Quantitative Easing and Portfolio Rebalancing: Evidence from Holdings Data in the Euro Area

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Understanding Asset Purchase Programmes

- In January 2015, the ECB announced a €1.1 tn asset purchase programme, now expanded to €1.7 tn
- Central banks in Japan, the U.K., and the U.S. implemented similar large-scale asset purchase programmes
- Data on holdings and rebalancing, while central to leading theories, are sparse
- We use new data on security-level holdings of investor sectors across euro-area countries to study the impact of QE on quantities and prices

Contributions

1. Document properties of investor portfolios in terms of euro-area duration, sovereign, credit risk, equity, and foreign (non-euro area) risk
2. Use detailed data on ECB purchases to measure portfolio rebalancing and risk rebalancing
3. Propose an estimator of the price effects of QE that can be applied at low frequencies

Five (Initial) Facts (2014Q4-2015Q3)

1. Strong home bias in fixed-income portfolios of investors in highly-indebted countries.
2. Banks in highly-indebted countries hold four (twice) times the amount of sovereign (credit) risk, while being 25% smaller.
3. The foreign sector, banks, and mutual funds first sell to the ECB.
4. The ECB absorbs duration, sovereign, and credit risk at 1-1.5% per quarter. Banks reduce their duration risk, and banks in high debt countries reduce holdings of sovereign and credit risk.
5. Yields decline in response to the QE programme. The effect is concentrated in the anticipation/announcement period

Summary of the Asset Purchase Programme

- Public Sector Purchase Programme (PSPP) announced on January 22, 2015, following a series of earlier programmes.
- Initial period: March 9, 2015 until September 2016.
- Monthly purchases of €60 bn are split as:
  - €44 bn: sovereign bonds.
  - €6 bn: supra-nationals.
  - €10 bn: covered bonds.
- Eligibility rules:
  - Residual maturity between 2y and 30y.
  - Yield-to-maturity > -20bp (deposit facility rate).
  - Purchase limit: Up to 33% (25%) of an issuer (issue).

Earlier purchase programmes Recent Changes

Data Sources

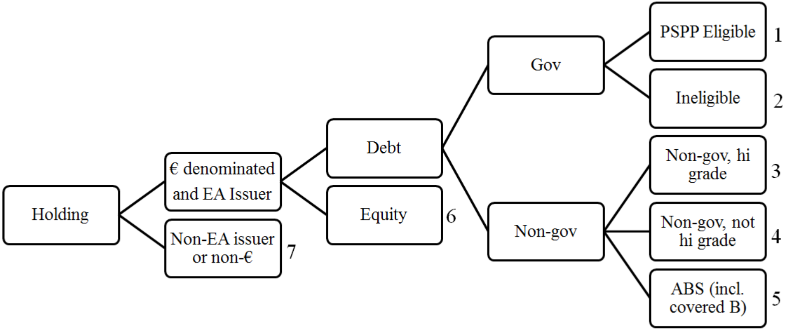
- Securities Holdings Statistics (SHS).
  - Quarterly ISIN-level portfolio holdings by investor sector of all euro-area countries from 2013Q4-2015Q3.
  - The data include equities, sovereign and corporate bonds (including medium-term notes), covered bonds, ABS, mutual fund shares, about €27 tn per quarter.
- Proprietary data on ISIN-level holdings from earlier purchase programmes and the current programme.
- Centralised Securities Database (CSDB).
  - Data on prices and securities characteristics.
- Additional data on credit ratings from Datastream and the collateral framework of the Eurosystem.
  - We assign the ratings following the Eurosystem priority rules.

Investor and Country Classification

- We consider the following classification of investor sectors:
  1. Monetary and financial institutions (MFI): Banks.
  2. Other financial institutions (OFI): Mutual and hedge funds, ...
  3. Insurance companies and pension funds: ICPF.
  4. Non-financial corporations.
  5. Government.
  6. Households.
  7. ECB (Eurosystem)
  8. Foreign (residual holdings)

- We often group countries by debt-to-GDP:
  - Country group 1: Austria, Germany, France, the Netherlands, Estonia, Luxembourg, Latvia, Slovakia, Finland, Malta, and Slovenia.
  - Country group 2: Italy, Spain, Portugal, Greece, Cyprus, Ireland, Belgium, and Lithuania.

