Online Appendix to
"The (Unintended?) Consequences of the Largest Liquidity Injection Ever"*

Matteo Crosignani
Federal Reserve Board

Miguel Faria-e-Castro
NYU

Luís Fonseca
London Business School

In this Online Appendix, we illustrate the dataset construction (section A), present additional derivations of the model developed in the paper appendix (section B), develop a simple model of the collateral trade taking into account that the central bank may trigger margin calls (section C), discuss summary statistics of LTRO uptakes by Portuguese banks (section D), illustrate the ECB collateral framework (section E), present additional figures (section F), and present additional tables (section G).

A Dataset Construction

In this section, we provide a more detailed description of the data that we used, and how we transformed the data. As mentioned in the main text, our master dataset is the merger of two proprietary datasets, appended with a public one:

1. Monetary and Financial Statistics (MFS), a proprietary dataset from the BdP, that includes monthly balance sheet data for all monetary and financial institutions regulated by the BdP. We have data on book values, disaggregated by type of asset/liability, type of counterpart, geographical location of counterpart, and, for some assets and lia-

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bilities, maturity.[1] Monetary and financial institutions are divided in three categories: banks, savings institutions, and money market mutual funds. Most of the institutions are banks; savings institutions is an obsolescent category that applies only to agricultural credit cooperatives. Money market funds are small given the undeveloped nature of the Portuguese money funds market. More specifically, the different dimensions for which data are available are: (i) Asset category: banknotes and coins, loans and equivalent (with repricing date up to 1 year, 1 to 5 years, more than 5 years), securities except equity holdings (up to 1 year, 1 to 2 years, more than 2 years), equity holdings, physical assets, and other assets (of which derivatives); (ii) Counterparty's geographical area: Portugal, Germany, Austria, Belgium, Cyprus, Slovenia, Spain, Estonia, Finland, France, Greece, Netherlands, Ireland, Italy, Latvia, Luxembourg, Malta, Slovakia, European Monetary Union excluding Portugal, Non-EMU Countries, European Central Bank; (iii) Counterparty's institutional sector: monetary and financial institutions, social security administration, local government, regional government, insurance and pension funds, private individuals, central government, other financial intermediaries, non-financial firms, other sectors. For the other side of the balance sheet, the counterparty classification is the same, and the liability categories are: demand deposits, deposits redeemable at notice (less than 90 days, more than 90 days), other deposit equivalents (less than 1 year, 1 to 5 years, more than 5 years), repurchase agreements, securities (up to 1 year, more than 1 year), other liabilities, capital and reserves. Crosignani et al. (2015) describes this dataset in more detail and analyzes the evolution of the balance sheets for the Portuguese monetary financial sector during the full sample period.

2. *Sistema Integrado de Estatísticas de Títulos* (SIET), another proprietary dataset from

[1] Maturity, as classified by the MFS, refers to next residual repricing maturity, or time left until the next repricing date. Lending, for example, is disaggregated as lending with maturity less than 1 year, between 1 and 5 years, and more than 5 years. This measure of maturity does not coincide with contractual residual maturity if the contract is repriced at a frequency lower than its contractual maturity. Due to the institutional characteristics of the Portuguese financial markets, most long-term loans such as mortgages are floating rate loans, indexed to some reference rate such as the Euribor. This means that they are classified as short-term loans in our dataset.

the BdP, which contains monthly information on quantity (face value), book value, and market value for all ISINs that refer to debt instruments issued by the Portuguese central government and a few public companies, and that are owned by financial institutions domiciled in Portugal. This dataset corresponds to the universe of financial institutions in Portugal, conditional on them owning any of these securities. It includes several types of institutions, including monetary and financial institutions, mutual funds, hedge funds, pension funds, brokerage companies, etc.

3. CMVM, a public dataset on the portfolio composition of all mutual funds that are allowed to operate in Portugal. This dataset is extracted and compiled from the CMVM website, to which all mutual funds are required, by law, to submit a detailed composition of their portfolio at market values. This dataset is monthly until September 2013, after which it becomes quarterly.

