

FUNDING QUANTITATIVE EASING TO TARGET INFLATION

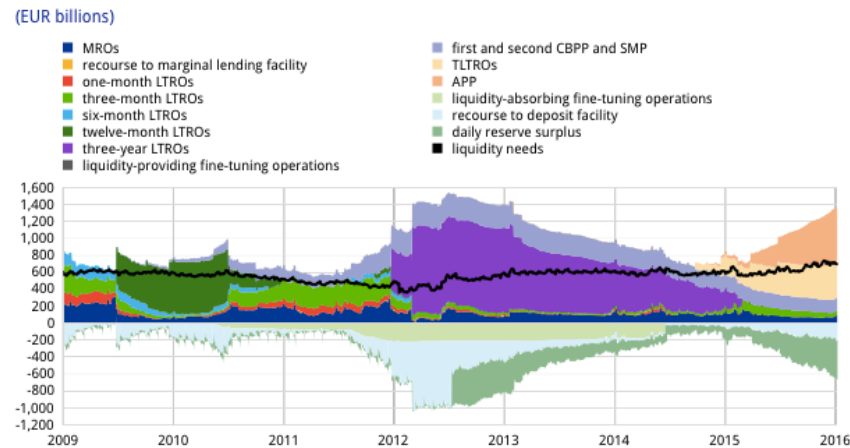
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London School of Economics

National Bank of Belgium
Brussels, 13th of October, 2016

QE IN THE PAST

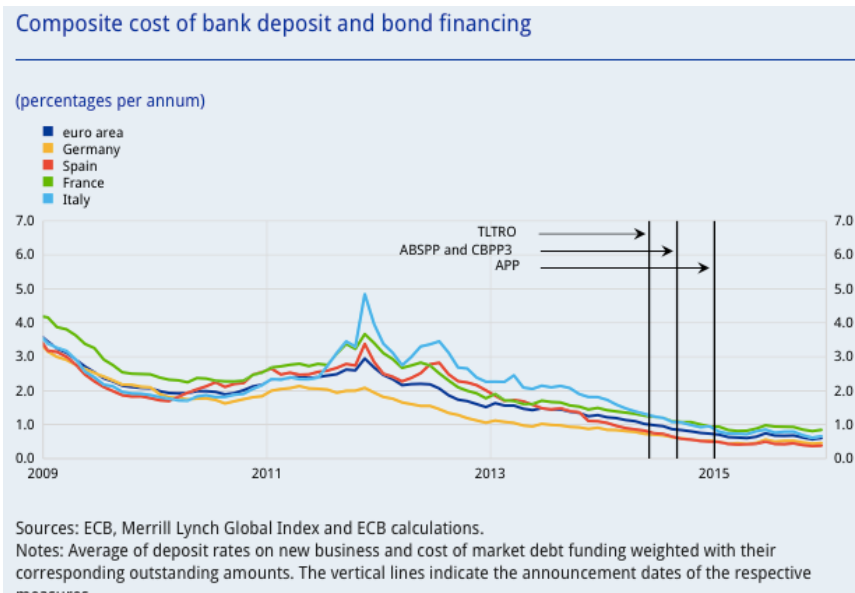
Eurosystem balance sheet

1. Focus on asset side



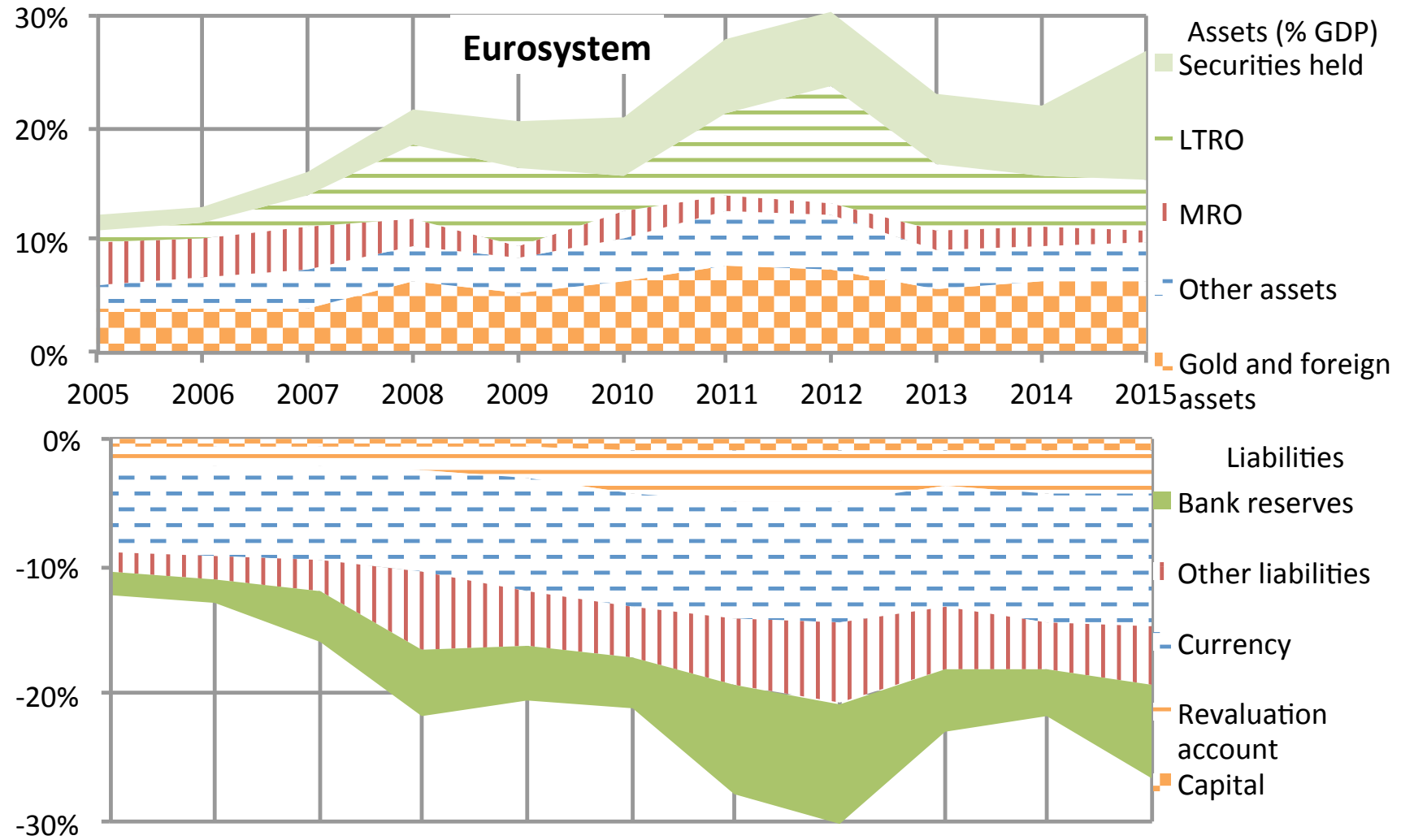
Source: Eurosystem.