Classification of Securities

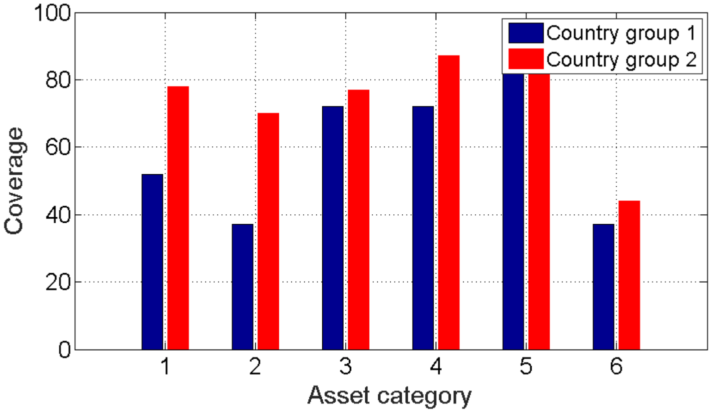


Holdings Before the Start of the PSPP

- Little is known about the distribution of risks in fixed income markets.
- We document basic facts summarizing the initial conditions *before* the start of the PSPP:
    1. How heterogenous are portfolios across investor sectors and geographically?
    2. Who holds PSPP-eligible debt?
    3. What are the risk characteristics of investors' portfolios?
    4. How are duration, sovereign and credit, and equity risks distributed in the euro area?

Coverage by Asset Category

Share of assets held by euro area investors



Holdings of PSPP-Eligible Debt by Holder Country

Holder country	ICPF			Banks			Mutual funds		
France	490	35	65	235	23	57	87	11	28
Italy	209	56	90	250	26	96	81	30	84
Germany	82	31	14	321	25	60	185	17	32
The Netherlands	207	44	32	86	26	44	102	20	11
Spain	106	44	86	200	26	91	39	25	90
Belgium	112	55	64	73	34	58	13	15	33
Other	57	30	35	153	16	51	229	7	4
Total	1264	40	61	1317	24	69	735	12	29

- Column 1: Euro investment in PSPP-eligible debt (in bn).
- Column 2: % of portfolio invested in PSPP-eligible debt.
- Column 3: % of PSPP-eligible debt invested in home country.

By Issuer Country

Measuring Risk Characteristics

- We define linear risk measures for euro-area interest, sovereign, credit, and equity risk:
  - Interest rate risk: Duration.
  - Sovereign risk: Credit rating.
  - Credit risk: Credit rating.
  - Equity: Unit beta.
- We convert credit ratings to 5-year default probabilities using data from Moody's (2015) to account for the non-linear link between ratings and default probabilities.
- We measure risk at the portfolio level and the distribution of aggregate risk across investor sectors and geographies.

Portfolio Risk Characteristics

$\frac{\text{Debt}}{\text{GDP}}$	Sector	Duration	Sovereign	Credit	Equity	Foreign
Low	Banks	7.38	0.34	0.53	4	21
	MFs	6.08	0.57	1.19	19	51
	ICPF	7.58	0.29	0.95	6	20
	Household	3.69	0.46	1.57	53	16
High	Banks	8.54	1.54	1.28	3	13
	MFs	6.76	1.25	1.74	12	57
	ICPF	6.35	1.19	1.48	4	11
	Household	3.96	1.33	2.18	24	10
	Foreign	6.75	0.49	1.08	—	—
	ECB	4.28	1.54	0.56	0	0

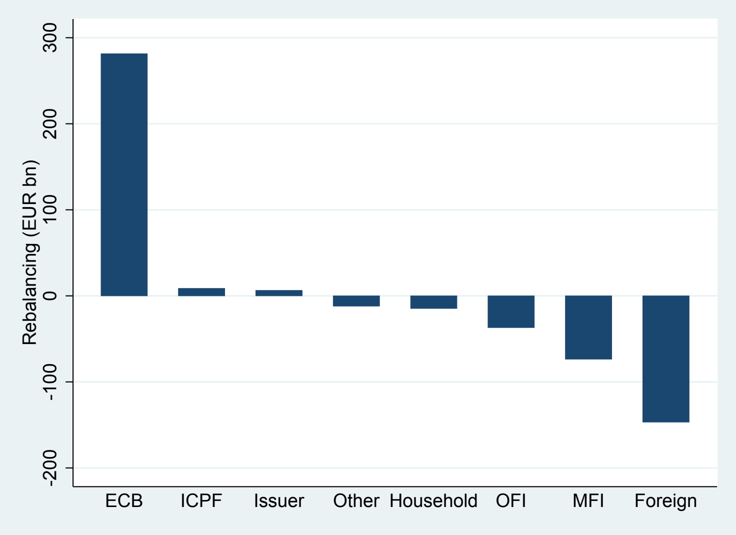
- Duration risk similar across country groups.
- Sovereign and credit risk concentrated in country group 2.