For the MFS dataset, we keep the following information for each bank, in each period: assets, cash and equivalents, lending, lending to households, lending to non-financial firms, holdings of non-equity securities, holdings of government debt, holdings of Portuguese government debt, holdings of GIIPS government debt, holdings of equity securities, and other assets. For the other side of the balance sheet: equity and reserves, demand deposits, savings deposits, time deposits, repo, securities, other liabilities, short-term (less than 1 year) borrowing from the central bank, medium-term (1-2 years) borrowing from the central bank, and long-term (more than 2 years) borrowing from the central bank.

For the CMVM dataset, we retain the following characteristics: assets, net asset value, equities, non-government bonds, domestic government bonds, foreign government bonds, deposits, and shares in other funds.

For each of the MFS and CMVM institutions, we also manually classify them as to whether they are foreign (i.e. wholly-owned subsidiaries of a foreign company) and as to whether they are subsidiaries. This information is obtained by crossing information with other databases (SNL Financial, Bankscope, Bloomberg), as well as checking the institution's websites.

For the SIET dataset, we keep its original structure, a three-dimensional panel (j, i, t), where $j \in J$ is an ISIN, owned by institution $i \in N$ at time $t \in T$. For each observation, the SIET gives us quantity (face value), market value, and book value. The latter is only available for certain institutions, but we only use it for consistency purposes. Note that while the datasets intersect, neither is contained in each other: the MFS includes monetary financial institutions which may not own any Portuguese sovereign debt security and thus are excluded from the SIET dataset, while the SIET dataset includes other types of institutions that are not included in the MFS dataset, such as pension funds, etc. The CMVM dataset includes some money market funds which are both in SIET and MFS, some mutual funds which are in SIET (i.e. those which have domestic government bonds) and others which are not (those which do not have domestic government bonds).

B Model Derivations

Bank Portfolio Choice, Equilibrium Conditions, and Proposition 1 We solve the banks' problem backwards, starting at $t = 1$. At this period, the bank chooses how to rebalance its long-term debt portfolio and whether to store/borrow from funding markets,

$$\begin{aligned} &\max_{b'_L, d} \left[b'_L + d \left\{ \mathbf{1}[d \geq 0] + \kappa \mathbf{1}[d < 0] \right\} \right] \\ &\quad \text{s.t.} \\ &W_1 = q_1 b'_L + d \end{aligned}$$

Using the budget constraint, note that setting $d \geq 0$ is equivalent to setting

$$b'_L \leq \frac{W_1}{q_1}$$

In this case, the bank's payoff at $t = 2$ is equal to

$$\pi_2|_{d \geq 0} = b'_L + W_1 - q_1 b'_L$$

Since $q_1 < 1$, the bank seeks to set b'_L as high as possible. Will it ever set b'_L such that $d < 0$? In this case, the payoff is

$$\pi_2|_{d<0} = b'_L + \kappa W_1 - \kappa q_1 b'_L$$

We will assume that funding costs are high enough that $\kappa \underline{q} > 1$, in which case the optimal policy is to set $b'_L = 0$, and so $d < 0$ is inconsistent with optimality. The bank still runs the risk of borrowing: assuming it cannot short-sell long-term bonds, $b'_L \geq 0$, the bank needs to borrow whenever $W_1 < 0$. This occurs when

$$b_S + q_1 b_L + c - R€ < 0$$

Note that it occurs whenever the value of the portfolio is low enough due to a low realization of q_1, or whenever the bank has borrowed enough at $t = 0$, that is, $R€$ is high. In such case, the value of the payoff is

$$\pi_2|_{d<0, b'_L=0} = \kappa W_1 < 0$$

We can then characterize the bank's strategies at $t = 1$, given q_1, as

$$b'_L = \begin{cases} b_L + \frac{b_S + c - R€}{q_1} & \text{if } q_1 \geq \frac{R€ - c - b_S}{b_L} \\ 0 & \text{otherwise} \end{cases}$$

$$d = \begin{cases} 0 & \text{if } q_1 \geq \frac{R€ - c - b_S}{b_L} \\ b_S + q_1 b_L + c - R€ & \text{otherwise} \end{cases}$$

Note then that the expected value of $t = 2$ profits at $t = 0$ can be written as

$$\mathbb{E}_0[\pi_2] = \int_{\underline{q}}^{\frac{R€ - c - b_S}{b_L}} \kappa \left[b_S + q_1 b_L + c - R€ \right] \mathrm{d}F(q_1) + \int_{\frac{R€ - c - b_S}{b_L}}^{\bar{q}} \left[b_L + \frac{b_S + c - R€}{q_1} \right] \mathrm{d}F(q_1)$$