2. Focus on financial stability and economic activity

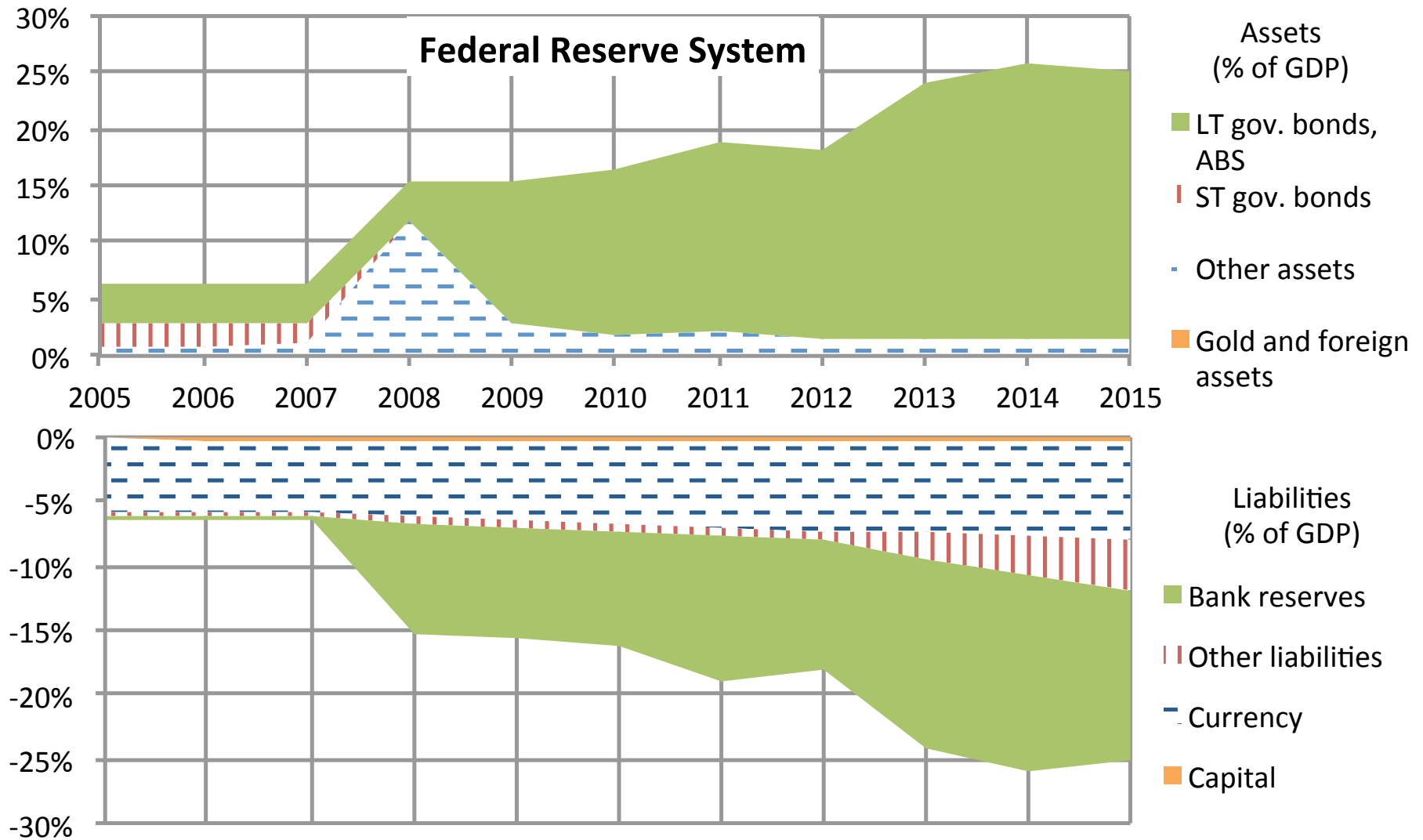


Source: ECB (2016)