Risk Distribution

$\frac{\text{Debt}}{\text{GDP}}$	Sector	Duration	Sovereign	Credit	Foreign	Size
	Banks	19	6	13	13	3117
	MFs	9	7	13	47	4719
Low	ICPF	14	4	12	9	2275
	HH	1	0	4	2	806
	Other	1	0	2	2	1110
	Total	44	17	44	73	12027
	Banks	19	24	22	6	2439
	MFs	2	6	3	16	1457
High	ICPF	5	11	5	2	887
	HH	3	5	7	2	977
	Other	1	4	1	1	545
	Total	30	50	38	27	6305
	Foreign	25	28	18	–	–
	ECB	1	3	0	0	136

- Despite the relatively small size, banks in highly-indebted countries hold about a quarter of all sovereign and credit risk.

Changes in holdings of PSPP eligible bonds (2015Q2+Q3)



Portfolio Rebalancing: Flows in Euros billion (average 2015Q2-Q3)

Debt/GDP	Sector	Asset category 1	2	3	4	5	6	7	Total
	Banks	-24	12	-13	-6	-23	-2	-9	-65
	Mutual funds	-7	11	-2	1	-9	47	14	55
Low	ICPF	4	-2	1	1	-4	1	11	12
	Household	-1	-1	-1	-6	-1	-1	-1	-12
	Other	-3	2	0	0	-2	2	-3	-4
	Banks	-13	6	-3	21	-25	2	-8	-20
	Mutual funds	-12	1	0	-1	-1	3	14	4
High	ICPF	0	3	0	0	-2	0	4	5
	Household	-7	-1	0	-19	0	3	-1	-25
	Other	-3	1	0	-2	0	-3	-2	-9
	ECB	141	14	0	0	23	0	0	178
	Foreign	-73	-5	-11	9	-10	–	–	–
	Issuer	3	42	-28	-2	-55	–	–	–

Portfolio Rebalancing: Risk Distribution

		Duration risk			Sovereign risk			Credit risk		
$\frac{\text{Debt}}{\text{GDP}}$	Sector	Pre	Q2	Q3	Pre	Q2	Q3	Pre	Q2	Q3
Low	Banks	19	18	17	6	6	6	13	14	14
	MFs	9	10	10	7	8	8	13	15	15
	ICPF	14	14	15	4	5	5	12	14	15
	HH	1	1	1	0	0	0	4	4	4
	Other	1	1	1	0	1	0	2	2	2
High	Banks	19	18	17	24	22	21	22	17	18
	MFs	2	2	2	6	6	6	3	4	4
	ICPF	5	5	6	11	11	12	5	5	6
	HH	3	2	2	5	4	4	7	7	5
	Other	1	1	1	4	4	4	1	1	1
	Foreign	25	24	24	28	27	27	18	17	17
	ECB	1	2	4	3	5	6	0	1	2

Portfolio Rebalancing: Key Points

- Foreign sector and banks are main sellers of PSPP eligible assets
- Little rebalancing from the insurance sector
- Limited rebalancing to other asset classes
- ECB absorbs 1% to 1.5% of outstanding risk per quarter
- Reduction in share of duration risk held by banks, reduction of sovereign risk in high debt countries

Yields: Methodology and Main Results

- In a third part, we identify the impact of ECB purchases on asset prices.
- We solve potential endogeneity concerns by focusing on government yields at the issuer country level for 5 maturity brackets.
- Key results
  - OLS estimates suggest that a purchase of 1% of the outstanding are associated with a -5.2bps fall in yields
  - These estimates are in line with those of other studies
  - Results suggest that most of the effect is concentrated in the announcement period
  - Instrumental variables regressions give larger effect of QE - suggestive of supply response

Regression results

Conclusions

- Use micro-data on sector-level portfolio holdings to understand how asset purchase programmes
- Initial conditions in fixed income markets very different.
- We summarize rebalancing in terms of flows and in terms of duration, sovereign, and credit risk.
- We provide a simple risk accounting framework to measure risk concentration.
- We propose an estimator to understand the impact of QE on asset prices.

