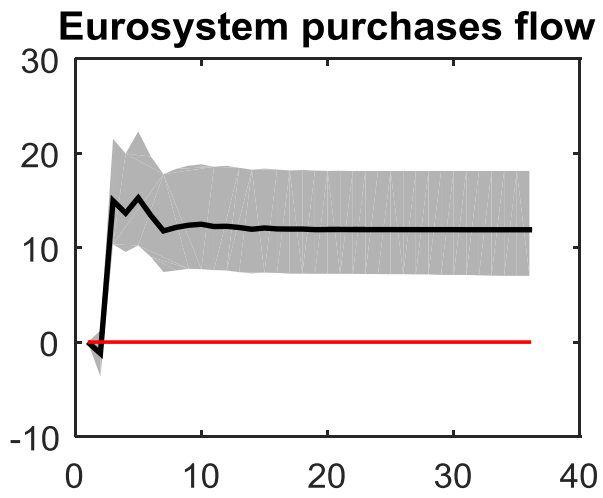


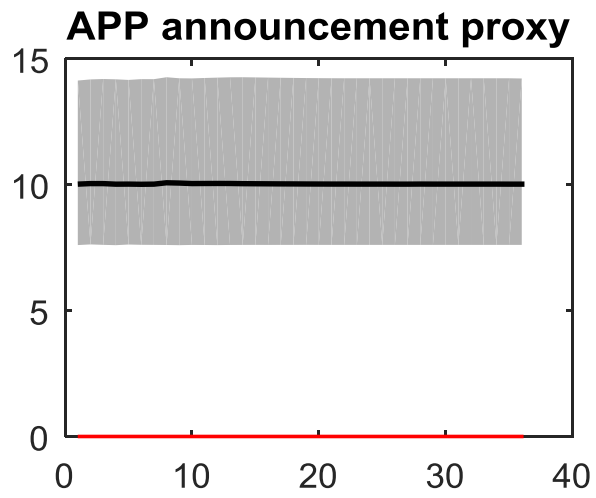


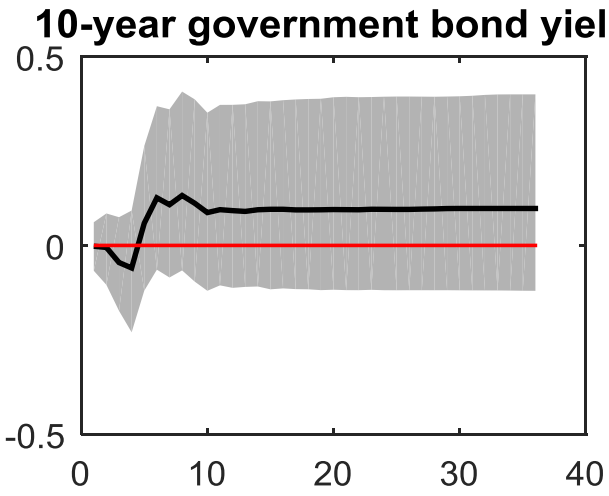


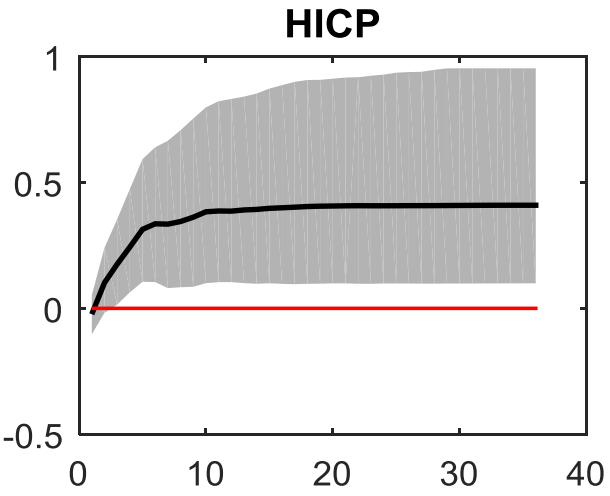
Macroeconomic impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the March 2016 APP announcement shock





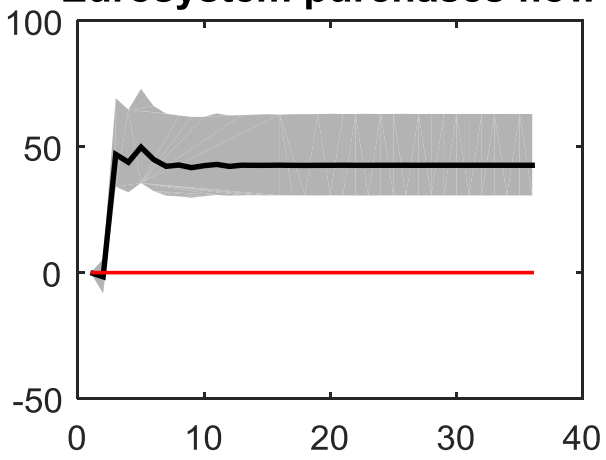




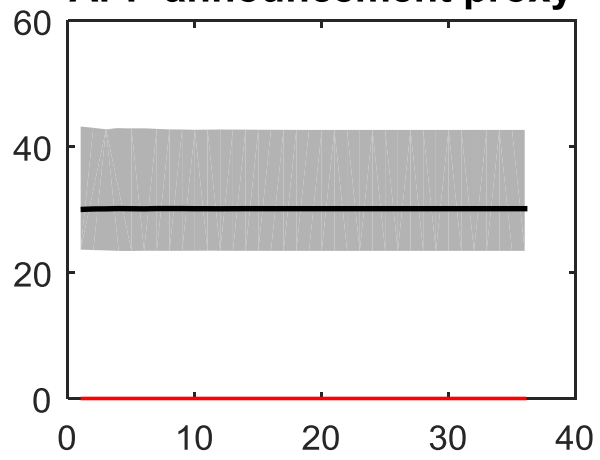
Yield curve impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock

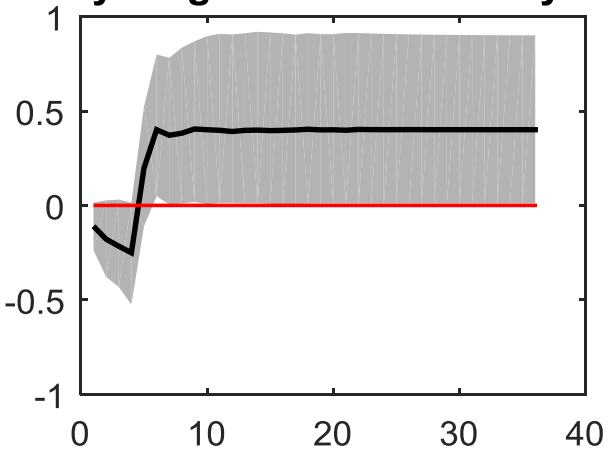
Eurosystem purchases flow



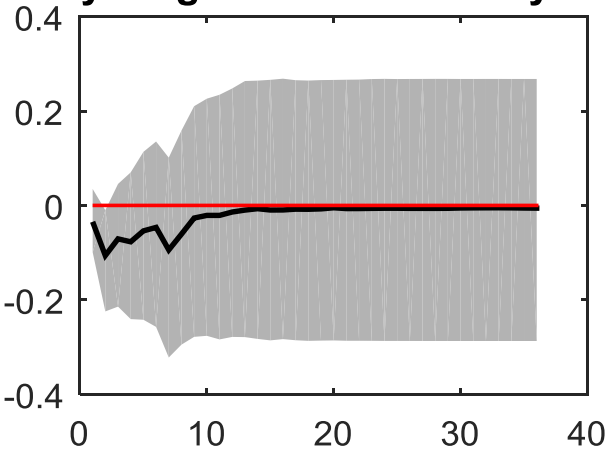
APP announcement proxy



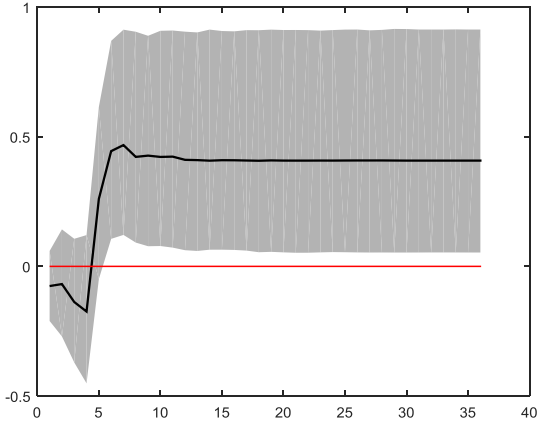
10-year government bond yield



1-year government bond yield

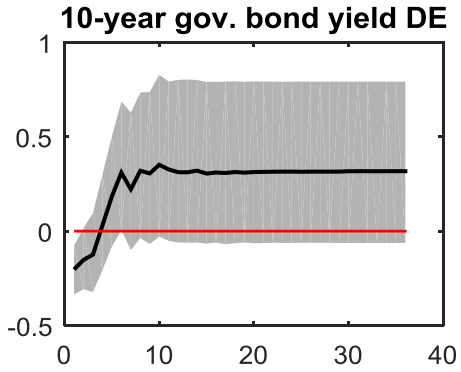


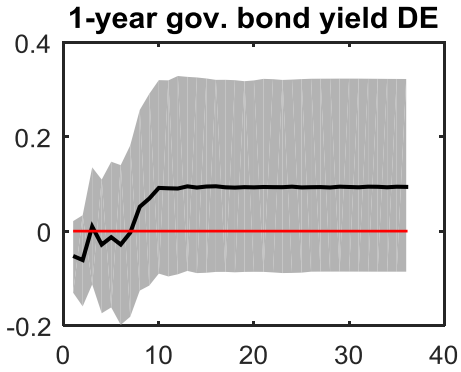
IRF of slope YC

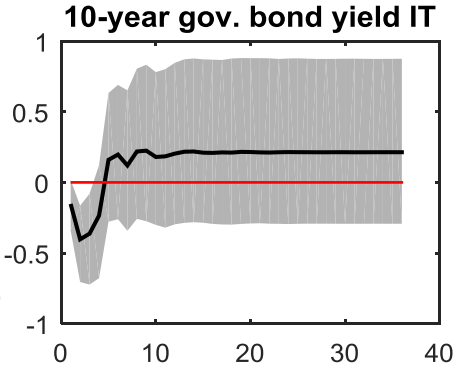


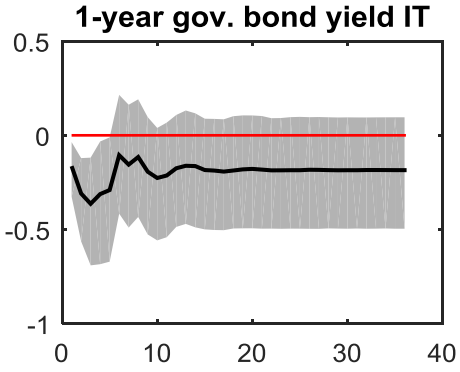
Cross-country YC impact: Impulse Response Functions

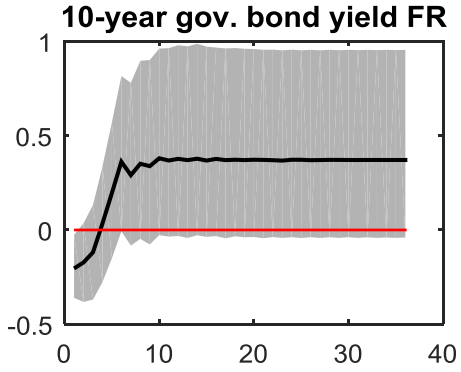
IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock

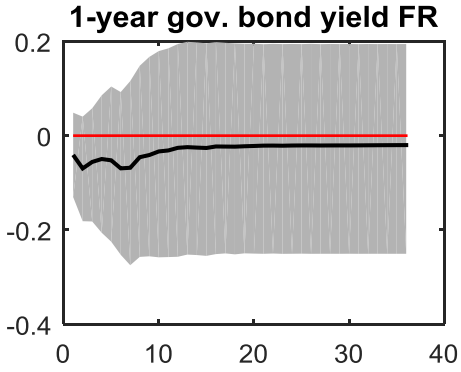


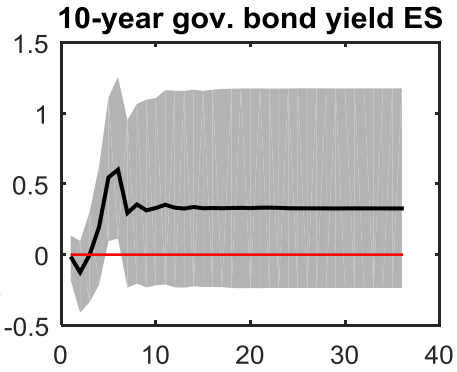


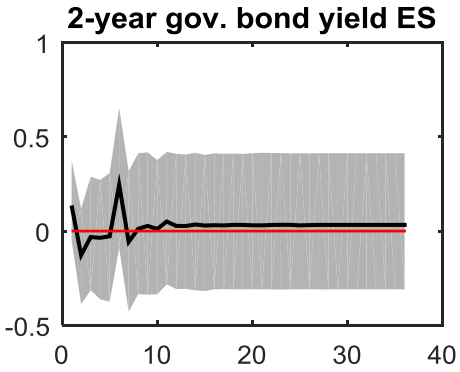






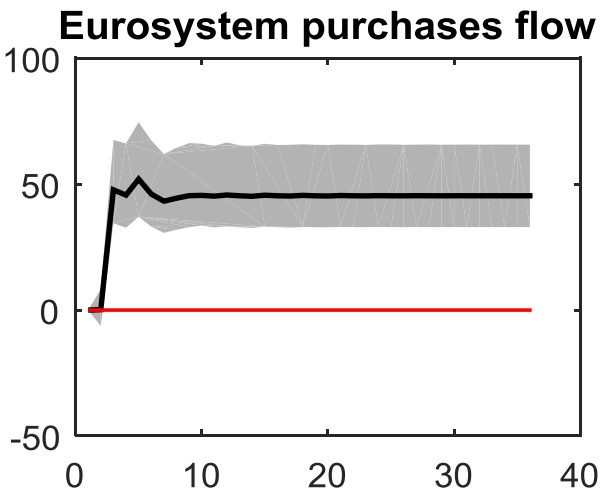


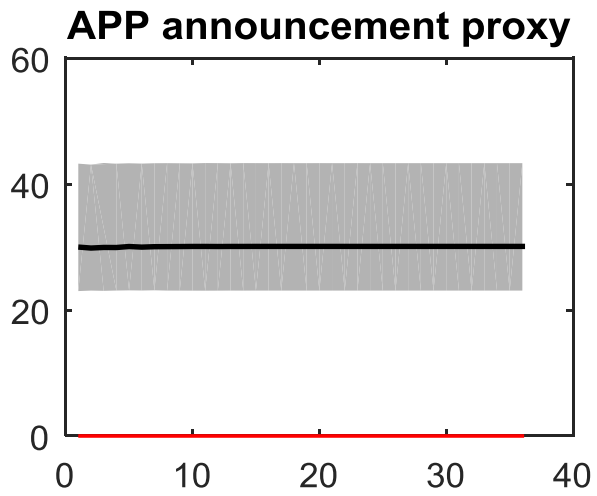


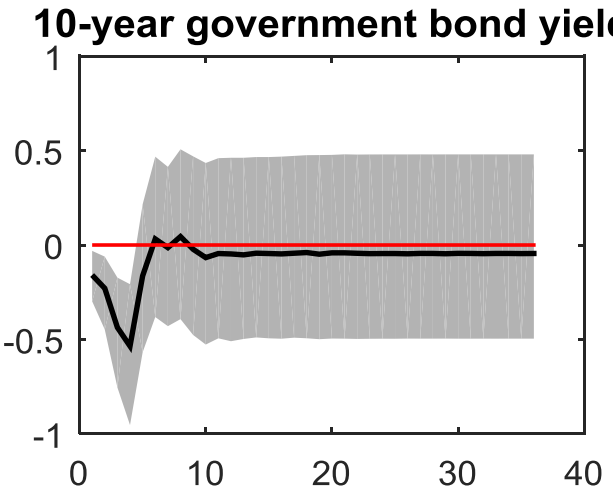


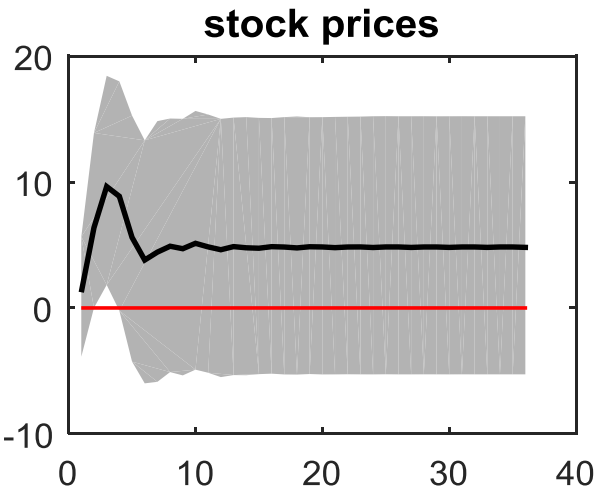
Financial market impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock





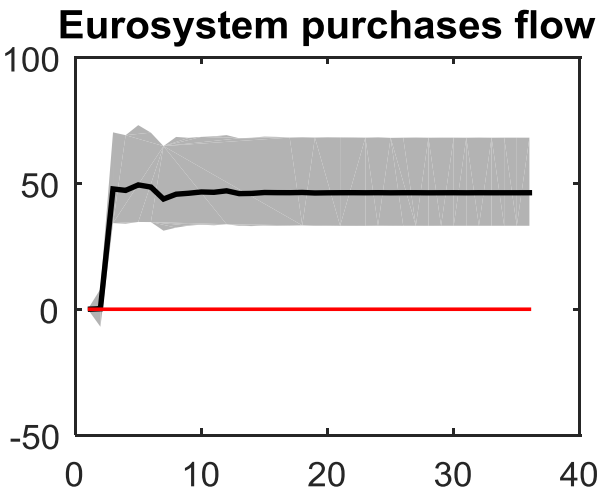


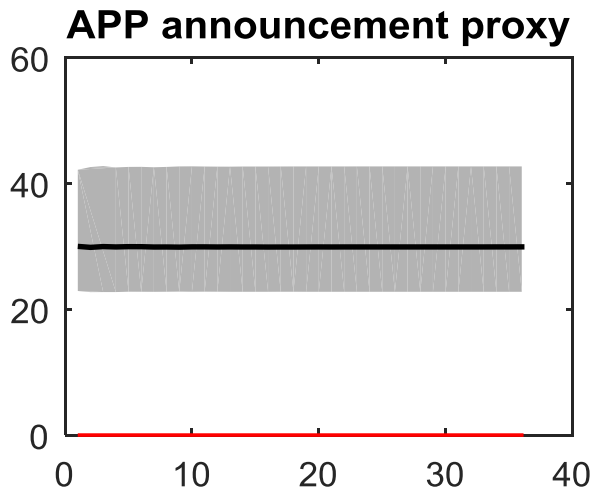


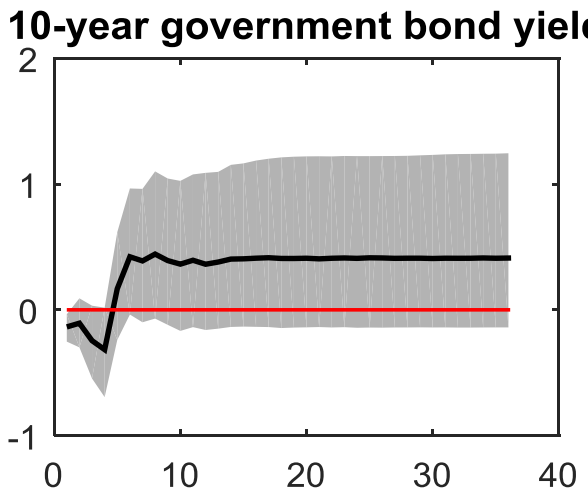
Portfolio rebalancing channel

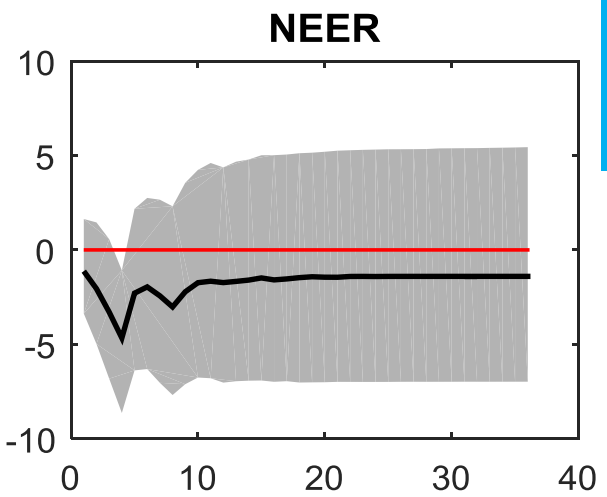
Financial market impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock





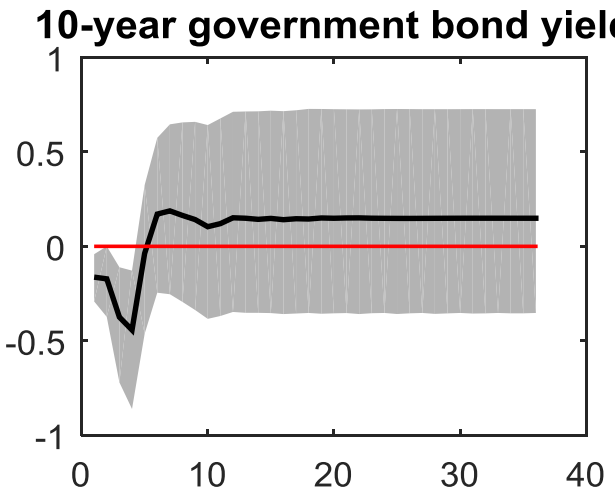


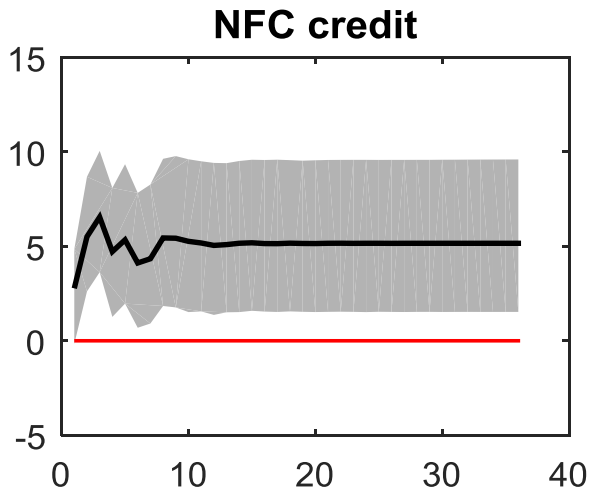


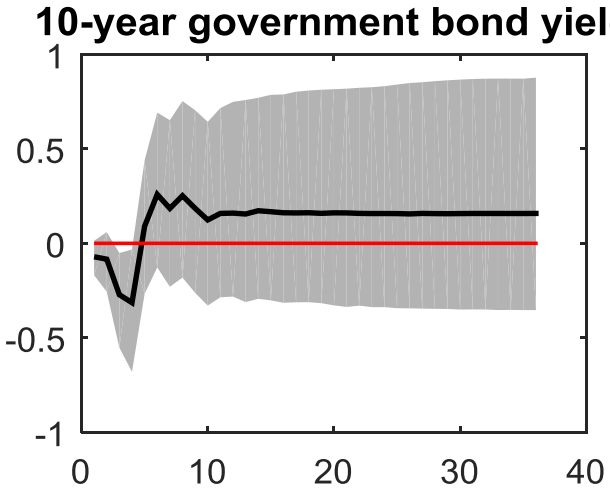
Exchange rate channel

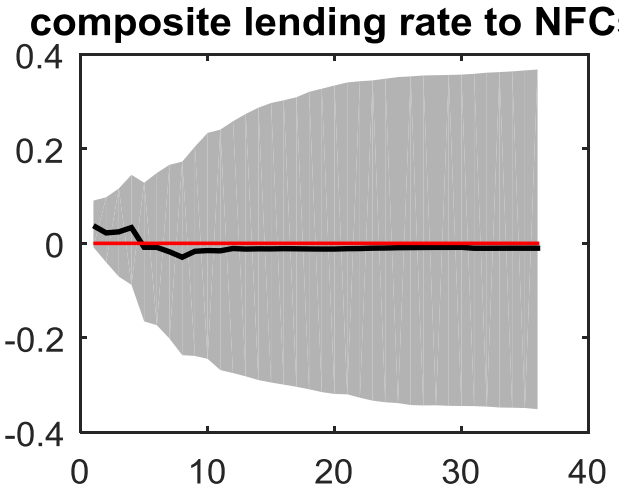
Credit market impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock





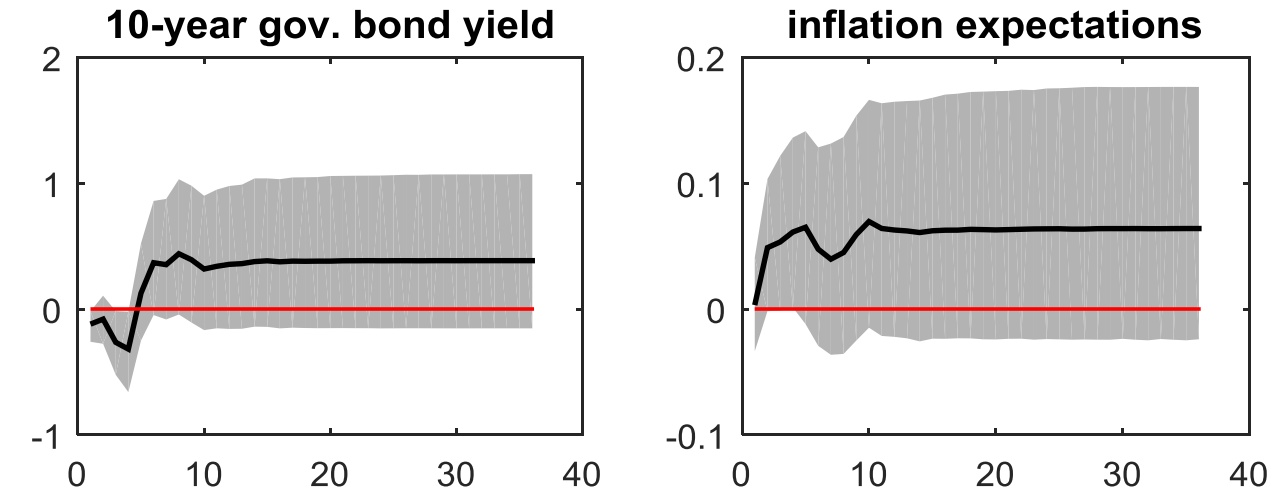




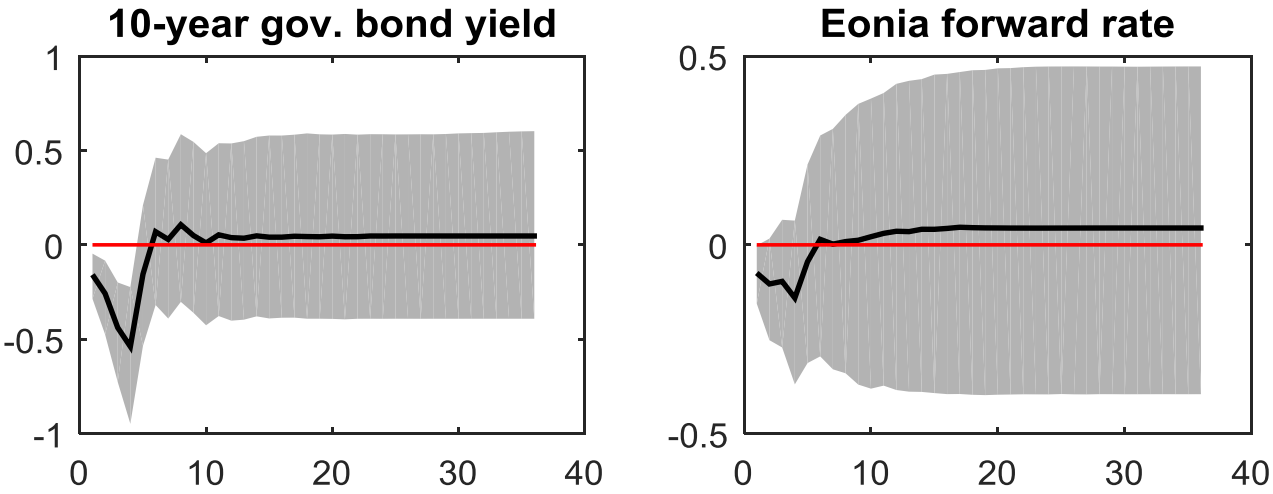
Credit channel

Other channels: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock



Re-anchoring channel



Signalling channel

Robustness and conclusions

Robustness

- Results appear robust across various dimensions
  - Alternative **APP announcement shock proxy**: one-tenth unexpected
  - Alternative **variables**: HICPex, employment, LT & ST yields (GDPw)
  - Alternative **identification scheme**: sign restrictions

Conclusions

- Evidence points to a significant impact of the APP announcements
  - **Macro**: Real economic activity and HICP
  - **Yield curve**: Driven by LT rates, flattening then steepening
  - **Portfolio rebalancing channel**: stock prices
  - **Exchange rate channel**: exchange rates
  - **Credit channel**: NFC credit and bank lending rates

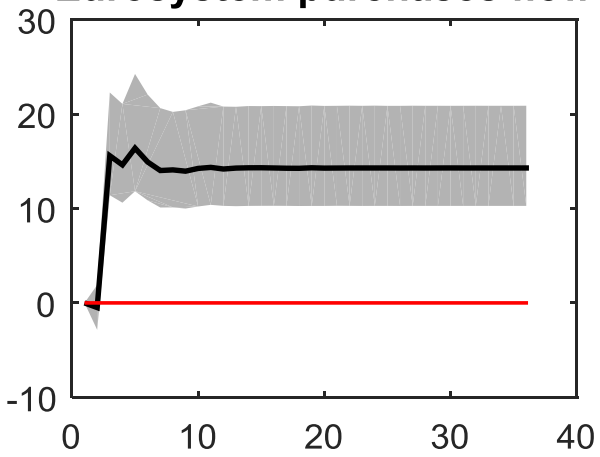
Thank you

Background slides

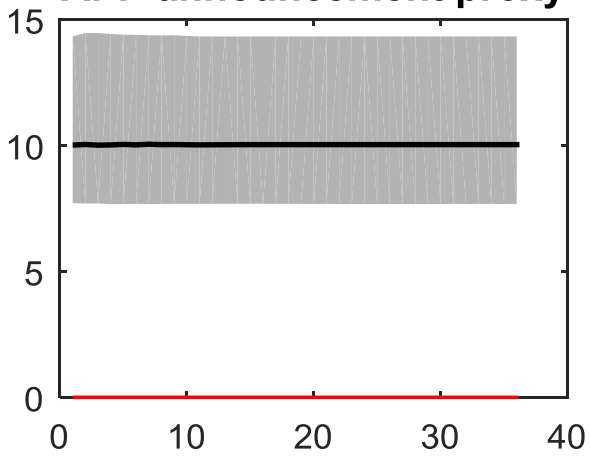
Yield curve impact: Impulse Response Functions

IRFs of variables in levels (cumulated changes) to the March 2016 APP announcement shock

Eurosystem purchases flow

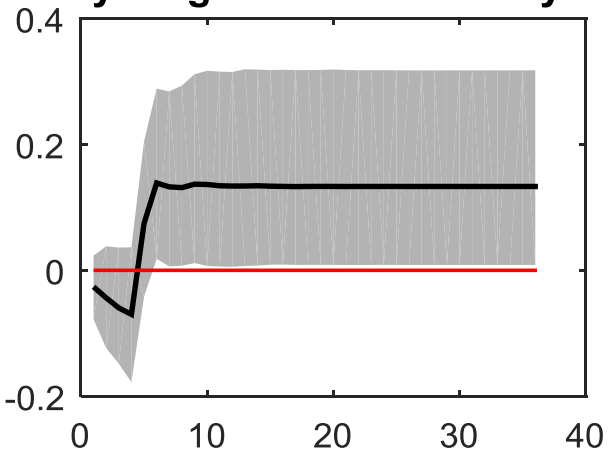


APP announcement proxy

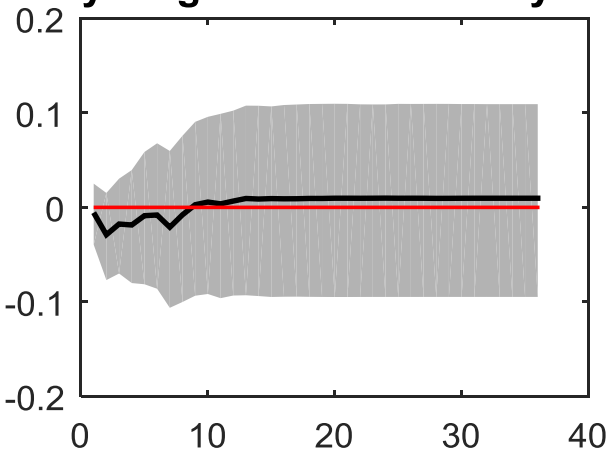


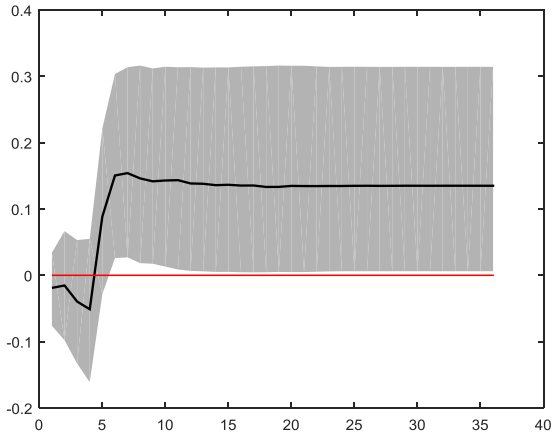
IRF of slope YC

10-year government bond yield



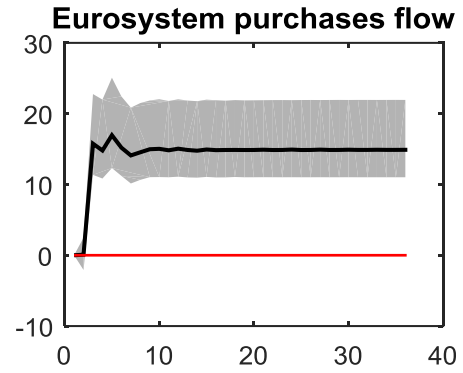
1-year government bond yield

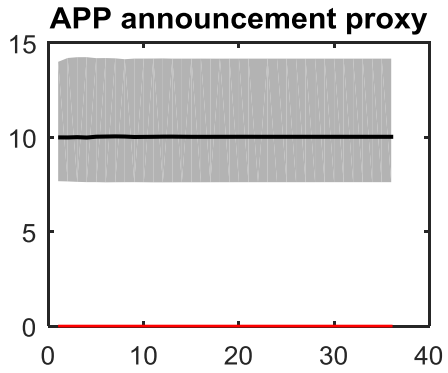


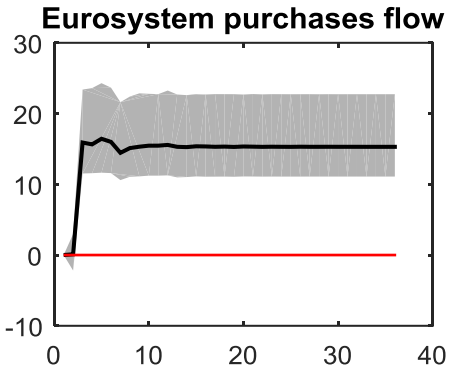


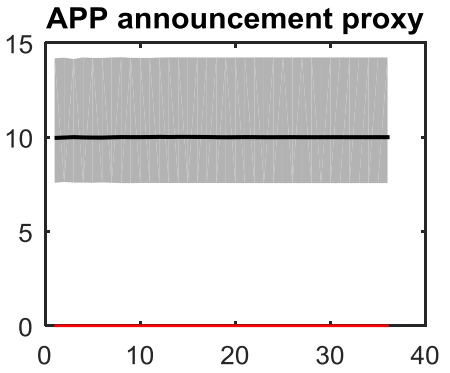
Financial market impact: Impulse Response Functions

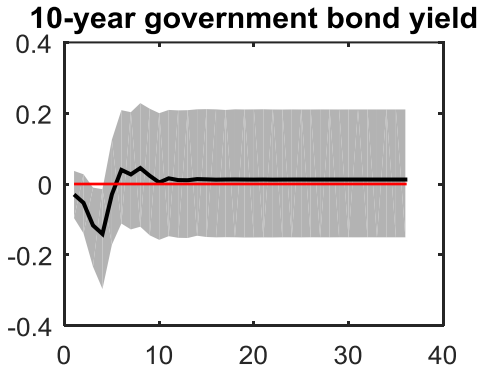
IRFs of variables in levels (cumulated changes) to the March 2016 APP announcement shock