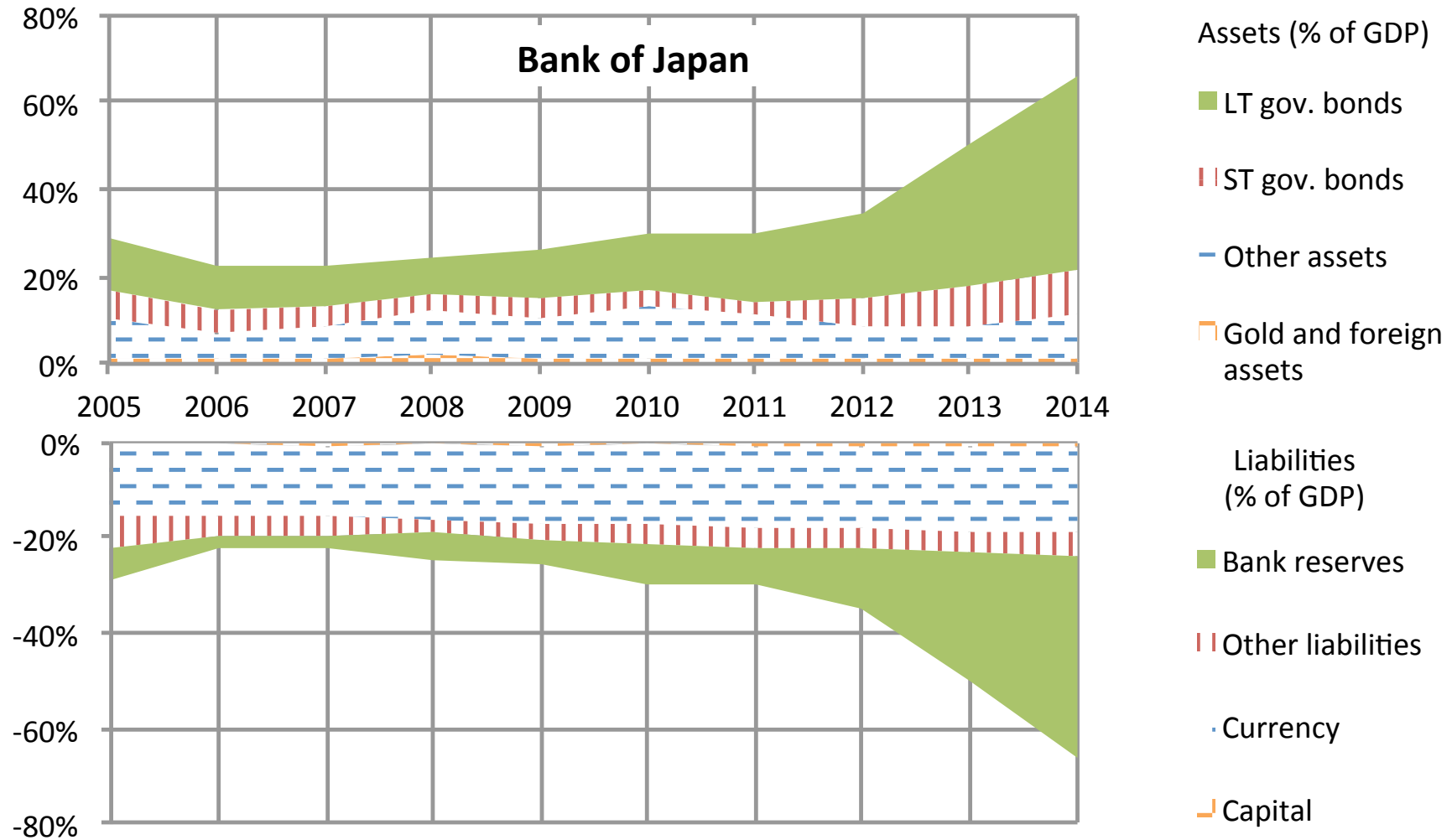
BALANCE SHEET OF CB 2005-15



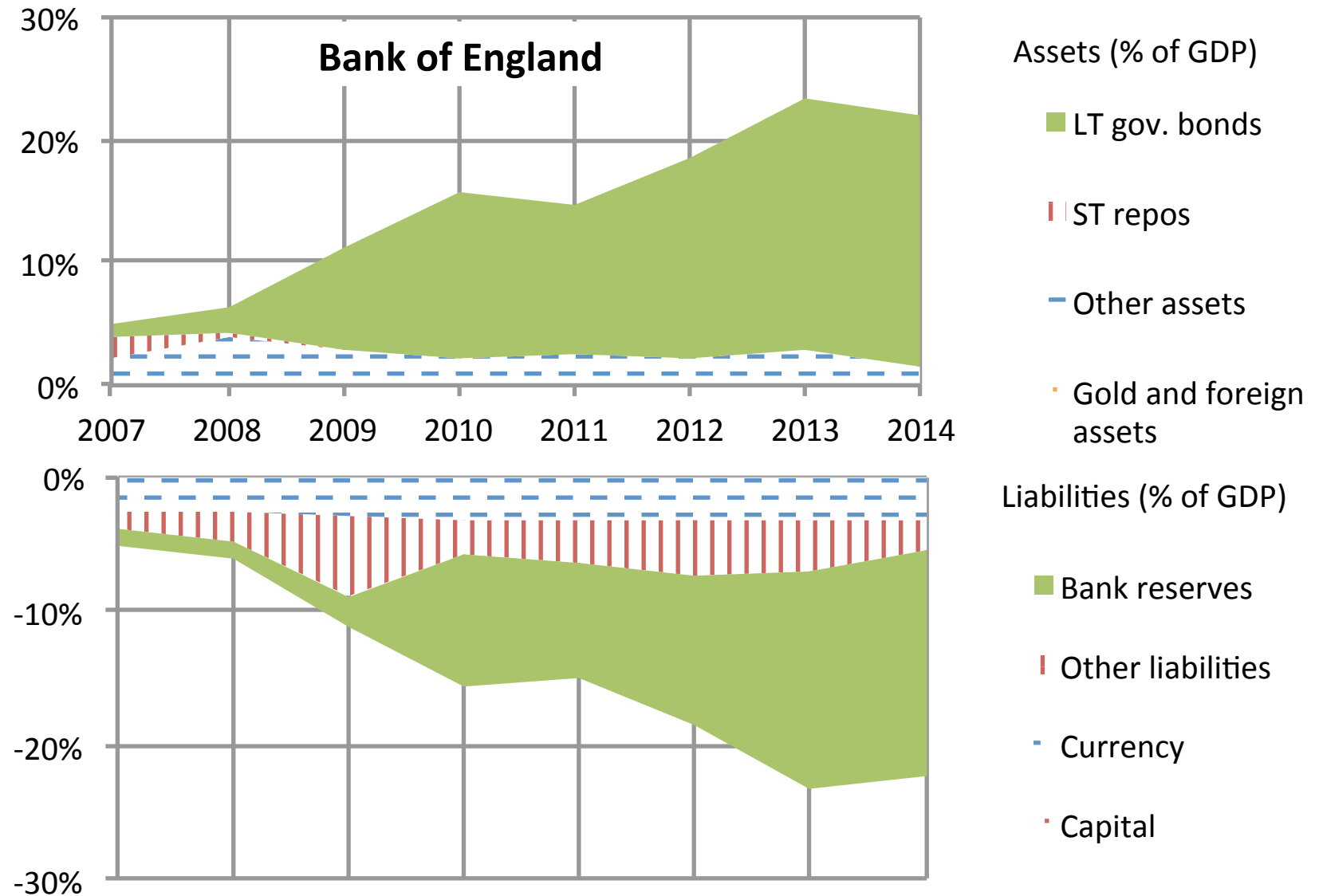
BALANCE SHEET OF CB 2005-15



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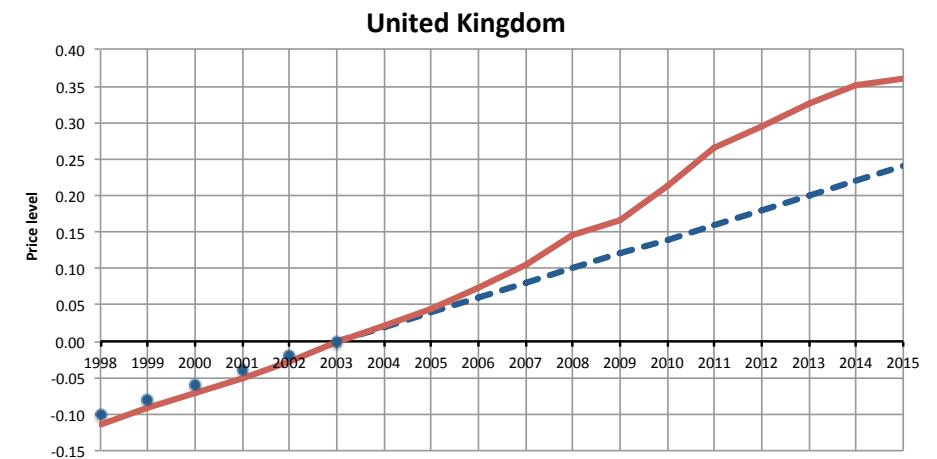
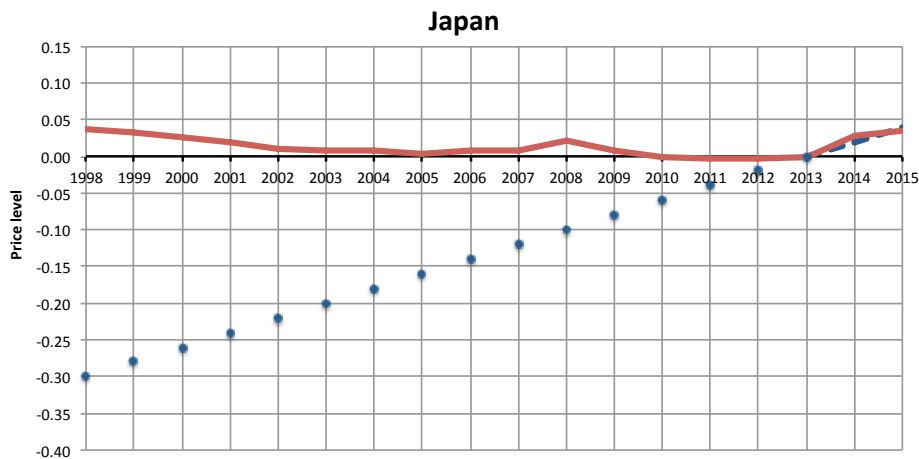
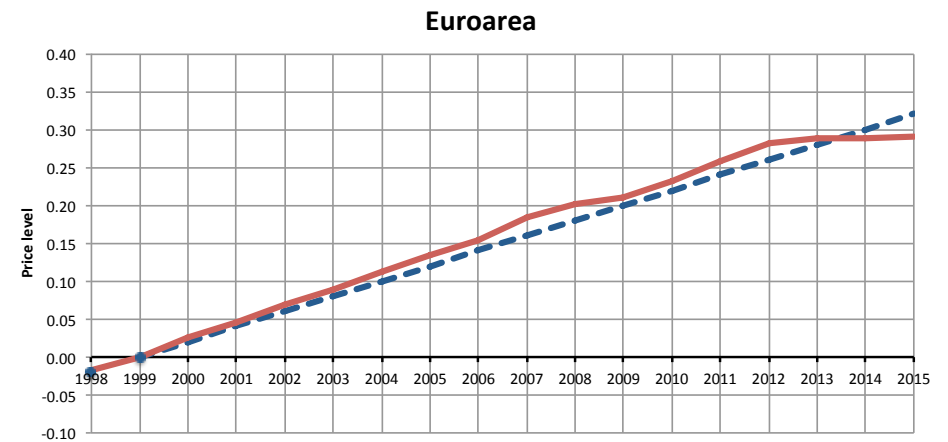
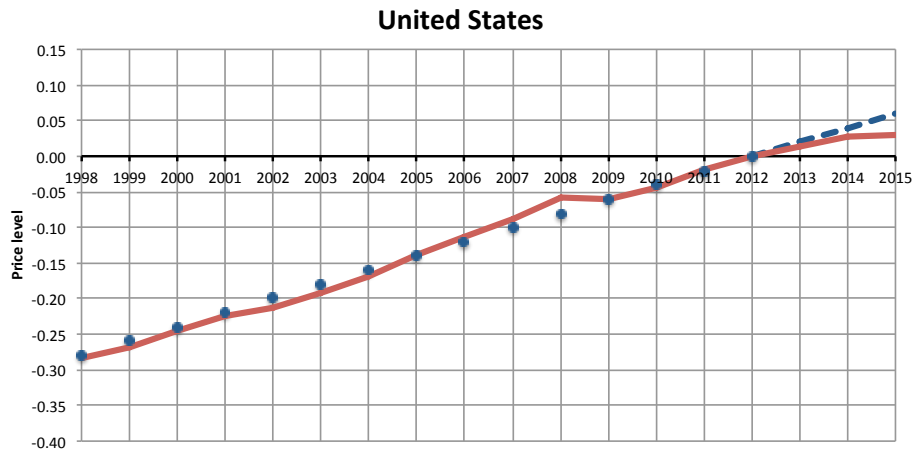
RESERVES