Motivating Theories

1. Irrelevance theorems.
   - Wallace (1981) and Eggertson and Woodford (2003).
2. Positive effects of QE:
   (i) Reduction in risk premia due to reduction in risk and portfolio rebalancing (Vayanos and Vila, 2009).
   (ii) Asset purchases to signal commitment (Eggertson and Woodford, 2003).
   (iii) Relax financial constraints of compromised institutions (Brunnermeier and Sannikov, 2016).
3. Negative effects of QE:
   (i) Risk concentration (Stein, 2013 and Coimbra and Rey, 2016).
   (ii) Reduction in safe assets (Krisnamurthy and Vissing-Jorgensen, 2011).

Subsequent Adjustments to the Programme

- December 2015:
  - End date changed to March 2017.
  - Deposit facility rate dropped to -30bp, which modifies the eligibility criteria.
- March 2016:
  - Programme size scaled up to €80bn per month.
  - Deposit facility rate dropped further to -40bp.
  - Investment-grade corporate bonds also eligible.
- The total size of the programme is around €1.7 tr as a result of these changes.

Return

Earlier Asset Purchase Programmes

- CBPP-1: July 2009-June 2010, €60 bn.
- CBPP-2: November 2011-October 2012, €16 bn.
- SMP: May 2010-September 2012, €210 bn.
- ABSPP/CBPP-3: September 2014, small in size initially, but extended as part of the extended asset purchase programme in January 2015.
- The bonds that are purchased as part of these programmes will be held to maturity.

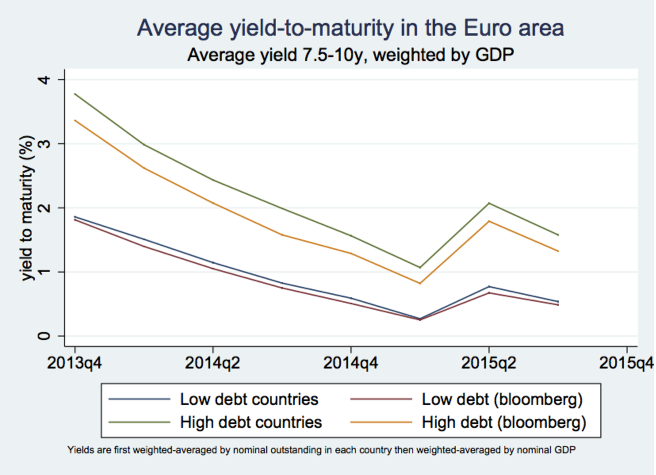
Return

Portfolio Rebalancing Before the PSPP

		Asset category							
Group	Sector	1	2	3	4	5	6	7	Total
1	Banks	9	6	-13	-2	-13	4	-25	-34
1	Mutual funds	7	4	-2	7	-4	19	95	126
1	ICPF	3	8	-4	3	-2	1	11	20
1	Household	-1	0	-1	-6	-1	3	2	-4
1	Other	5	-2	0	1	-1	-1	2	4
2	Banks	15	-9	2	-45	-19	-4	4	-56
2	Mutual funds	10	1	0	4	0	15	33	63
2	ICPF	6	4	-1	0	-1	1	1	10
2	Household	-6	-1	-1	-23	0	3	-12	-40
2	Other	-2	0	0	-3	0	-12	-5	-22
	ECB	-6	6	0	0	30	–	–	30
	Foreign	22	-42	1	-25	-12	–	–	–
	Issuer	62	-25	-18	-90	-45	–	–	106

Return

Yield Dynamics



Return

Holdings of PSPP eligible debt by Issuer Country (2013Q4-2015Q1)

Issuer country	ICPF	Banks	Mutual funds	ECB	Foreign	Total
Italy	260	317	195	67	299	1358
Germany	112	249	144	0	749	1311
France	372	180	111	0	606	1294
Spain	132	211	100	26	155	678
The Netherlands	82	61	38	0	143	329
Belgium	122	74	36	0	67	319
Other	179	223	111	20	262	843
Total	1259	1316	735	114	2282	6136