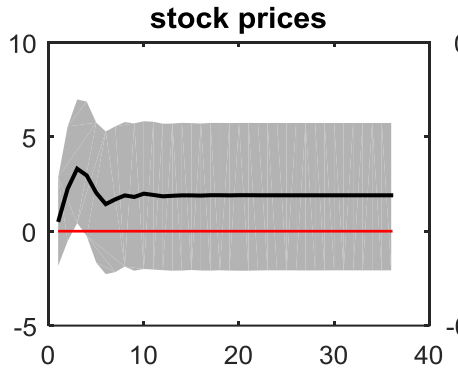


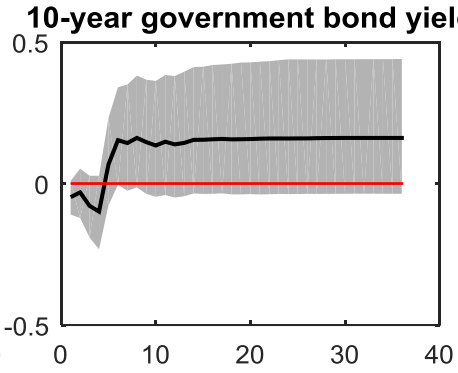


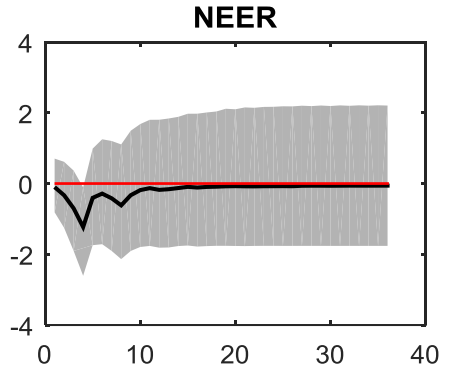






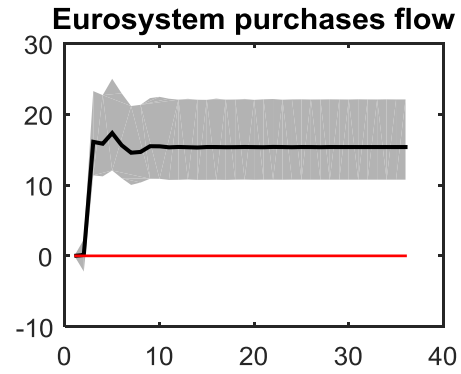


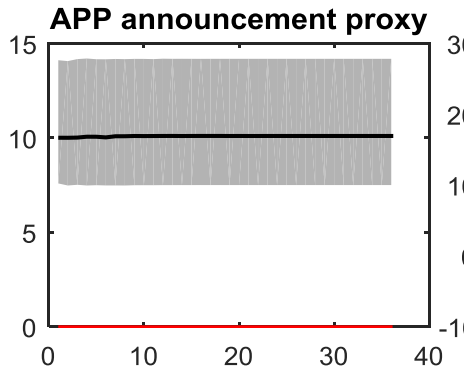


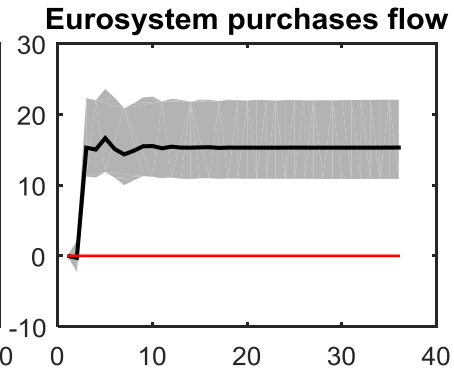


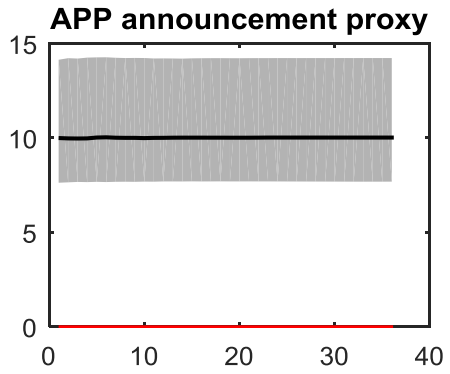
Credit market impact: Impulse Response Functions

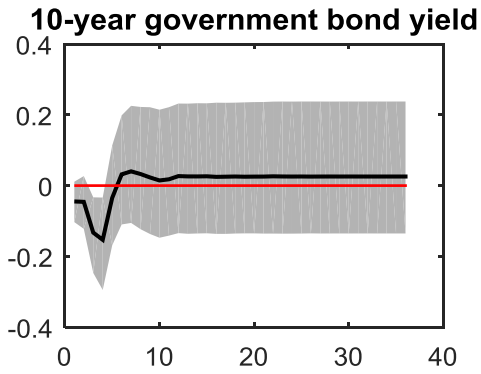
IRFs of variables in levels (cumulated changes) to the March 2016 APP announcement shock

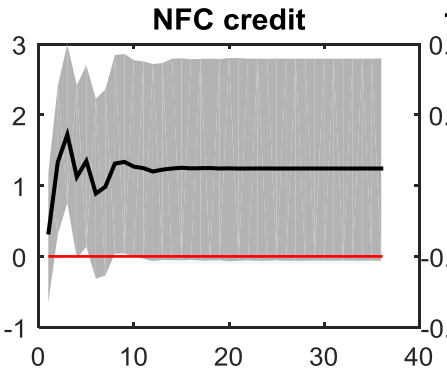


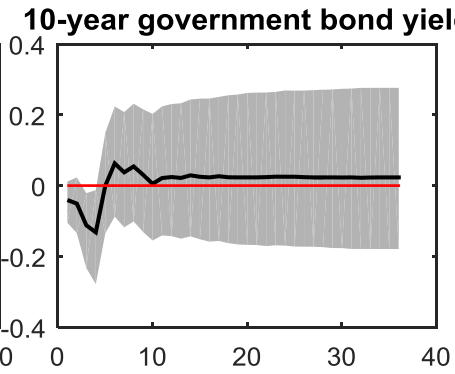


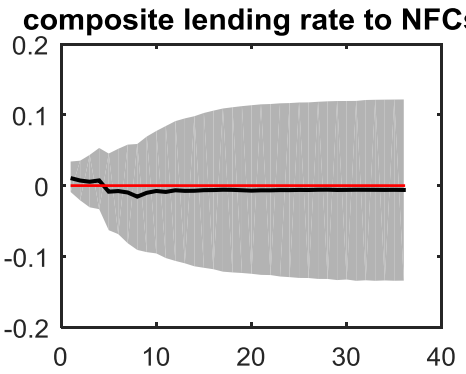












Literature

- Impact of the APP on financial markets
  - Altavilla, Carboni and Motto (2015)
  - De Santis (2016)
  - Andrade, Breckenfelder, De Fiore, Karadi and Tristani (2016)
  - Koijen et al (2016)
  - Albertazzi, Becker and Boucinha (2016)
  - Altavilla, Canova and Ciccarelli (2016)
  - …

- Impact on the macroeconomy
  - Andrade, Breckenfelder, De Fiore, Karadi and Tristani (2016)
  - Altavilla, Canova and Ciccarelli (2016)
  - Wieladeck and Garcia Pascual (2016)
  - Gambetti and Musso (2017)
  - …

Model specification

- TV-VAR a la Cogley-Sargent (2005) and Primiceri (2005)

$$y_t = A_{0,t} + A_{1,t} y_{t-1} + ... + A_{p,t} y_{t-p} + \varepsilon_t$$
$$\theta_t = \theta_{t-1} + \omega_t$$

where

- ε_t is a Gaussian white noise with zero mean and covariance Σ_t
- ω_t is a Gaussian white noise with zero mean and covariance Ω
- $A_t = [A_{0,t}, A_{1,t}..., A_{p,t}]$
- $\theta_t = vec([A_{0,t} \;\; A_t]')$

- Structural IRF: $C_t(L) S_t H_t$
- Structural shock: $e_t = H_t' S_t^{-1} \varepsilon_t$

where

$$C_t(L) = \sum_{k=0}^{\infty} C_{k,t} L^k$$
$$C_{k,t} = \mathcal{S}_{N,N}(\mathbf{A}_t^k)$$
$$\mathbf{A}_t = \begin{pmatrix} A_t \\ I_{n(p-1)} \quad 0_{n(p-1),n} \end{pmatrix}$$

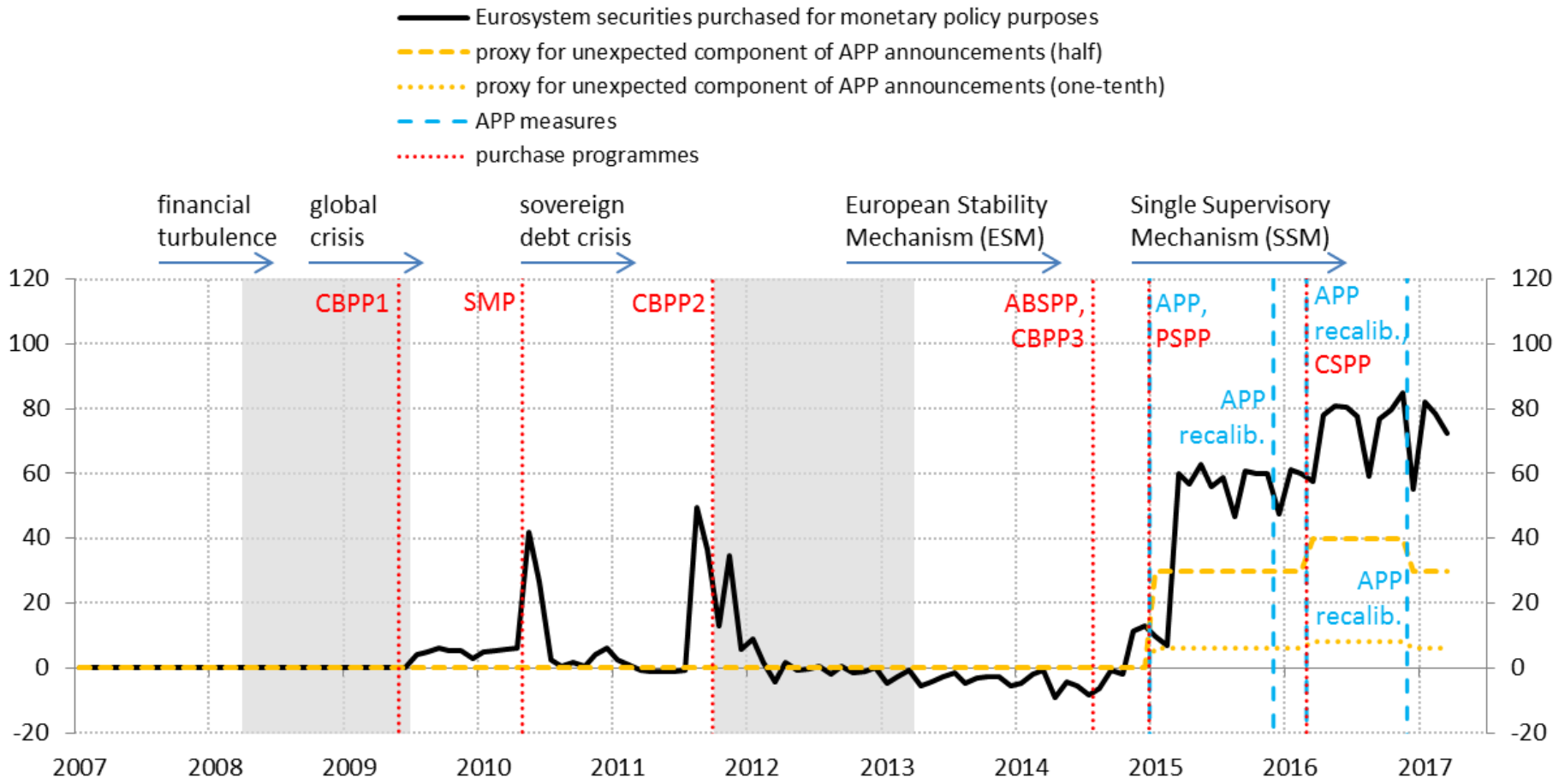
Model estimation

- Estimation via Bayesian methods, specifically use Gibbs Sampler algorithm as in Primiceri (2005) to draw from the joint posterior distribution of model parameters
    - Algorithm is iterative: each iteration is done in seven steps and consists in drawing a subset of coefficients conditional on a particular realisation of the remaining coefficients and then using such a realisation in the conditional densities of the remaining coefficients
    - Once algorithm is initialised at some values, under regularity conditions and after a burn-in period, iterations on these seven steps produce draws from the joint density
- Priors:
    - Priors for initial states are assumed to be normally distributed
    - Priors fro hyperparameters are assumed to be distributed as independent inverse-Wishart
    - Small degree of variation
- Make 20000 repetitions discarding the first 15000 and collecting one out of five draws.