Really: interest-paying, voluntarily-held, deposits by financial institutions at the central bank

Exceptional because:

- historically unprecedented in the United States;
- economically distinct from currency;
- new government asset in banks' portfolio, twice larger weight than Treasuries (2015);
- one of the largest traded securities outstanding with common issuer and maturity;
- monetary policy chooses volume and remuneration

TARGET AND ACTUAL P : 1998-2015



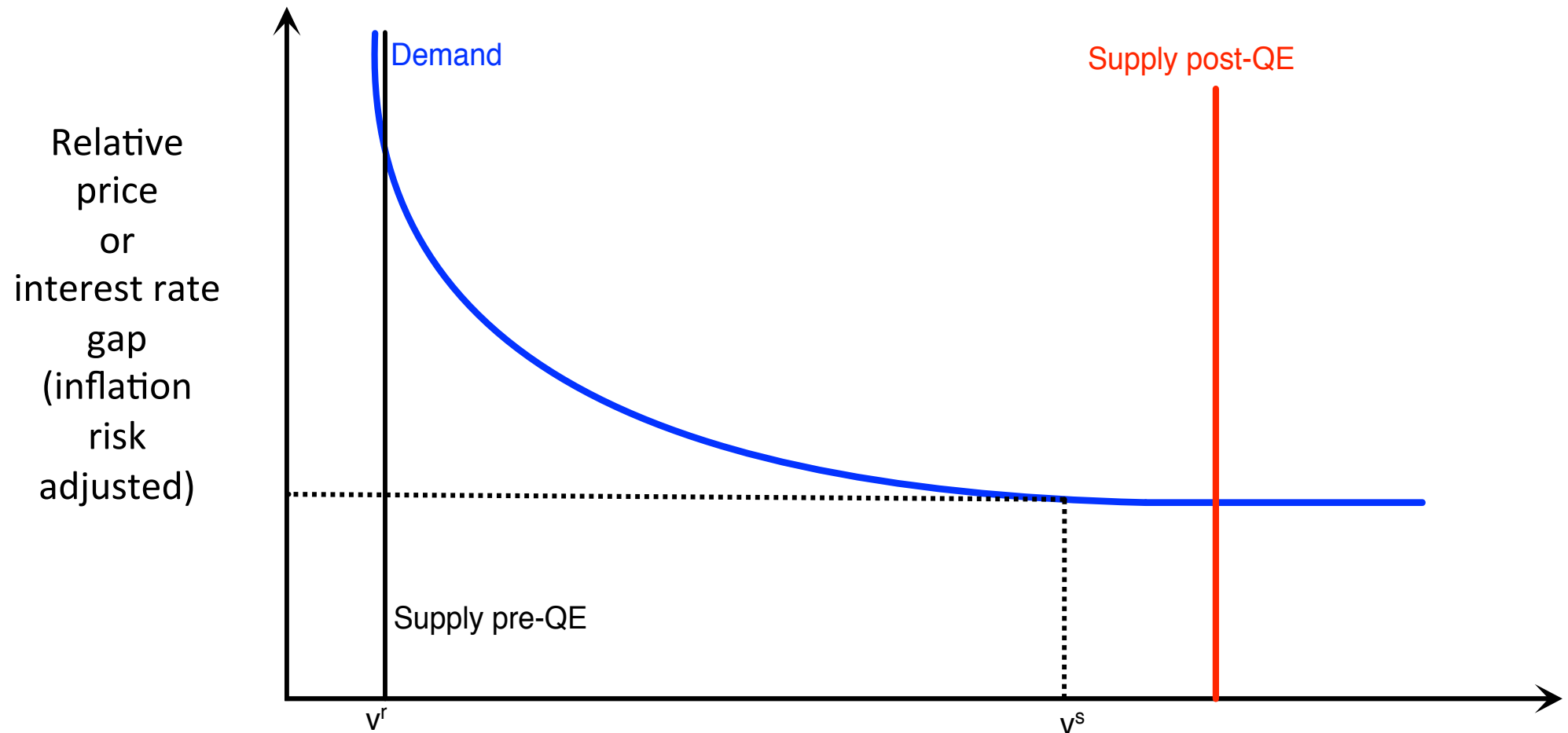
Notes: For all countries, the target price level is in the dashed blue line from the date of the announcement of the target forward, circles extend it backwards for an hypothetical target, and the actual price level is in the solid red line, with both normalized to equal to zero at the date of adoption of the target. For the United States, the inflation target was adopted in January of 2012 using the personal consumption expenditures deflator as the reference measure. For the Euro area, the target was adopted in January of 1999 for the harmonized consumer price index. For Japan, the target for the consumer price index was adopted in January of 2013. For the Bank of England, the target for the consumer price index target was adopted in December of 2003 (replacing an old target for the retail price index of 2.5%). The target for all four is a 2% annual growth in the price level. The vertical axis is in a log scale, and the range is the same for all four regions to ease comparisons.