Return

Instrumenting ECB Purchases

- The weight of country c in the capital key is:

$$K_c = \frac{1}{2}\left[\frac{GDP_c}{\sum_c GDP_c} + \frac{Pop_c}{\sum_c Pop_c}\right].$$

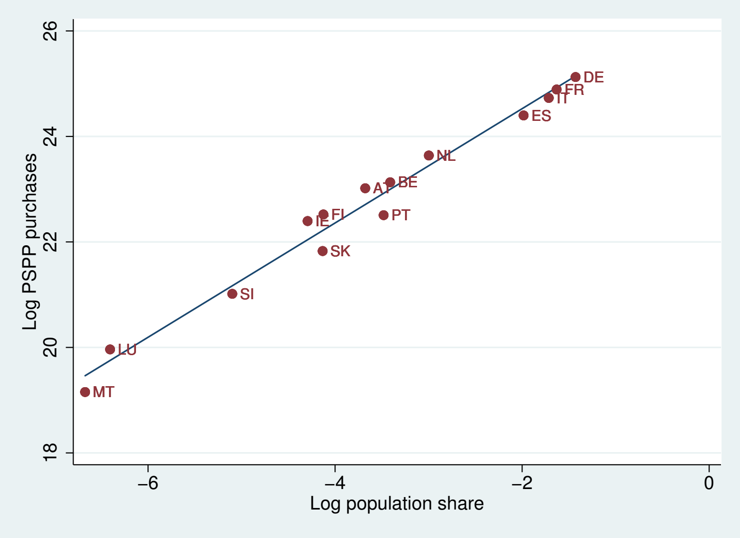
- GDP per capita depends on economic conditions and we control for it directly. We assume that population size is exogenous.
- The maturity distribution at the time of purchase may be endogenous to supply changes by countries.

  $\Rightarrow$ Use the maturity distribution in 2014.
- Instrument for PSPP purchases:

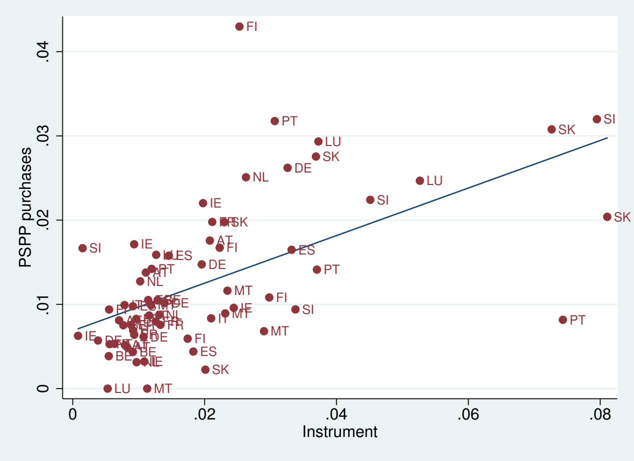
$$\widehat{Q}_{c\tau} = \frac{Pop_c}{\sum_c Pop_c} \times \mu_{c\tau}^{2014Q2},$$

  where $\mu_{c\tau}^{2014Q2}$ is the maturity distribution in 2014Q2.

Cross-country Purchases and Population Size



Instrument and PSPP Purchases



- Both the instrument and PSPP purchases are scaled by the size of the PSPP-eligible bond market in 2014Q2.

Instrumental Variables Estimator

	First stage		Second stage		
	Estimate	t-stat.	Estimate	t-stat.	
Instrument	0.24	4.13	QE purchases	-27.38	-3.45
Maturity group			Maturity group		
$[5, 7.5]$	-0.0037	-1.34	2	-0.56	-5.53
$[7.5, 10]$	-0.0014	-0.48	3	-0.69	-6.88
$[10, 15]$	-0.0064	-2.19	4	-0.99	-7.91
$[15, 30]$	-0.0076	-2.47	5	-1.06	-7.60
Log(GDP) p.c.	0.0017	0.0024	Log(GDP) p.c.	0.065	0.76
P(default)	-0.029	-0.37	P(default)	-11.18	-4.38
N	67				
R-squared	44%				

- Bias in OLS estimator suggests that central banks buy bonds that trade at relatively low prices.
- However, the confidence intervals are overlapping.