Robustness: Alternative proxy for APP announcement

Eurosystem security purchases and APP announcement proxy

(outstanding amounts, EUR billions)

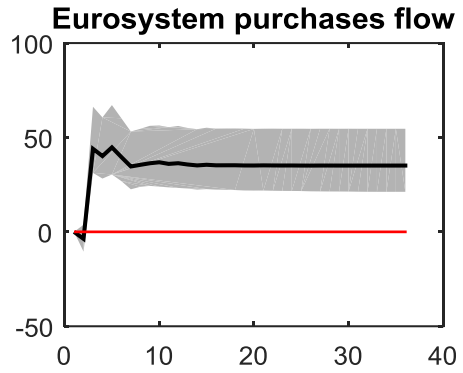


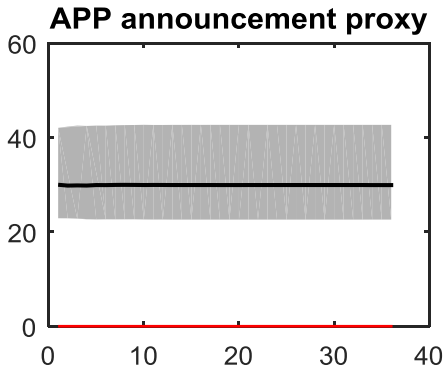
Source: ECB.

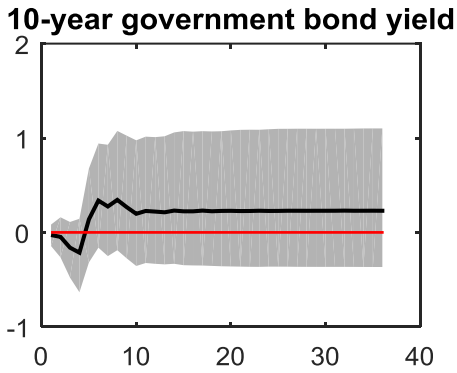
Macroeconomic impact: Impulse Response Functions

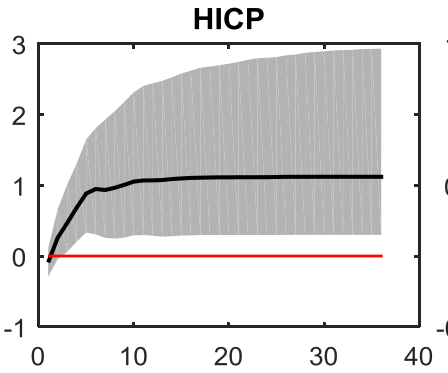
IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock

BASELINE APP PROXY (50%)

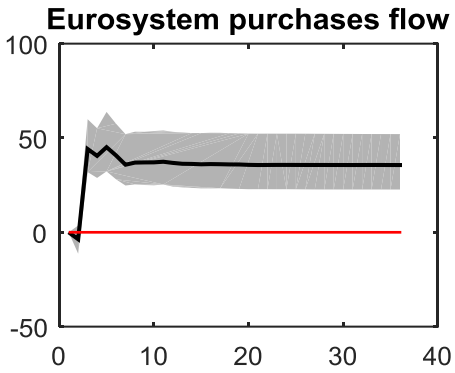


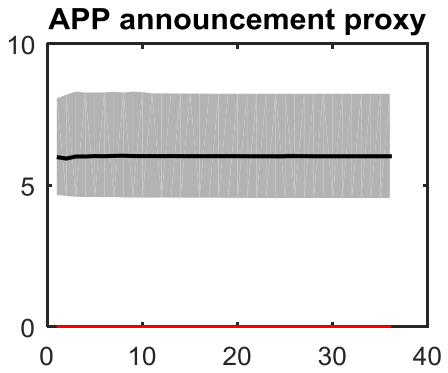


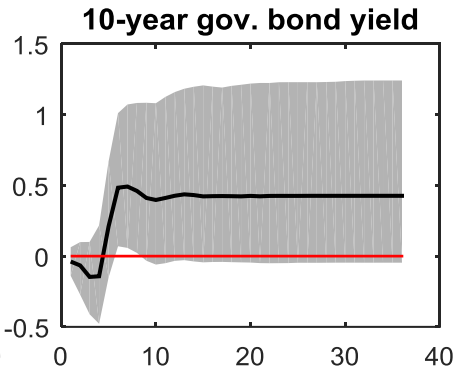


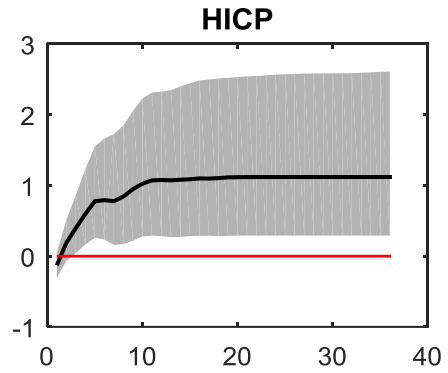


ROBUSTNESS APP PROXY (10%)





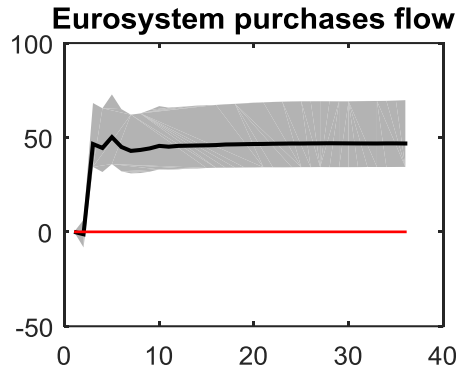


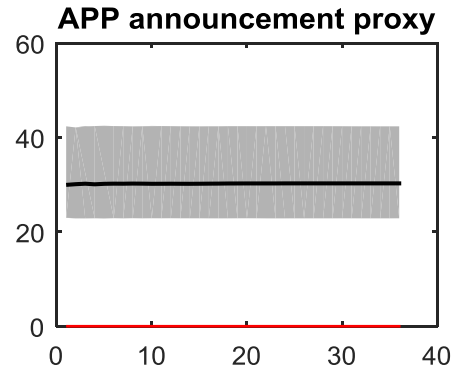


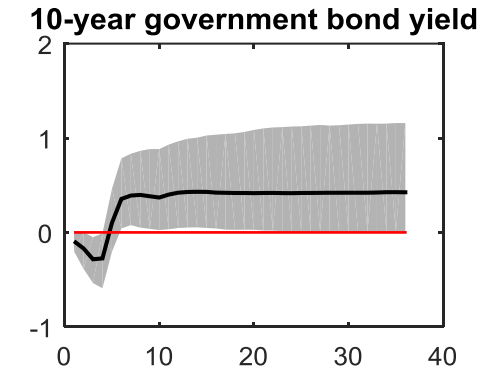
Macroeconomic impact: Impulse Response Functions

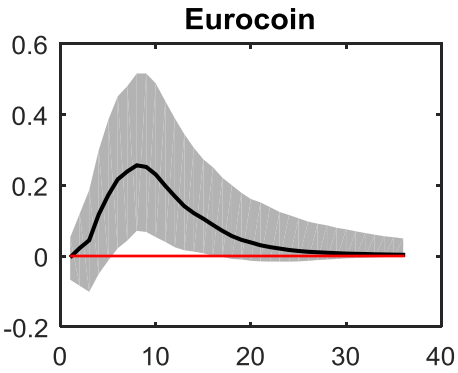
IRFs of variables in levels (cumulated changes) to the January 2015 APP announcement shock

BASELINE APP PROXY (50%)

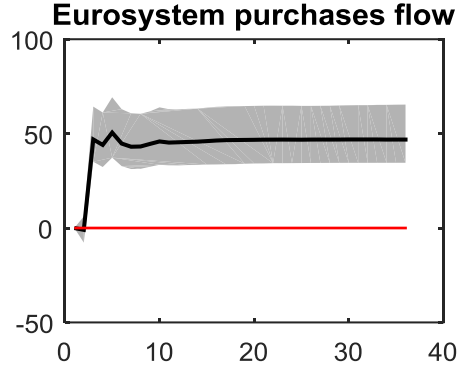


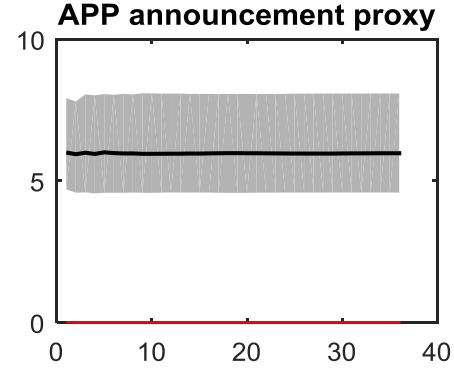


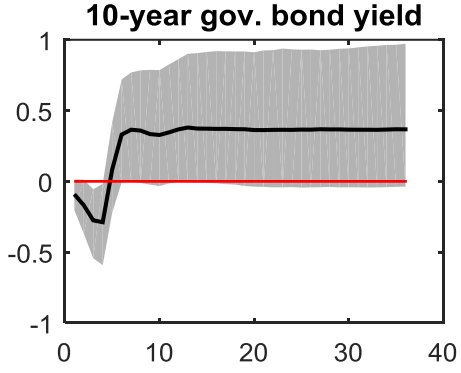


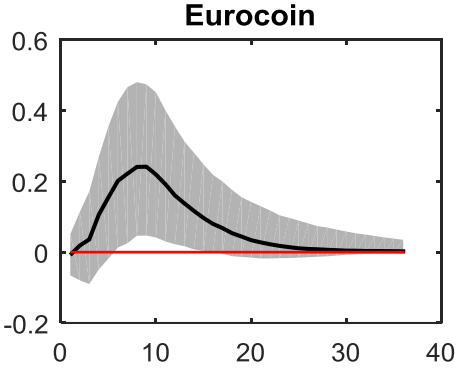


ROBUSTNESS APP PROXY (10%)





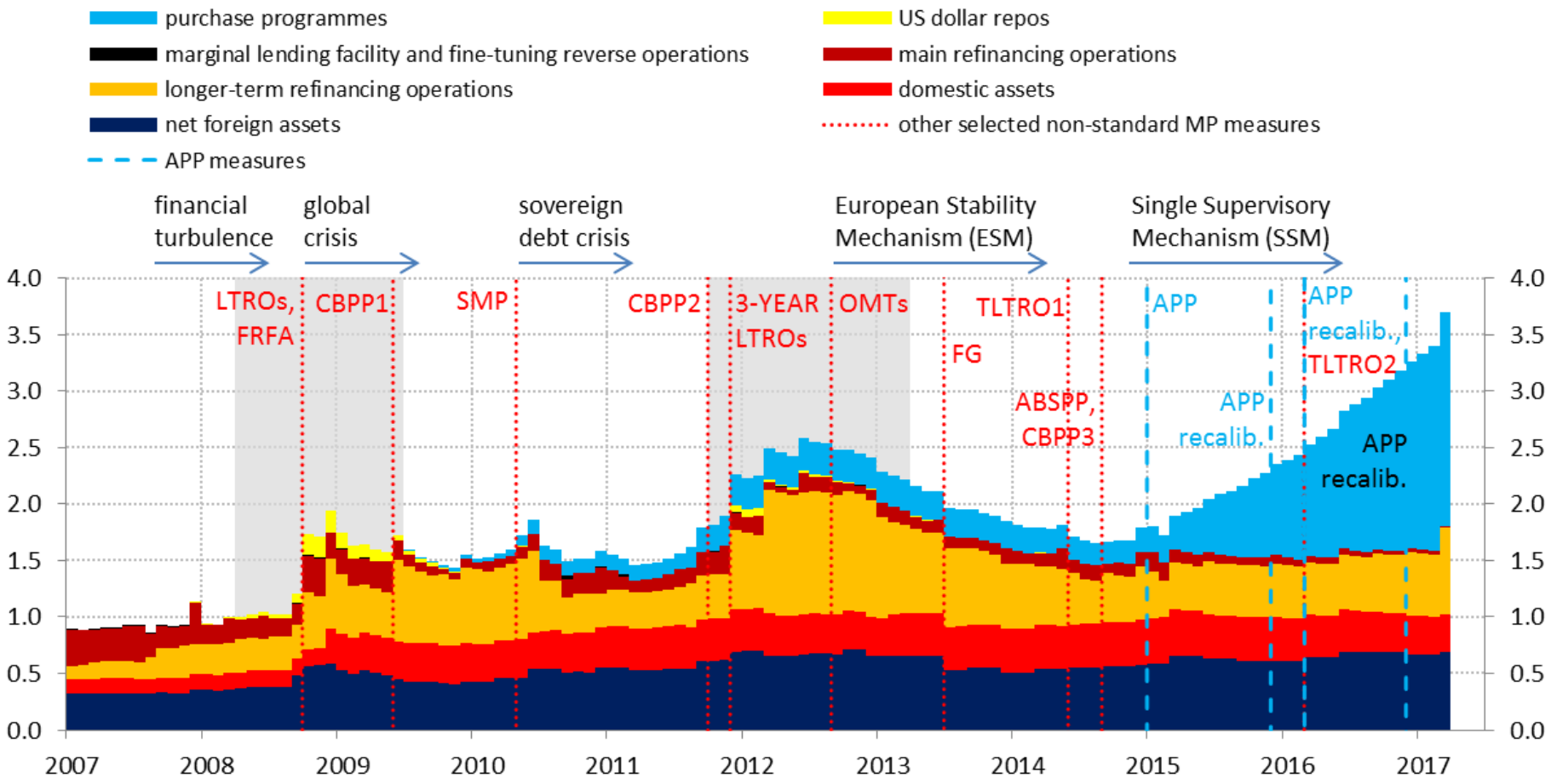




Data: Eurosystem balance sheet

Breakdown of the simplified Eurosystem balance sheet: assets

(outstanding amounts, EUR billions)