I. The market for reserves is saturated



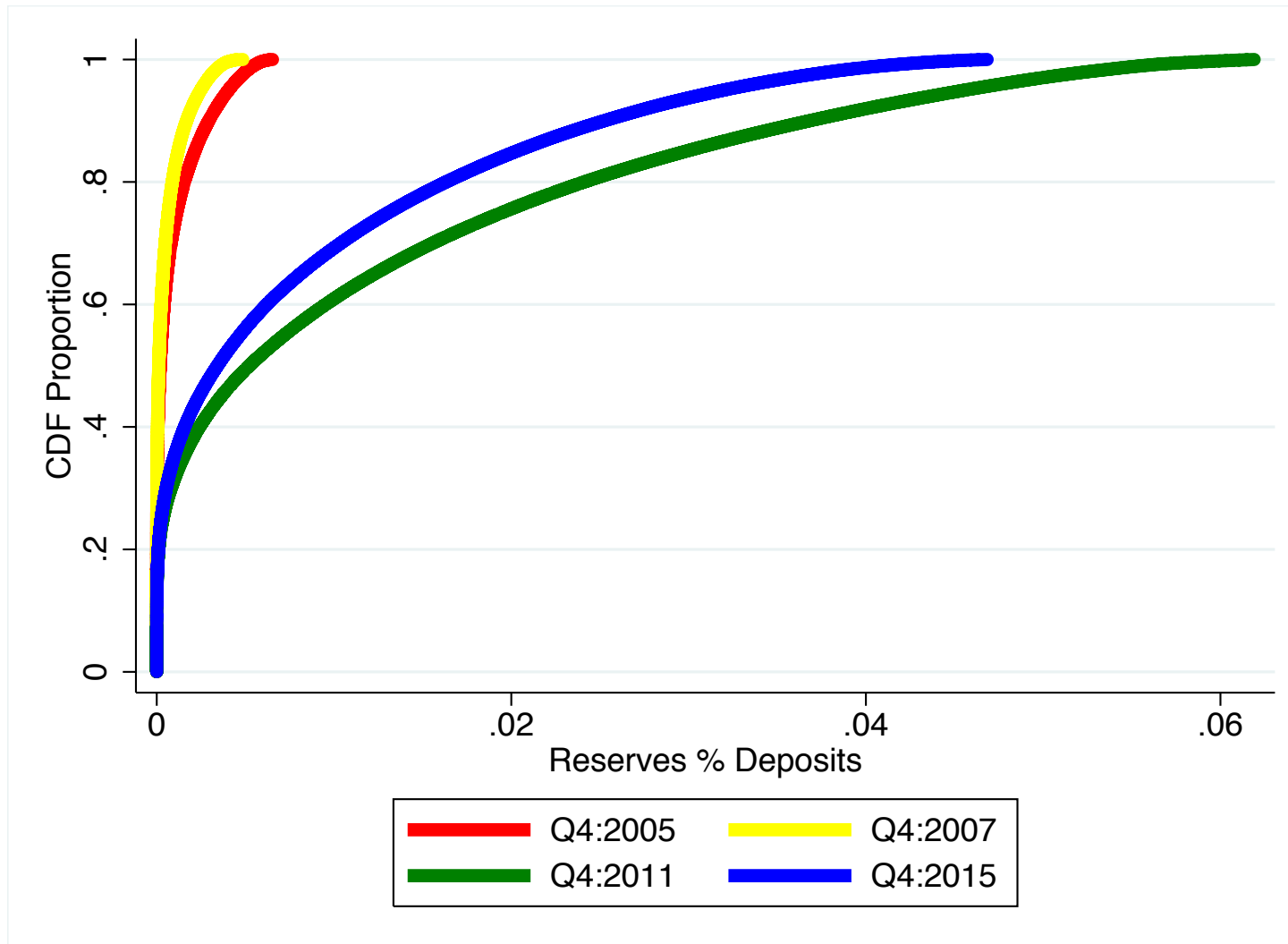
THE MARKET FOR RESERVES

Figure 3. Equilibrium in the market for reserves



EVIDENCE I: US HOLDINGS

Figure 5. Distribution functions of reserves/deposits across banks



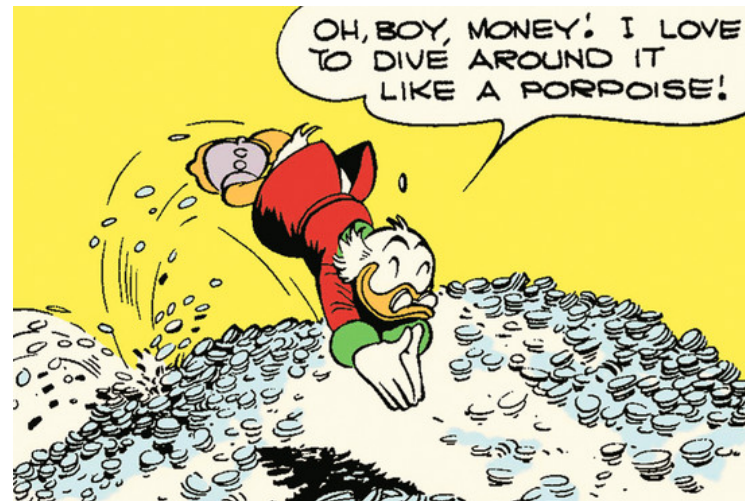
EVIDENCE 2: U.S. RATES

Variables	(1) Reserves	(2) Reserves	(3) Reserves	(4) Reserves	(5) Reserves	(6) Reserves
$i_{\text{Reserves}} - i_{\text{FederalFunds}}$	-0.174 (0.112)		-0.119 (0.112)		-0.199 (0.127)	-0.467** (0.185)
$i_{\text{Reserves}} - i_{\text{Tbill}}$		0.0140 (0.156)		0.187 (0.162)	0.0878 (0.171)	0.352 (0.219)
Obs	53	53	53	53	53	88
Trend	No	No	Yes	Yes	No	No
F Test	2.40	0.01	1.93	2.40	1.40	3.49**
Adj. R sq.	0.022	0.019	0.033	0.043	0.010	0.087

Notes: The left-hand side in all regressions is the difference in log real reserves. In columns 1 to 5, the sample goes from December 2011 to June 2016; in column 6 it starts in December 2008. A time trend is included in columns 3 to 6. Robust standard errors in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

2. Interest rates and QE are separate policy instruments

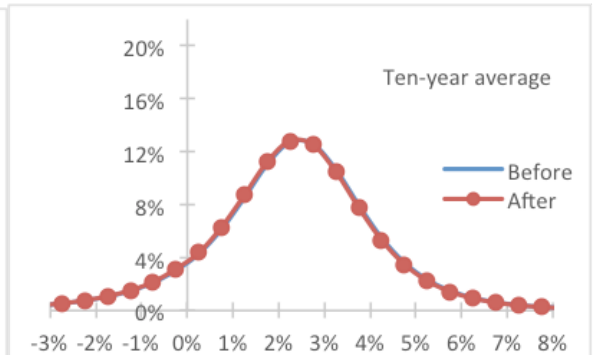
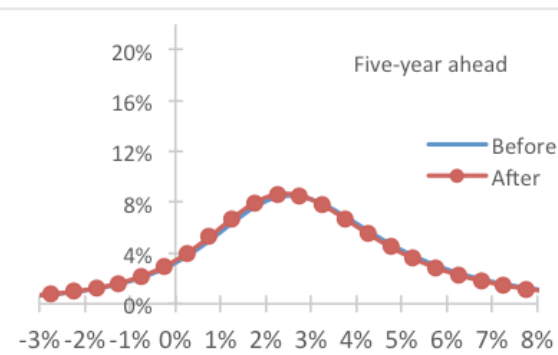
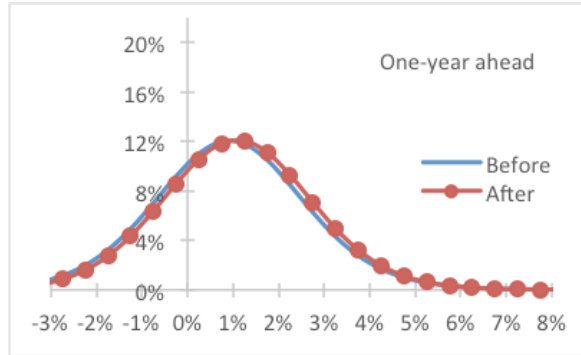


IN A SATURATED MARKET

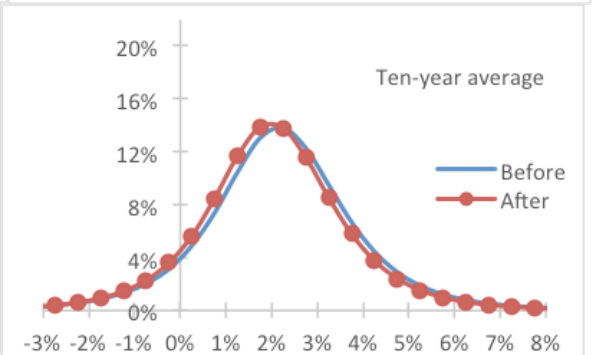
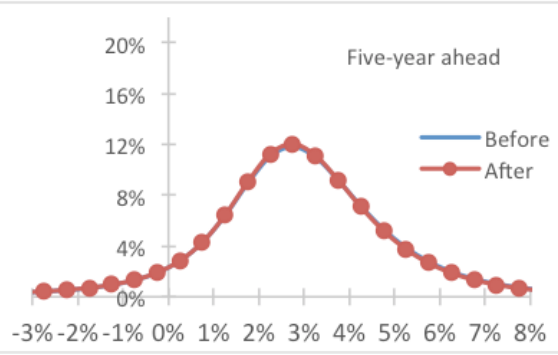
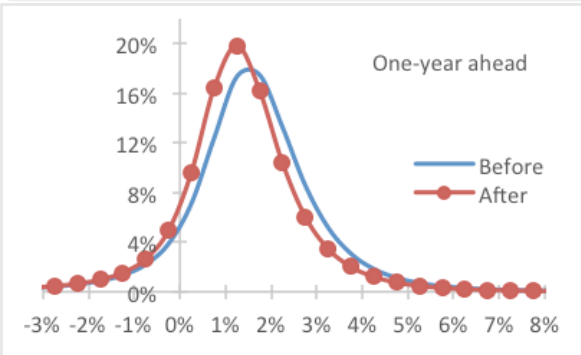
- The **interest on reserves** controls inflation, since risk-adjusted expected real return is pinned down. Interest on reserves replaces previous open-market operations of targets for the federal funds rate.
- The **quantity of reserves** has no effect on inflation. Further QE, whether it purchases government bonds or mortgage-backed securities, whether it extends or contracts maturities, whether markets misinterpret tapering or not, should have approximately no effect on inflation expectations.