Announcement or Purchasing Period?

Period	2014Q2-2015Q3		2014Q2-2015Q1		2015Q1-2015Q3	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
QE purchases	-8.29	-2.64	-9.20	-1.82	0.91	0.22
Maturity group						
[5, 7.5]	-0.44	-5.76	-0.61	-4.98	0.17	1.68
[7.5, 10]	-0.57	-7.56	-0.96	-7.88	0.39	3.82
[10, 15]	-0.78	-9.45	-1.16	-8.71	0.38	3.41
[15, 30]	-0.80	-9.34	-1.53	-11.09	0.73	6.33
Log(GDP) p.c.	0.091	1.45	0.28	2.75	-0.19	-2.20
P(default)	-10.64	-5.00	-10.57	-3.08	-0.075	-0.03
N	67		67		67	
R-squared	74%		77%		52%	

- 2014Q2-2015Q1: Anticipation/announcement period.
- 2015Q1-2015Q3: Purchase period.

Identifying the Impact on Yields

- ECB purchases may be endogenous to economic conditions.
- Therefore, we build an instrument that attempts to isolate the exogenous variation in purchases.
- We use two features of the QE programme:
  - *Across* countries, purchases follow the capital key.
  - *Within* countries, guideline to buy according to the market.
- Key finding: larger effect using instrument
- In the future, we may be able to exploit the issue/issuer limit and the deposit facility rate restriction.

Implications for Bond Yields

- Goal: Identify the impact of ECB purchases on asset prices.
  - Time variation: disentangle the effect of purchases from that of other events
  - Endogenous asset purchases
- Solution: focus on government yields at the issuer country level for 5 maturity brackets: $[2,5], [5,7.5], [7.5,10], [10,15], [15,30]$.
- Hence, we are interested

$$\Delta y_{c\tau} = a + bq_{c\tau} + \gamma' X_{c\tau} + \epsilon_{c\tau},$$

where $\Delta x = x(2015Q3) - x(2014Q2)$ and:

  - $q_{c\tau}$: ECB purchases in country c in maturity bracket τ, normalized by the size of the market in country c in 2014Q2.
  - $X_{c\tau}$: Other variables that drive yield changes such as maturity, economic conditions, sovereign risk.

OLS Estimates

Period	2014Q2-2015Q3	
Maturity group	Estimate	t-stat.
QE purchases	-8.29	-2.64
$5 - 7.5$	-0.44	-5.76
$7.5 - 10$	-0.57	-7.56
$10 - 15$	-0.78	-9.45
$15 - 30$	-0.80	-9.34
Log(GDP) p.c.	0.091	1.45
P(default)	-10.64	-5.00
N	67	
R-squared	74%	

Back-of-the-Envelope Calculation

- Most of the effect is in the announcement period, not the purchase period, so we need to scale the coefficient by 7/19 months. Announcement Effect

- Size of the PSPP-eligible market: €5.9tn.

- Euro area GDP in 2014: €10.1tn.

- Back-of-the-envelope: If the ECB buys 10% of euro-area GDP:

$$10.1/5.9 \times -8.3 \times 7/19 \times 10 = -52\text{bp}$$

- Confidence interval: $(-14\text{bp}, -94\text{bp})$.

Evidence Based on Event Studies

Table 1: Impact of QE programs on 10 yrs government bond yields*

	All QE episodes	Euro area	US			UK	Japan	
		APP 03/15-09/16	LSAP1 12/08-03/10	LSAP2 11/10-06/11	MEP 09/11-12/12	APF1 03/09 - 01/10	CME+ 12/08-08/11	QQE 04/13-09/14
Size (% of GDP)		11%	12%	4%	3%	14%	21%	23%
Median	53	43	76	45	60	67	11	20
Range	10-175	27-64	32-175	33-138	23-175	34-107	10-12	14-26

*Based on results from 24 studies listed in Appendix B. The table indicates the size of the purchases conducted within each program as a share of domestic GDP, the periods when the purchases were conducted, and the median and range of the impact on 10-yrs bond yields, expressed in bps, standardized to purchases of 10% of GDP.

Source: Andrade, De Fiore, Karadi, Tristani (2016).

- Effect in line with other studies
- We also instrument purchases with the rules
- Key result: larger coefficient estimate suggests supply response to purchases

Return