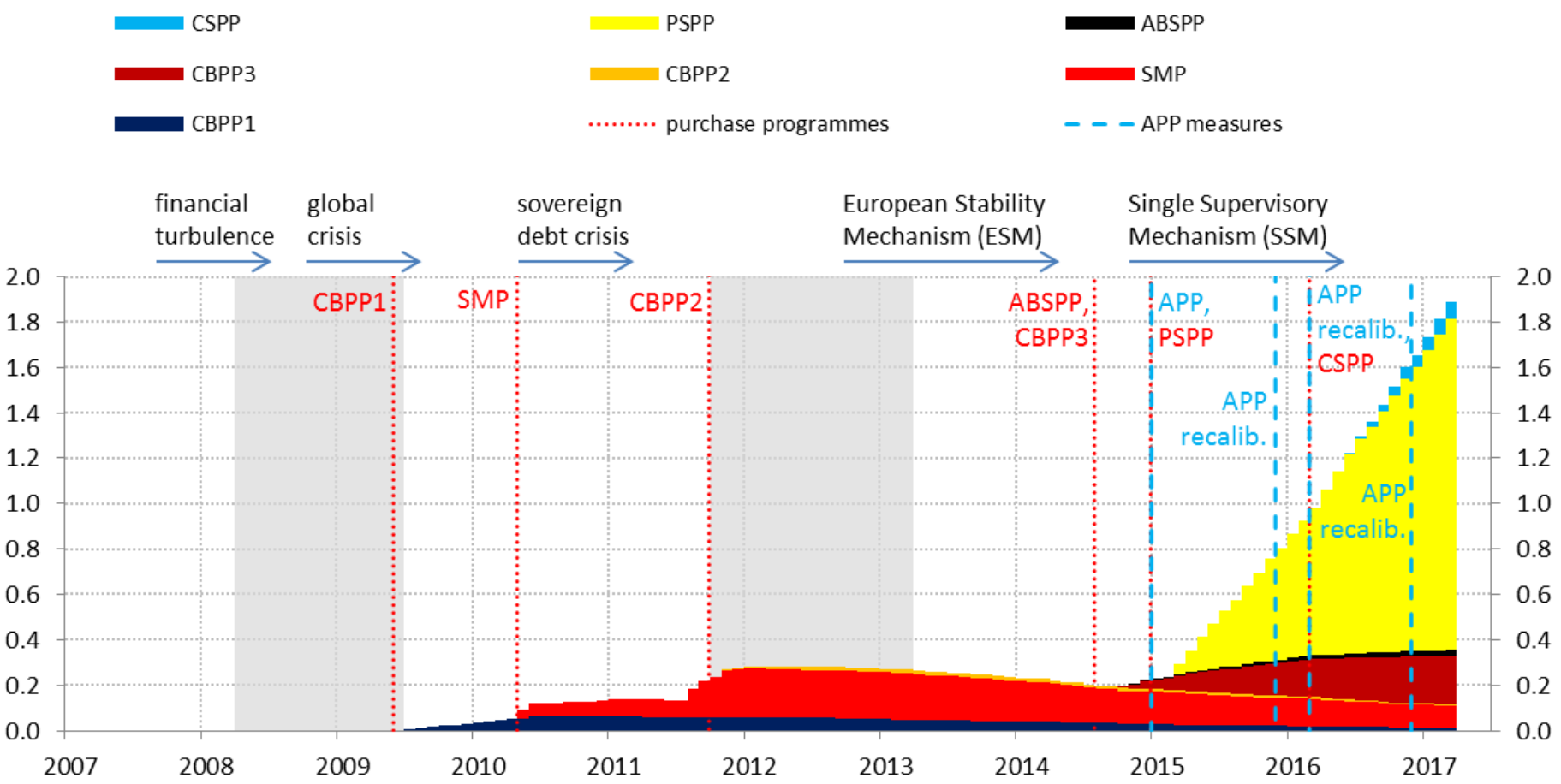


Source: ECB.

Data: Eurosystem securities held for monetary pol. purposes

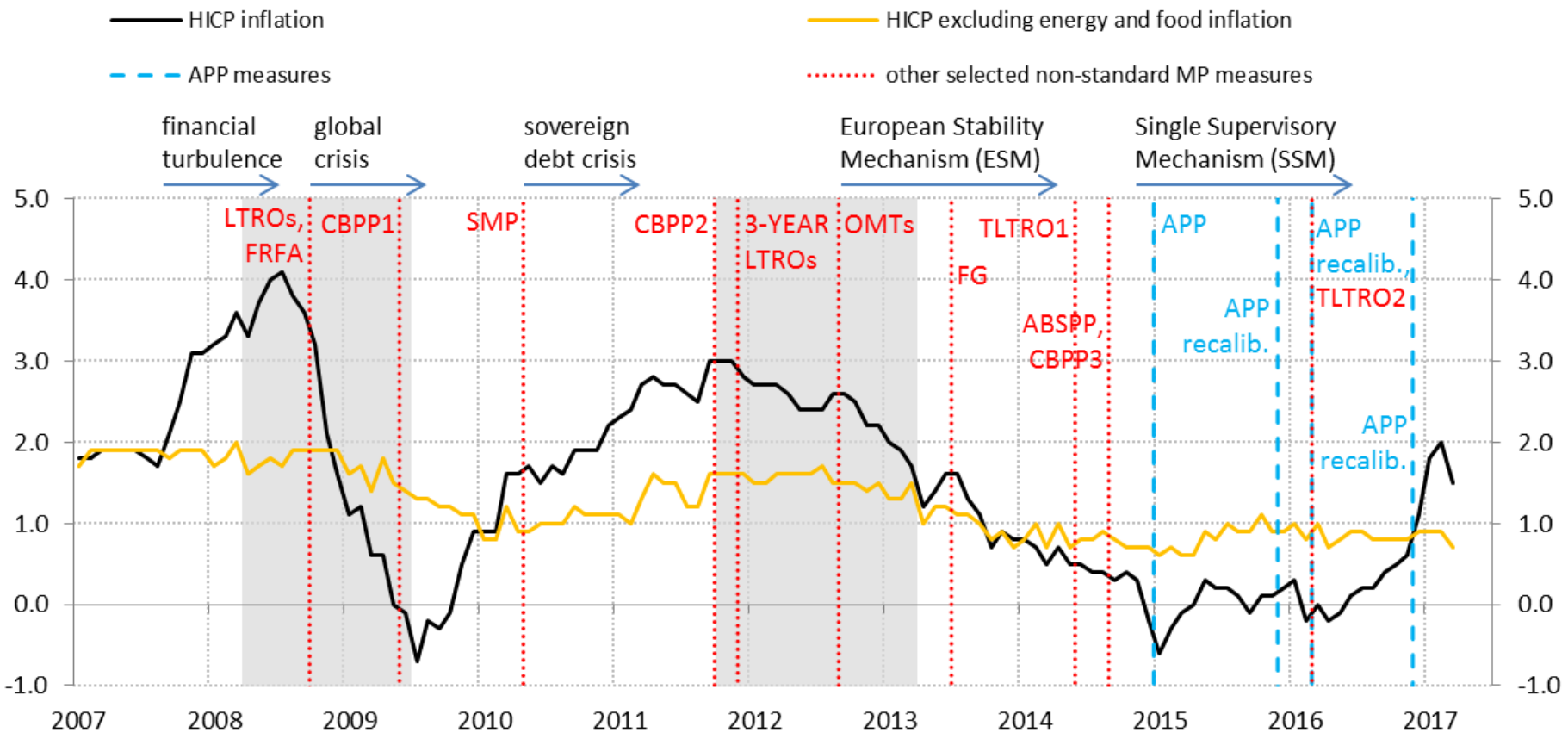
A Breakdown of the Eurosystem purchase programmes

(outstanding amounts, EUR billions)



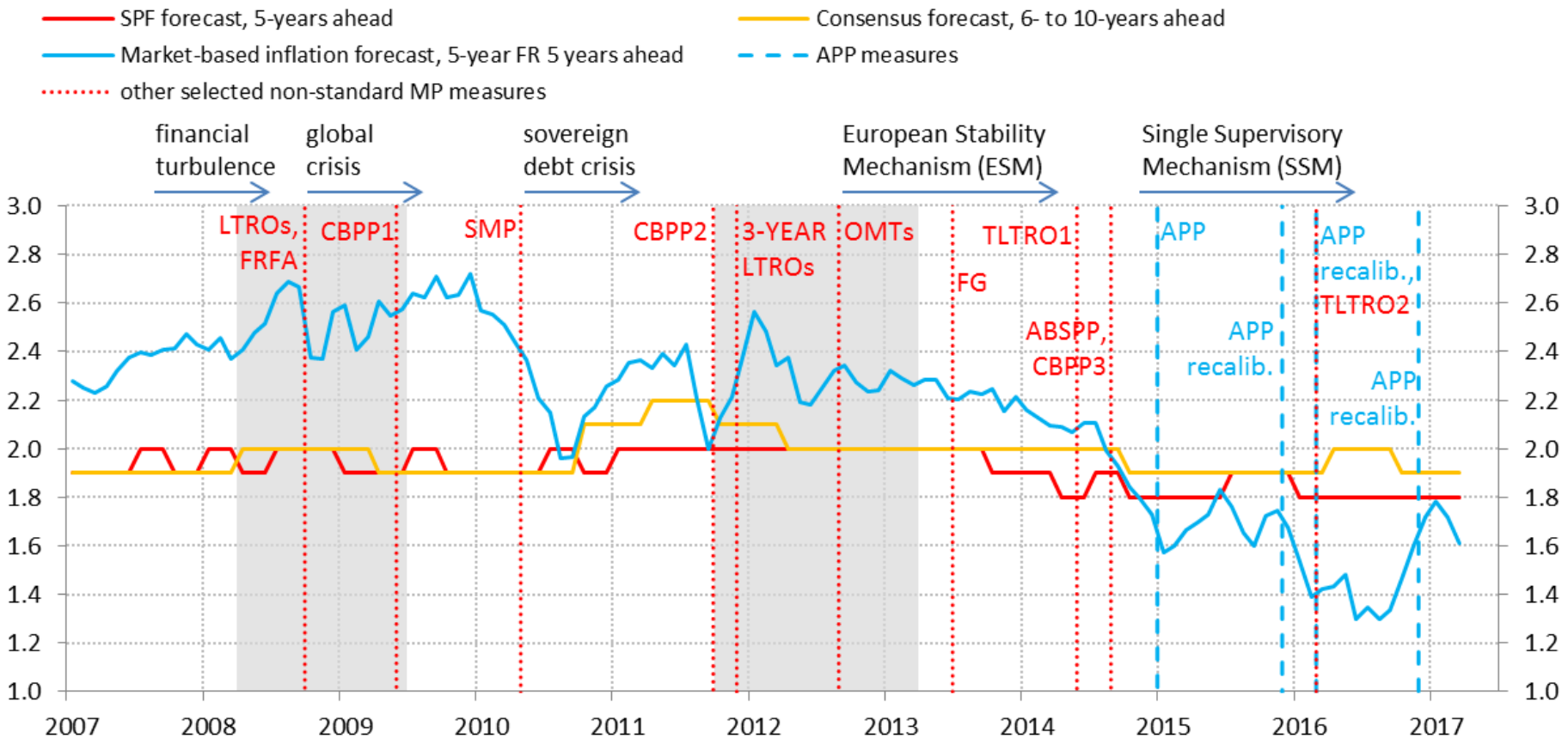
Source: ECB.