EVIDENCE: U.S. INFLATION OPTIONS

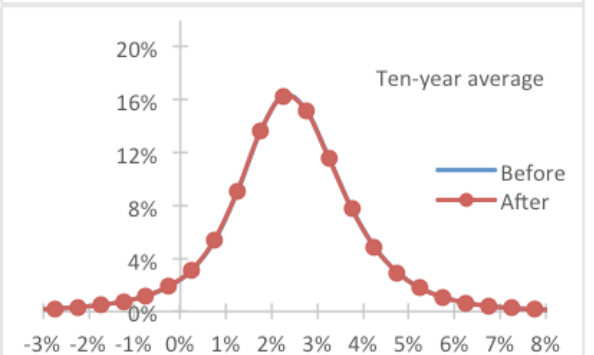
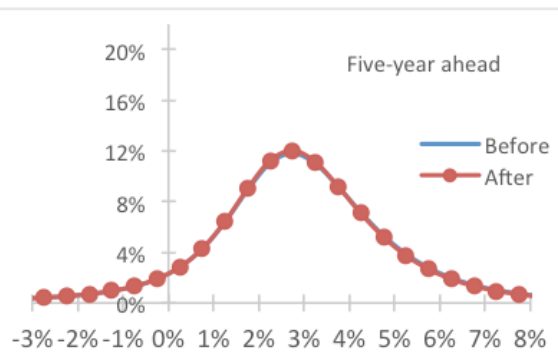
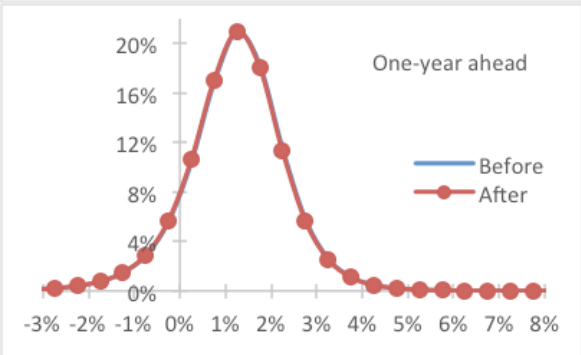
QE2
(3-Nov-10)



QE3
(21-Sep-11)

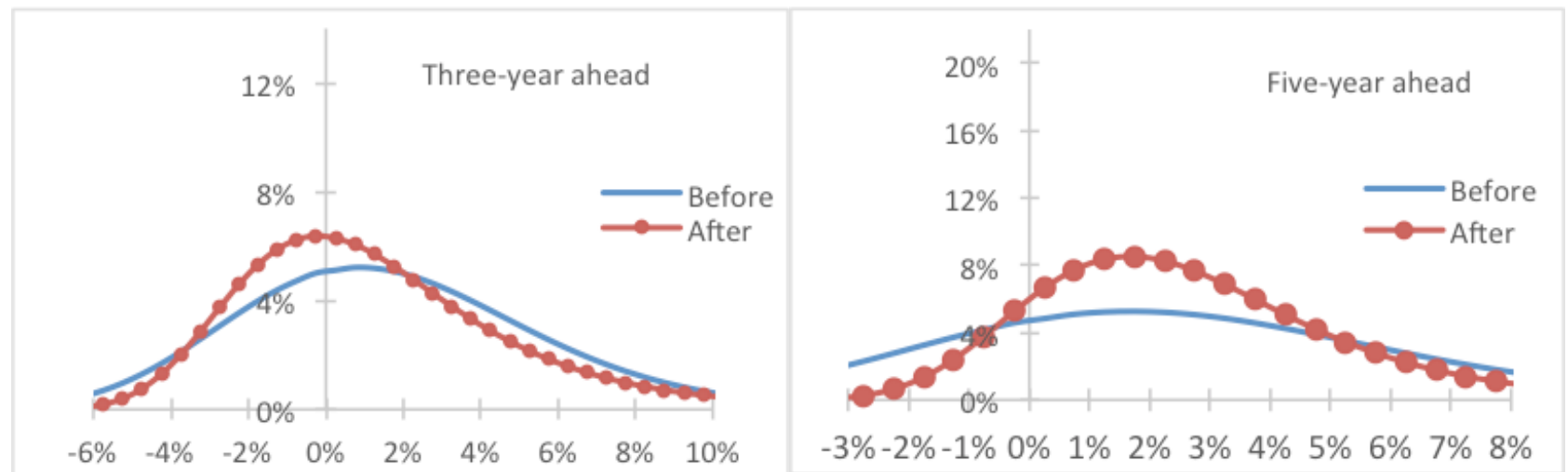


QE4
(22-May-13)



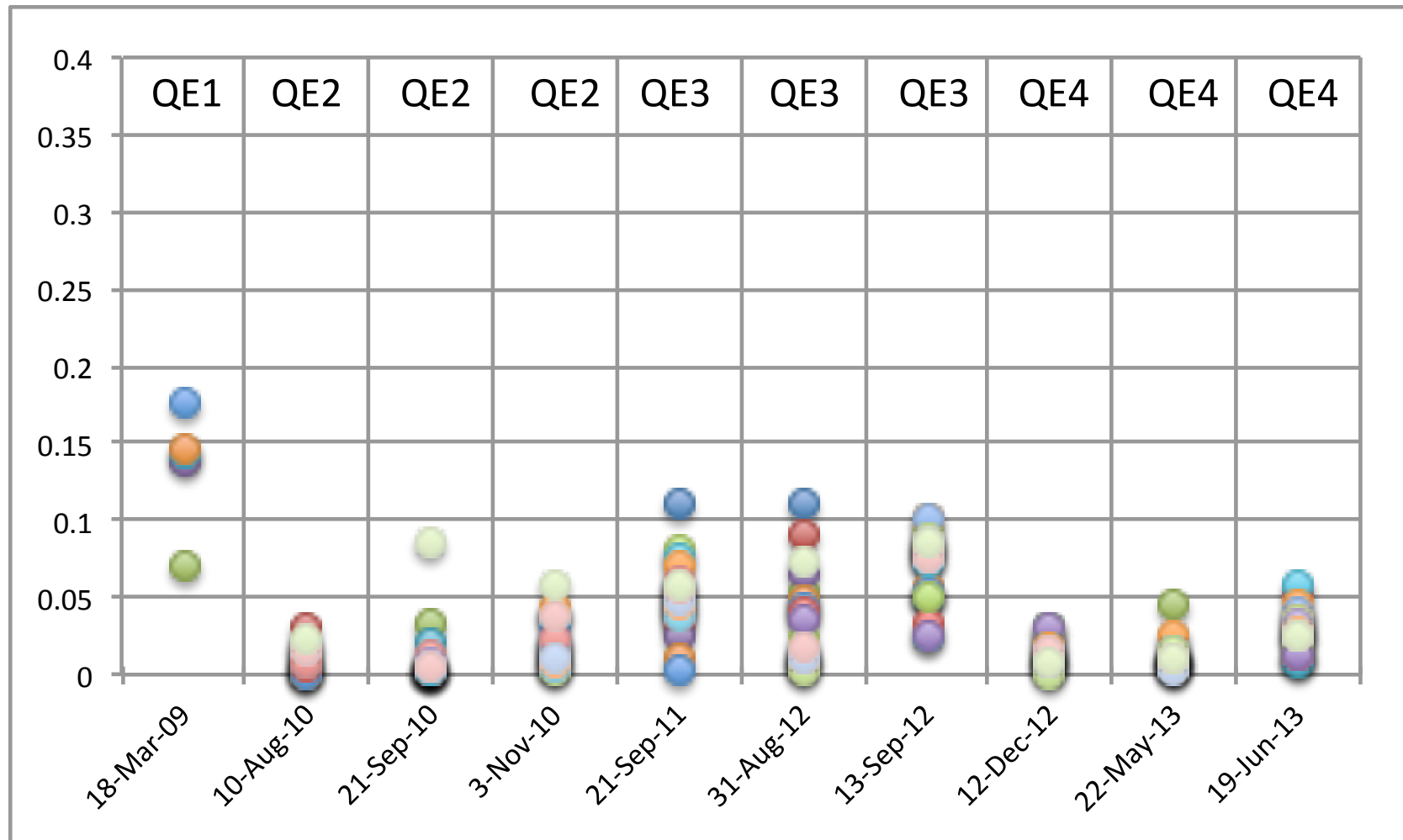
EVIDENCE: U.S. INFLATION OPTIONS

QE1
(18-Mar-09)



EVIDENCE: U.S. INFLATION OPTIONS

Figure 12. Kolmogorov-Smirnov statistics for a change in the distribution of inflation for all horizons at each QE date



3. Can reserves stay at an elevated level?



BACKGROUND

- Central banks arose as **clearing houses** for the deposit notes of commercial banks.
- To uphold it, they were given monopoly issuance of currency, and commitment to exchange reserves and currency one to one at all times. So reserves became the **unit of account**, value = $1/P$
- Reserves are **voluntarily held** by banks, who may exchange them for currency at any time, but can also stop using the CB as a clearing house or accepting its reserves.