The bank's problem at $t = 0$ is then,

$$\max_{b_L, b_S, c, €} \mathbb{E}_0[\pi_2]$$
$$\text{s.t.}$$
$$W_0 + € = q_S b_S + q_L b_L + c$$
$$€ \leq (1 - h_L) q_L b_L + (1 - h_S) q_S b_S$$

In order to illustrate the forces at play, we now assume that $\kappa \to \infty$: the costs of financing in the intermediate period are prohibitive. The bank is infinitely averse to seeking out funding in the intermediate period and will therefore adjust its $t = 0$ decisions to avoid any shortfall. We believe that, while stark, this assumption captures the motive for holding liquid asset reserves at any point in time. Additionally, it simplifies considerably the solution and characterization of the model.

For $\kappa \to \infty$, we can restate the bank's problem as follows: the objective function now becomes

$$\mathbb{E}_0[\pi_2] = \int_{\underline{q}}^{\bar{q}} \left[b_L + \frac{b_S + c - R€}{q_1} \right] \mathrm{d}F(q_1) = b_L + (b_S + c - R€)\mathbb{E}_0 \left[\frac{1}{q_1} \right]$$

and the bank faces an additional (liquidity) constraint, imposing a zero shortfall in the second period even for the worst realization of q_1

$$b_S + c + \underline{q} b_L - R€ \geq 0$$

Letting (λ, δ, η) denote the Lagrange multipliers on the budget, collateral and liquidity constraints, respectively, and defining

$$\tilde{q} \equiv \mathbb{E}_0 \left[\frac{1}{q_1} \right]^{-1}$$

as the expected value of the price of the long-term bond at $t = 1$ adjusted by a Jensen term, we can write the first-order conditions for the bank's problem as

$$\begin{aligned} \tilde{q} - q_L[\lambda - \delta(1 - h_L)] + \underline{q}\eta &\leq 0 \perp b_L \geq 0 \\ 1 - q_S[\lambda - \delta(1 - h_S)] + \eta &\leq 0 \perp b_S \geq 0 \\ 1 - \lambda + \eta &\leq 0 \perp c \geq 0 \\ -R + \lambda - \delta - \eta R &\leq 0 \perp € \geq 0 \end{aligned}$$

Assuming that $b_S, b_L > 0$, and so that both first-order conditions bind, we can write the slope of the yield curve as

$$\frac{1}{q_L} - \frac{1}{q_S} = (\lambda - \delta)\left[\frac{1}{\tilde{q} + \underline{q}\eta} - \frac{1}{1+\eta}\right] + \delta\left[\frac{h_L}{\tilde{q} + \underline{q}\eta} - \frac{h_S}{1+\eta}\right]$$

Notice first that if none of these constraints bind, $\delta = \eta = 0$, the bank prices debt at each maturity using a traditional unconstrained arbitrage condition that equates inter-period returns,

$$\frac{1}{q_S} = \frac{\tilde{q}}{q_L} = \lambda$$

where λ measures the marginal cost of funds for the bank. If any of the constraints is active, however, the bank's preference is tilted towards short-term debt. This means that, for the same quantities of outstanding debt, the price of short-term debt increases relative to the price of long-term debt. Thus the yield curve becomes steeper.

We focus on equilibria with strictly positive yields, $q_S, q_L < 1$. From bank optimality, this means that cash is always a strictly dominated asset, $c = 0$. From the bank's optimality conditions, notice that there are two factors that may motivate a preference for short- over long-term debt from the bank's perspective: the first is if short-term debt commands a more favorable haircut, $h_S < h_L$. This preference is scaled by the multiplier on the collateral constraint, δ. The second is that short-term debt allows for better liquidity management, since it yields a certain cash-flow of 1 in the second period, while long-term debt yields a worst-case payoff of $\underline{q} < 1$. This preference is scaled by the multiplier on the liquidity constraint, η.