Data: Inflation



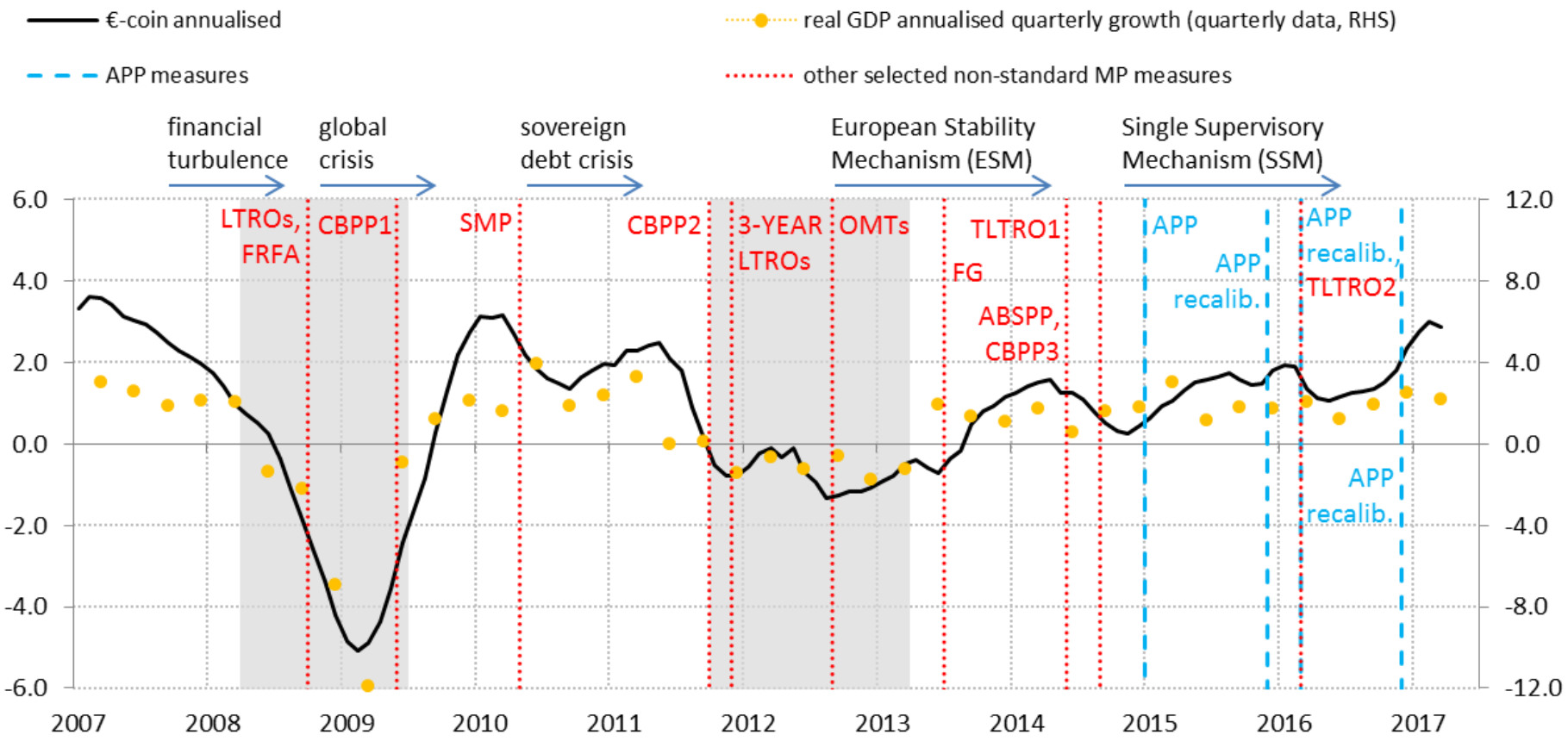
Source: ECB.

Data: Inflation expectations



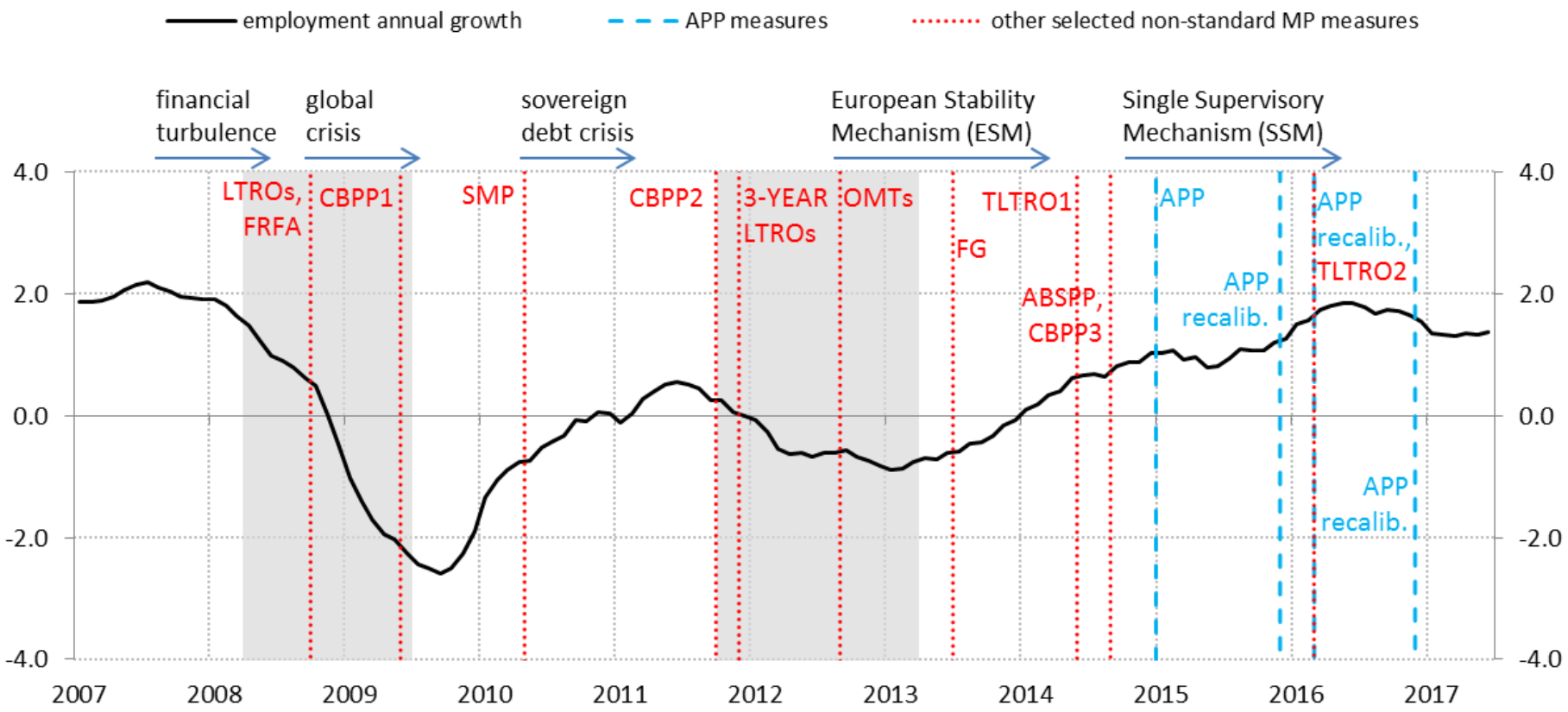
Source: ECB.

Data: Real GDP and Eurocoin



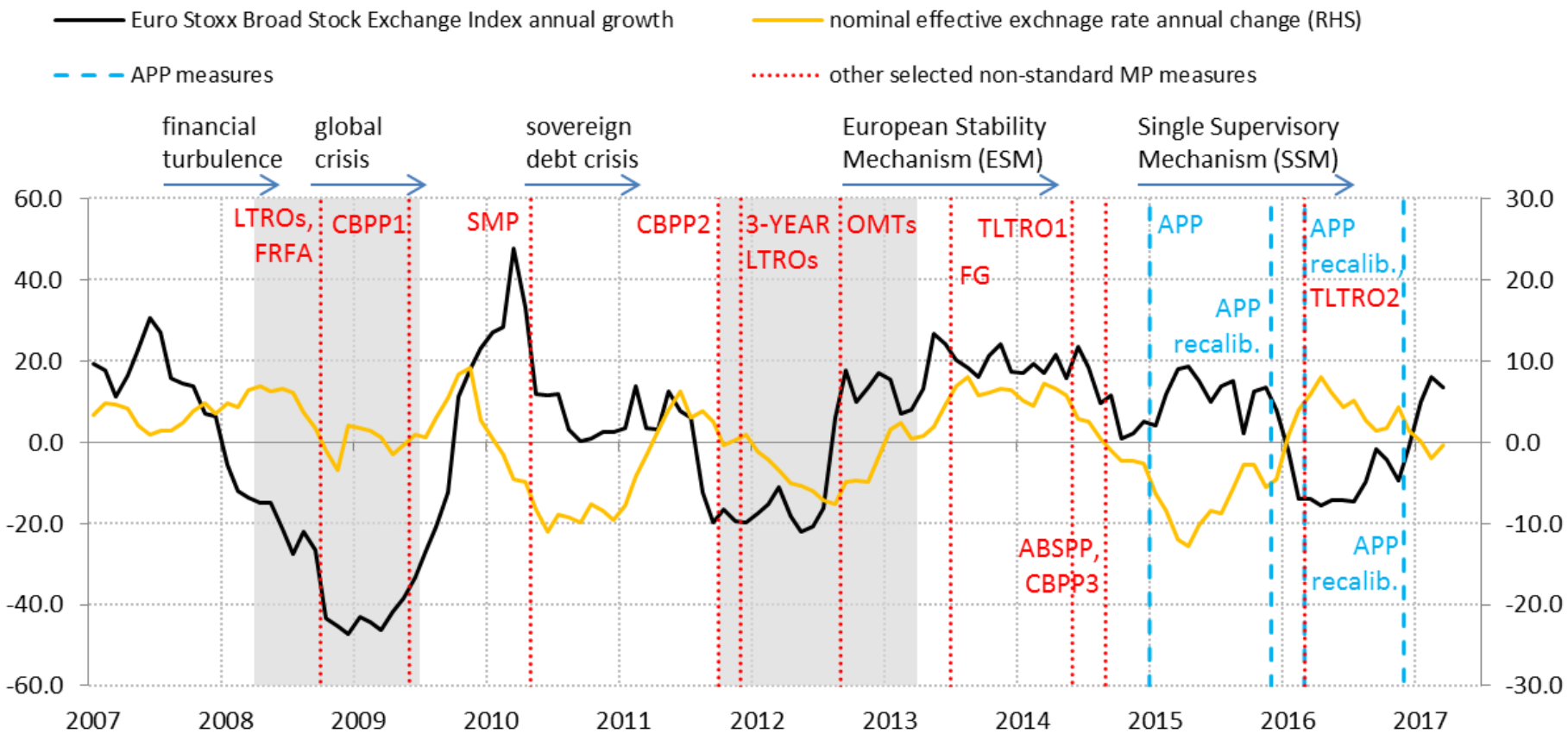
Source: ECB.

Data: Employment



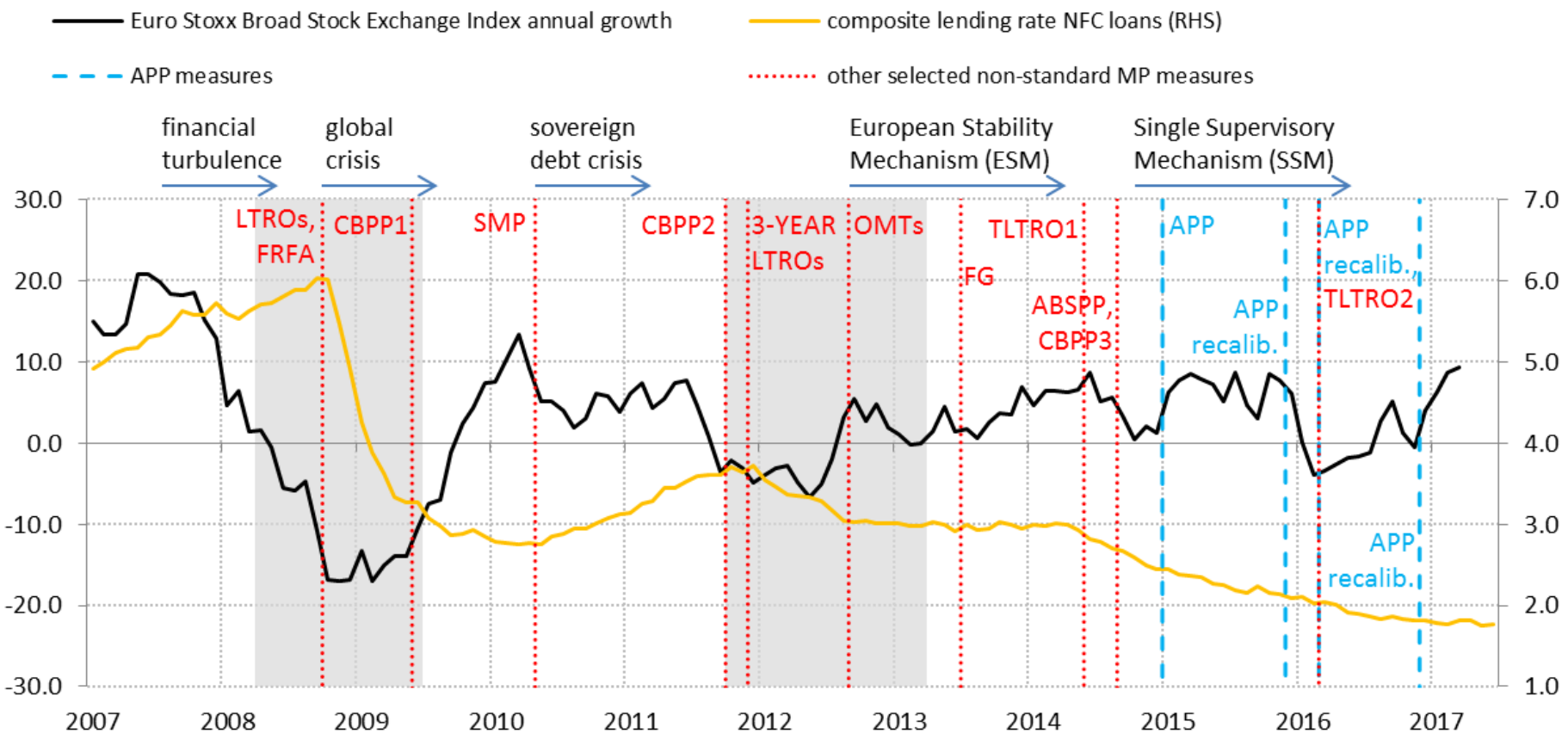
Source: ECB.