CENTRAL BANK INSOLVENCY

- Definition of **central bank insolvency**: if creditors (banks) stop wanting to hold the CBs liabilities, reserves become a Ponzi scheme. Solvent if:

$$\underbrace{v_t}_{Reserves} \leq \underbrace{q_t b_t}_{Assets} + \underbrace{\mathbb{E}_t \sum_{j=1}^{\infty} m_{t,t+j} s_{t+j}}_{PV\ seignorage} + \underbrace{\mathbb{E}_t \sum_{j=1}^{\infty} m_{t,t+j} d_{t+j}}_{PV\ government\ transfers}$$

- Real value of reserves shoots to zero = price level shoots to infinity. All the time, currency reforms, hyperinflation. Accounting capital or printing money don't change this.

THE RISKS

- If government commits to always recapitalize the central bank: fine. But asymmetry in net income dividend rules and unclear **fiscal support**.
- With **central bank independence**, income risk
 - Old Fed model: buy short-term government bonds, little to no risk.
 - Classic advanced country: foreign currency, exchange rate fluctuations.
 - New risk: steepening of the yield curve.
 - Long-term decline of buffer: seignorage falling.

THE S.U.B.

- Solvency upper bound: if all assets are worthless, if fiscal authority injects no capital
- Then solvency is the PV of seignorage

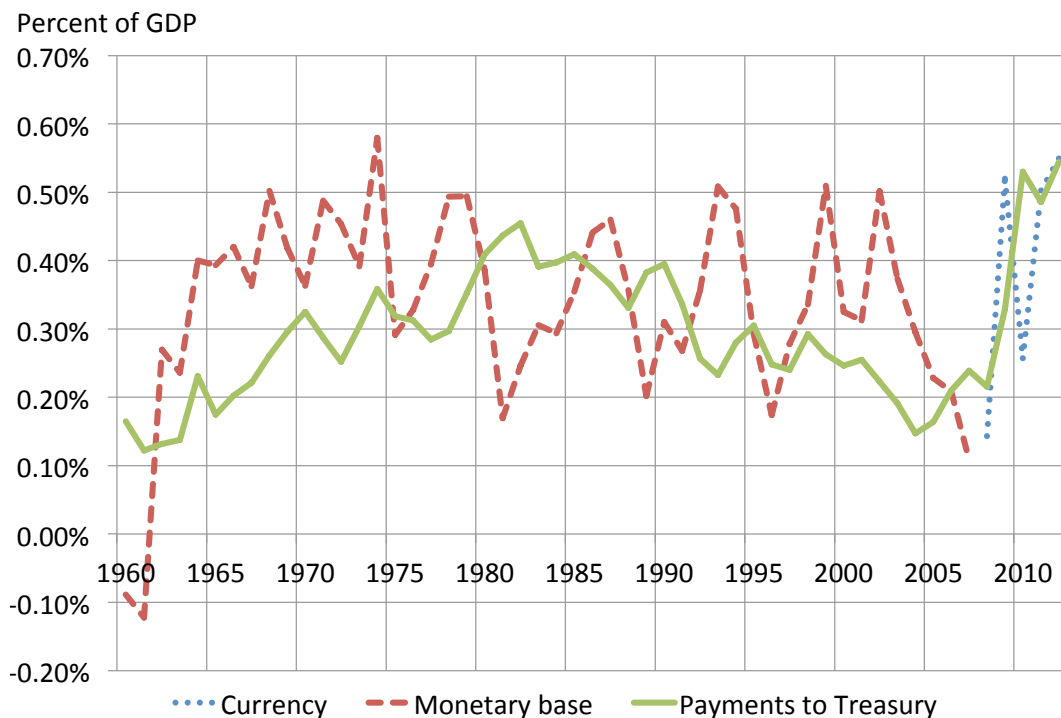
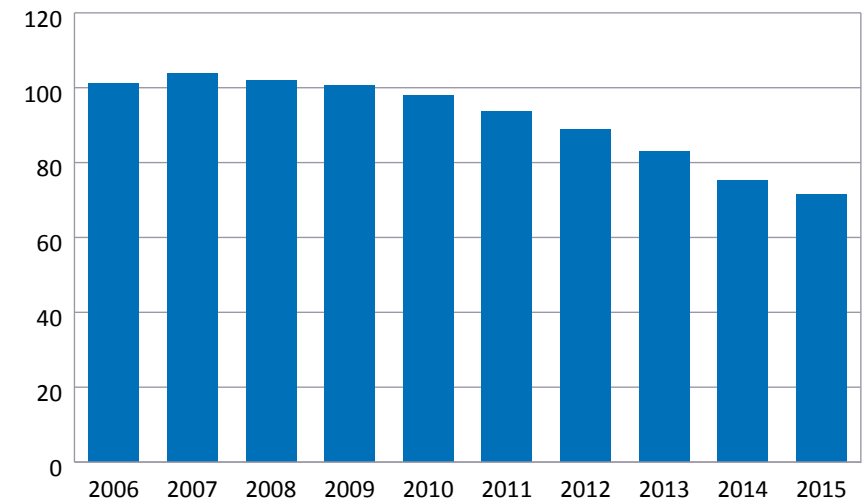


Chart 18

Average value of banknotes in circulation, SEK billion



Source: The Riksbank.

MEASUREMENT

$$s_t = \varepsilon + \hat{s}(\pi_{t-1,t}, \mathbb{E}_t \pi_{t,t+1})$$

- Three elements: (i) seignorage function, (ii) joint density, (iii) long-run risk

$$S_t = \mathbb{E} \left[\sum_{t=0}^{\infty} m_{0,t} s_t \right] = \sum_{t=0}^{\infty} \mathbb{E}(m_t \varepsilon_t) +$$

$$y_0 \sum_{t=0}^{\infty} R_t^{-1} \mathbb{E} G_t \times \int f(\pi_{t-1,t}, \cdot) \times$$

$$\hat{s} \left(\pi_{t-1,t}, \int \pi_{t,t+1} f(\pi_{t,t+1} | \pi_{t-1,t}) d\pi_{t,t+1} \right) d\pi_{t-1,t}$$

ESTIMATES

Table 4. The solvency upper bound for QE by the Fed

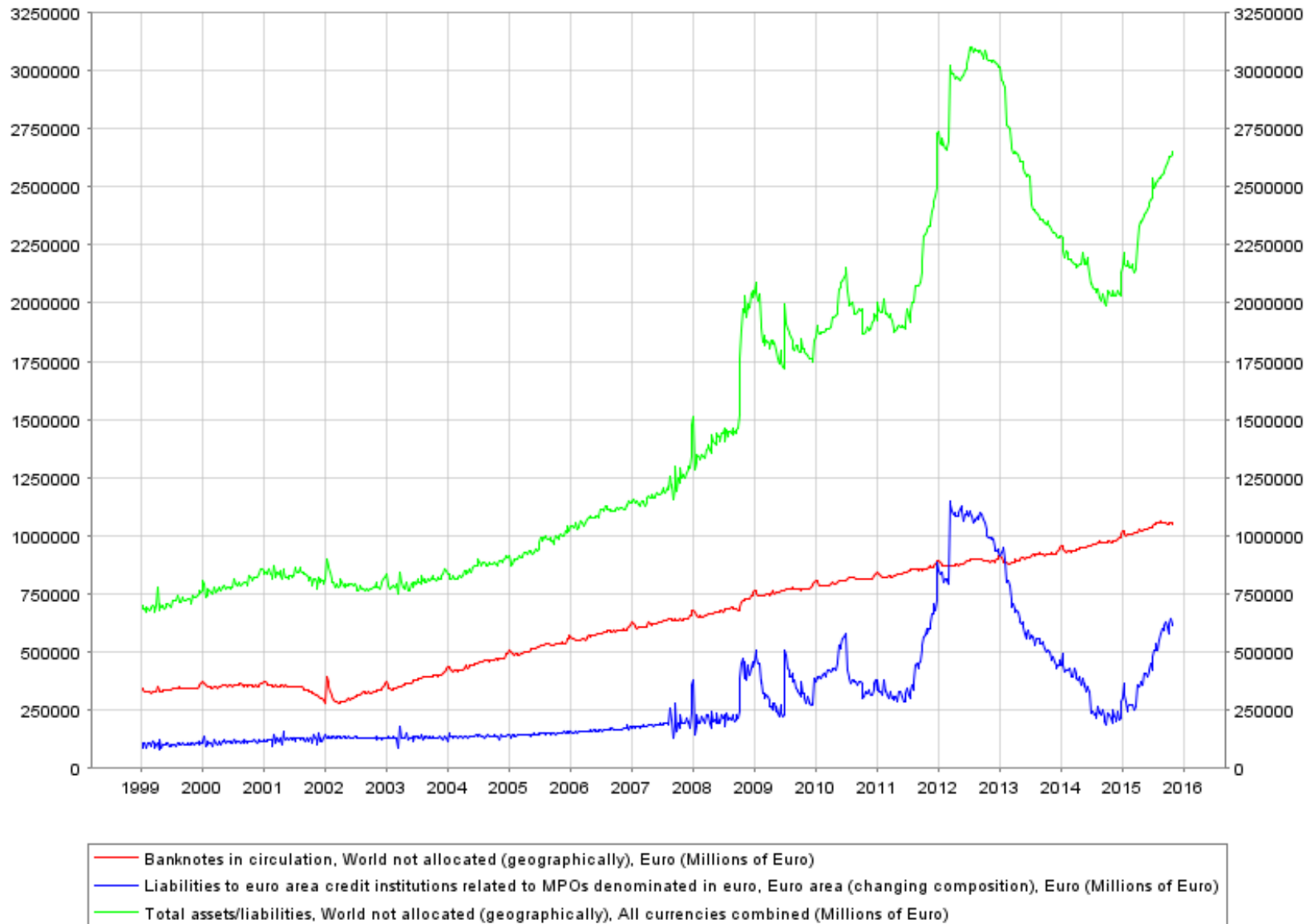
	Estimation method			
	Partial equilibrium		General equilibrium	
Discounting	Reduced-form	Structural	Reduced-form	Structural
Historical	19.0	16.4	13.8	19.0
Climate-change	25.8	22.5	25.8	18.7
Market-based	32.5	28.4	32.5	23.7

Notes: All numbers expressed as % of 2013 GDP

4. QE is not an helicopter drop of banknotes



UNCORRELATED BASE



Source (all series) : European Central Bank

THEY ARE DIFFERENT

Issuing reserves is **not** monetary financing

1. *Operational*: at the margin, agents are indifferent with holding extra reserves, but to hold more money need a change in nominal rates / inflation.
2. *Demand* for reserves is (close to) horizontal.
3. Issuing reserves generates no *seignorage* revenue.
4. Banknotes are a durable good, reserves are another form of government liability (*Modigliani-Miller-Wallace*).

HELICOPTER DROPS = END OF QE

Money supply:

- (i) issue banknotes to general public (may be spent),
- (ii) private sector can deposit banknotes at CB,
- (iii) central bank has no control over banknotes in circulation,
- (iv) unless stop paying interest on reserves, raise required reserves massively, end QE.

Money demand:

- (i) Downward-sloping demand for banknotes while flat demand for reserves.
- (ii) Lucas critique would surely hit.

5. Not out of firepower



"These are cheaper than the brand name, and just as ineffective."

HALL-REIS

Assumption: No arbitrage, for a generic asset with nominal payoff y_{t+1} , the price equals value:

$$q_t = p_t \mathbb{V}_t \left(\frac{y_{t+1}}{p_{t+1}} \right)$$

$\mathbb{V}_t(\cdot) : \mathbf{R} \rightarrow \mathbf{R}_0^+$ property $\mathbb{V}_t(z_t) = z_t \mathbb{V}_t(1)$. Can be stated in terms of SDF m_{t+1} such that $\mathbb{V}(z_{t+1}) \equiv \mathbb{E}(m_{t+1} z_{t+1})$.

Real interest rate:

$$\frac{1}{1 + r_t} = \mathbb{V}(1)$$

Goal is to ensure $p_t = p_t^*$:

ROBUST RESERVE RATE PROCESS

DEFINITION

A real payment-on-reserves monetary-policy process promises today to pay the holder of a unit of reserves $1 + x_t$ units of output next period; $1 + x_t$ is set in period t .

They are the unit of account so:

$$1 = p_t \mathbb{V}(1 + x_t) = \frac{p_t(1 + x_t)}{1 + r_t}$$

PROPOSITION

If the central bank sets the real payment on reserves to

$$1 + x_t = \frac{1 + r_t}{p_t^*},$$

the unique price level is $p_t = p_t^$.*

INTUITION

- The market equalizes real return on reserves and on indexed bonds.
- x_t is a **payment**, not a return. Value of reserves today must change for reserves to be equated. But that value is the inverse of the price level.
- Can be also implemented via an *indexed payment on reserves*: promise today $1 + x_t$ times p_{t+1} tomorrow.
- Can also be implemented via a *nominal payment on reserves*: promise today $(1 + i_t)p_t/p^*_t$, arbitrage between nominal bonds and reserves.

FORWARD RESERVES

- Term deposits at central bank, can likewise choose interest rates on them. Nothing stops central bank from trying to control 6-month rate via 6-month reserves, as opposed to overnight as it does now.
- Next step: can choose two (or more interest rates) as long as consistent plan with arbitrage.
- Two assumptions (shift to continuous time)
 - SDF M_t is an Ito process of dimension z
 - No arbitrage pins down relation between short rates $i_{t+\tau}$, forward rates $f_{t,\tau}$, and long-rates $i_t^{(\tau)}$

DETERMINACY RESULT

Theorem:

If at date t announce $z+1$ dates $\{t+\tau_{(j)}\}_{j=1}^z$ for which state either: (i) the long rates $i_t^{(\tau_{(j)})}$, (ii) the forward rates $f_{t,\tau_{(j)}}$, or (iii) the expected short rates $E_t(i_{t+\tau_{(j)}})$; each with some state-dependence on M_t/P_t , then the price level is uniquely determined as long as the derivative of the slope of the yield curve with respect to M_t is not zero at any of those dates.

APPLICATION

Proposition: If inflation may deviate from target because of lack of commitment, risk premia, control errors, then:

(i) forward guidance: if the central bank announces expected short rates, inflation will deviate from target due to lack of commitment, risk premia, and control errors.

(ii) short-long regime: if the central bank announces long rates, inflation will deviate from target due to risk premia and control errors.

(iii) forward reserves: if the central bank announces forward rates, inflation will deviate from target due to control errors.

6. Conclusion

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"Don't tell them we failed. Tell them we decided to temporarily postpone our success."

RESERVES AND INFLATION

1. First round of QE saturated market for reserves.
2. Further rounds of QE had no effect on inflation, and neither will future rounds.
3. Current level of reserves (or even half of it) can be maintained with small risk of solvency, and use interest on reserves to steer inflation.
4. Helicopter drops of currency are incompatible with large volume of reserves.
5. Innovating on the maturity and remuneration of reserves are further (extreme) options to raise inflation.

RESEARCH MOVING FORWARD

1970s high inflation gave rise to **monetarism**: studies of money demand, policies with non-borrowed reserves, measurement of monetary aggregates.

Focussing on liabilities and high inflation **today**:

1. Reservism.
2. Study of QE and demand for reserves
3. Measure SUB, transmission from interest on reserves to other short-term rates
4. Innovate on remuneration and maturity of reserves