Data: Stock prices and exchange rates



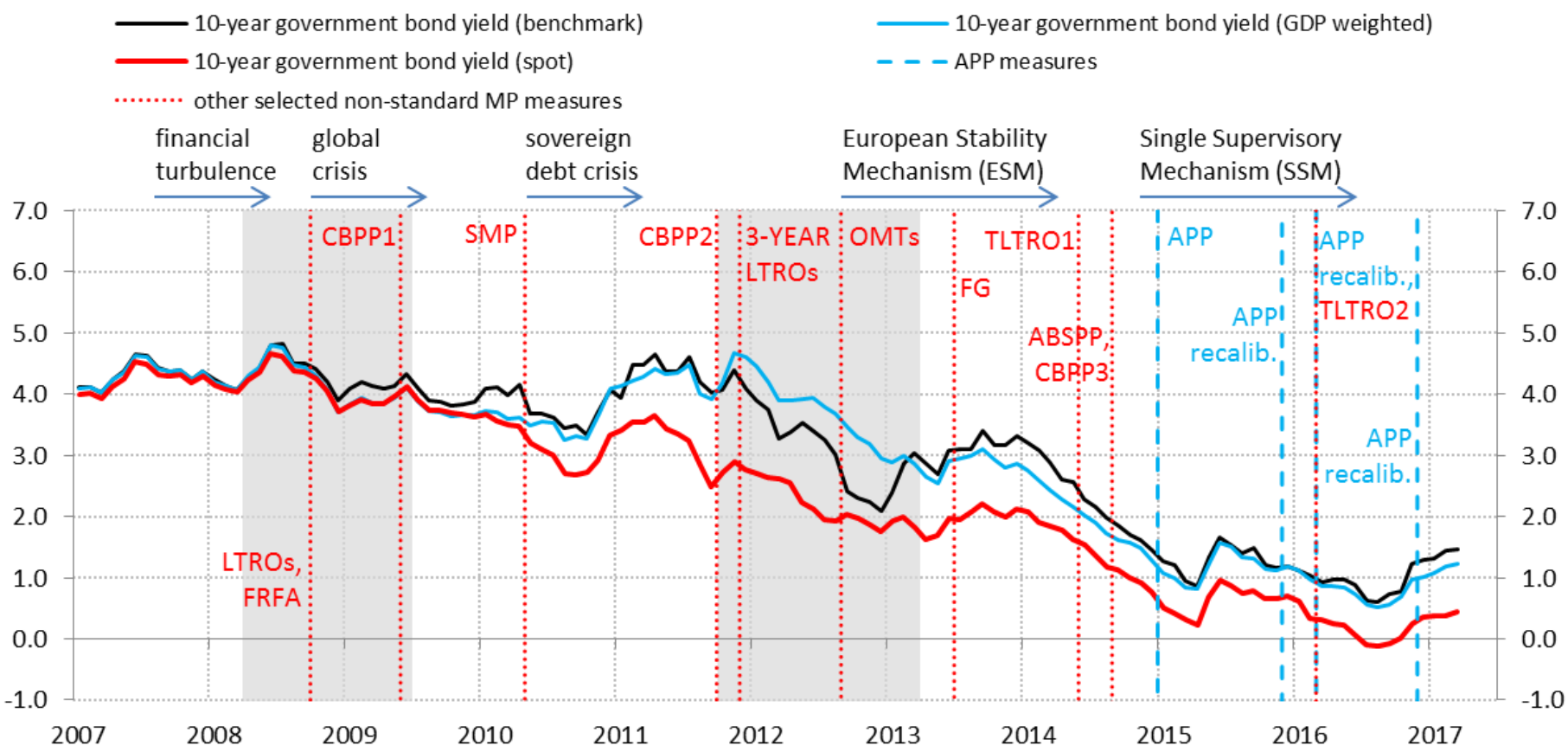
Source: ECB.

Data: NFC credit markets



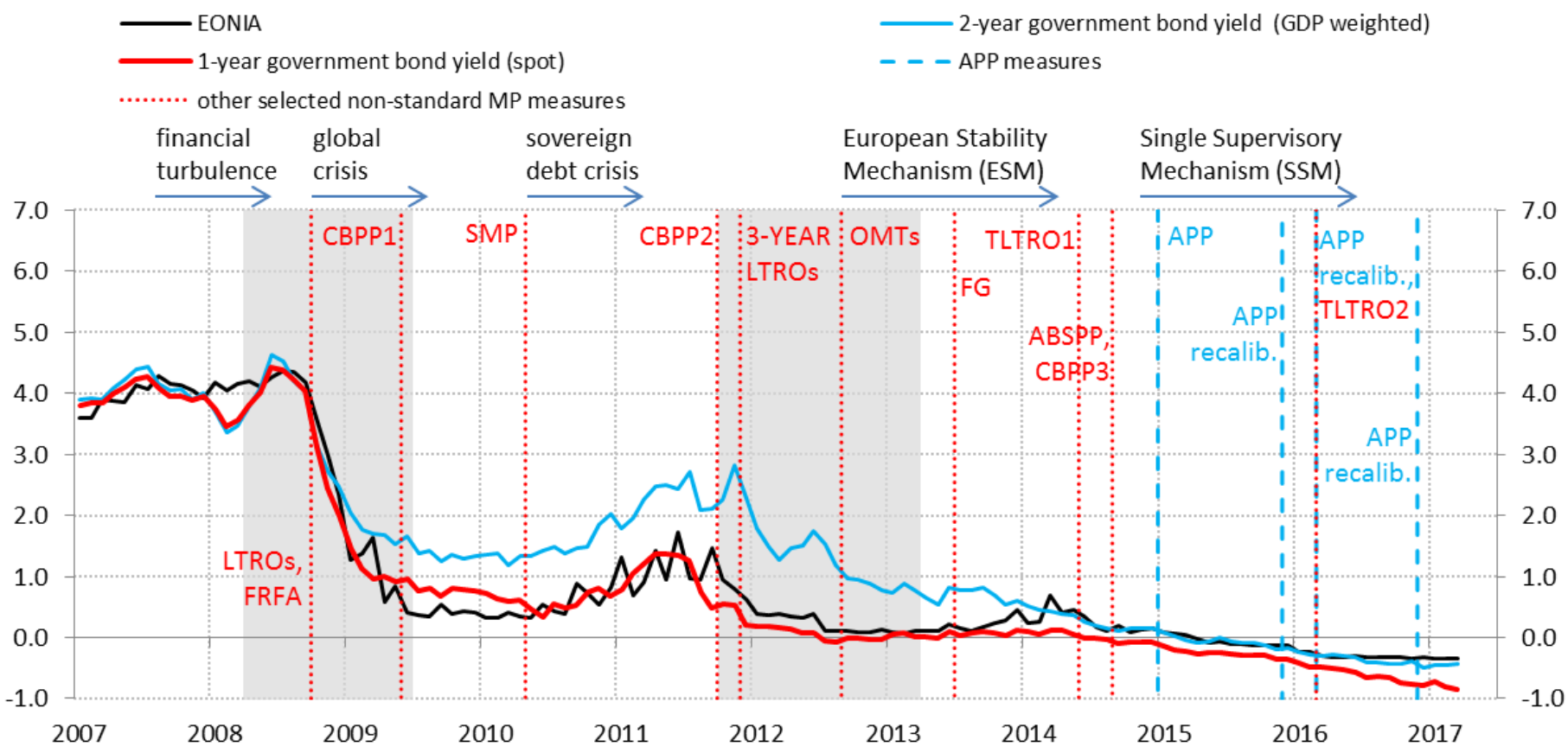
Source: ECB.

Data: Long-term interest rates



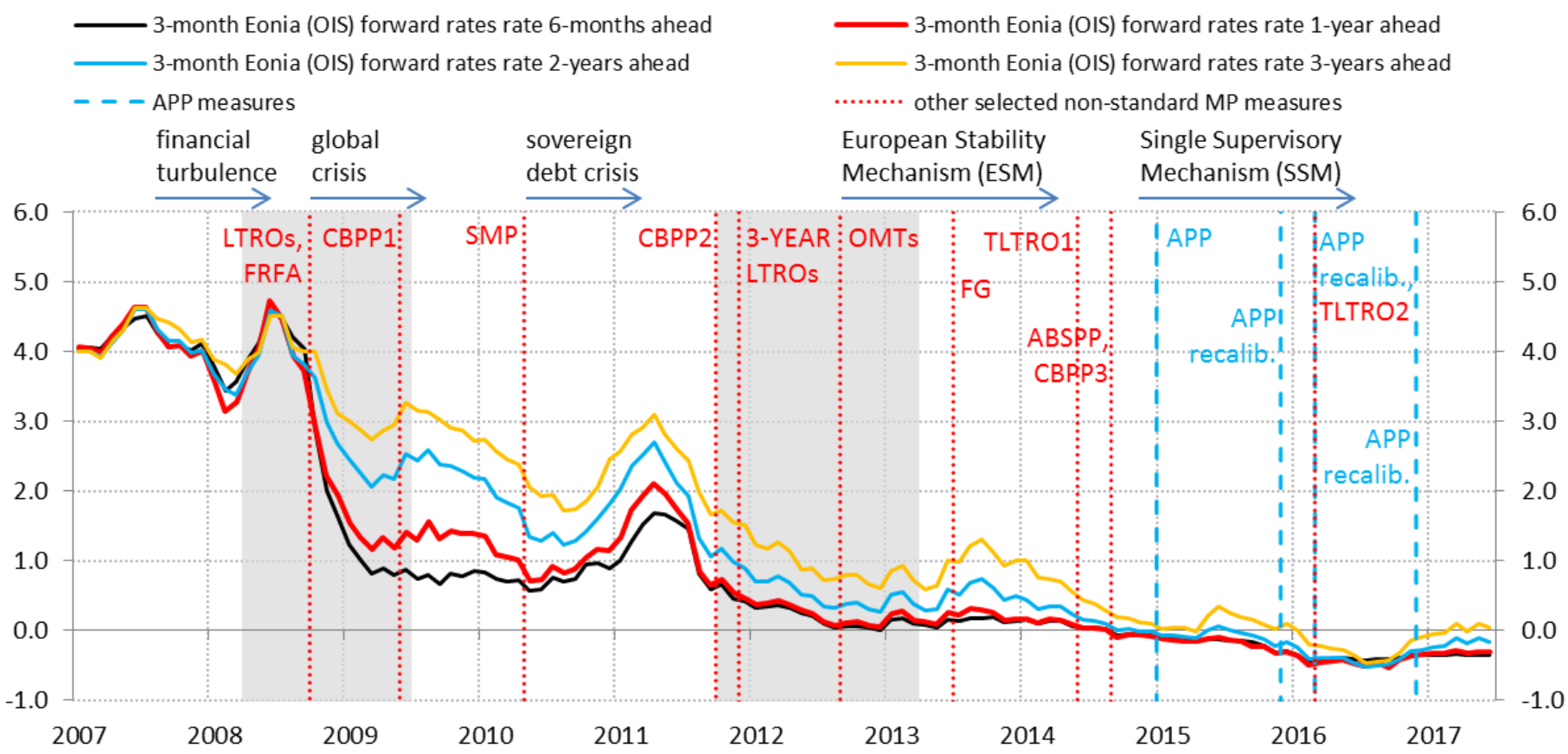
Source: ECB.

Data: Short-term interest rates



Source: ECB.

Data: Short-term forward rates



Source: ECB.