Proof of Proposition 2 We assume that we are in Region 4 of Proposition 1 throughout. For this, we assume that ϕ is large enough such that the change in R has a small enough impact on γ so as not to leave this region. We assume that $\bar{\gamma} \in (0, 1)$, and that ϕ is large enough such that $\gamma \in (0, 1)$, and both maturities will be issued in equilibrium, since this is the empirically relevant case. With our extension,the equilibrium of the model is now described by the following system

$$
\begin{aligned}
q_S &= \frac{1}{R} \\
q_L &= \frac{\underline{q}}{R} + \frac{\omega}{1-\gamma} \\
\gamma &= \bar{\gamma} + \phi^{-1}(q_S - q_L)
\end{aligned}
$$

We can solve for γ, yielding

$$
\gamma = \left[\frac{1+\bar{\gamma}}{2} + \frac{1-\underline{q}}{2\phi R}\right] \pm \sqrt{\left[\frac{1+\bar{\gamma}}{2} + \frac{1-\underline{q}}{2\phi R}\right]^2 - \left[-\frac{\omega}{\phi} + \bar{\gamma} + \frac{1-\underline{q}}{\phi R}\right]}
$$

We select the minus root, since it is one that produces a solution that is economically meaningful and satisfies $\lim_{\phi\to\infty} \gamma = \bar{\gamma}$. The derivative of γ with respect to R is

$$
\frac{\mathrm{d}\gamma}{\mathrm{d}R} = -\frac{1-\underline{q}}{2\phi R^2}\left[1 + \frac{1}{2}\frac{1-\bar{\gamma}-\frac{1-\underline{q}}{\phi R}}{\sqrt{\left[\frac{1+\bar{\gamma}}{2} + \frac{1-\underline{q}}{2\phi R}\right]^2 - \left[-\frac{\omega}{\phi} + \bar{\gamma} + \frac{1-\underline{q}}{\phi R}\right]}}\right]
$$

and it is negative for large enough ϕ, thus establishing the second result. To establish the first, let Ω denote the slope of the yield curve,

$$
\Omega \equiv \frac{q_S}{q_L} = \frac{1-\gamma}{\omega R + (1-\gamma)\underline{q}}
$$

So that

$$
\frac{\mathrm{d}\Omega}{\mathrm{d}R} = -\frac{\omega}{[\omega R + (1-\gamma)\underline{q}]^2}\left[1 - \gamma + R\frac{\mathrm{d}\gamma}{\mathrm{d}R}\right]
$$

For ϕ large enough, $\frac{\mathrm{d}\gamma}{\mathrm{d}R} \to 0$, and so the above term is strictly negative, establishing our claim. $\square$

C Model of Margin Calls and Collateral Trade

Consider a risk-neutral investor that lives for three periods, $t = 0, 1, 2$ and can choose at $t = 0$ to undertake a leveraged investment on either a short-term bond maturing at $t = 1$, a medium-term bond maturing at $t = 2$, or a long-term bond that does not mature in the investor's lifetime. The investor can partially finance this investment with a collateralized loan that matures at $t = 2$. If the value of the collateral falls (or the collateral matures) before the loan is due, the investor is subject to a margin call and needs to raise sufficient liquidity to compensate the lender for this shortfall. We assume that raising liquidity is costly: each unit of liquidity raised at $t = 1$ costs r at $t = 2$.

The bonds are priced by deep-pocketed, risk-neutral investors with discount factor $\eta < 1$. This means that the price of a bond with maturity s is η^s at $t = 0$. At each subsequent period $t = 1, 2$, with probability α, these investors may receive a preference shock that lowers their discount factor permanently by a factor of $\rho^- < \eta$, or raises their discount factor permanently by a factor of $\rho^+ > \eta$. Thus the price of a bond with maturity s at $t = 1$ becomes $(\rho^x \eta)^s$ after shock $x \in \{-, +\}$. This revaluation may trigger a margin call for longer maturity bonds. We assume that $\alpha\rho^- + (1 - \alpha)\rho^+ < 1$, so that the yield curve is always upward sloping (longer-term bonds are cheaper). This means that the frictionless yields for each of the bonds are

$$
\begin{aligned}
y_S &= \frac{1}{\eta} \\
y_M &= \frac{1}{\eta^2} \\
y_L &= \frac{\alpha\rho^- + (1 - \alpha)\rho^+}{\eta^2}
\end{aligned}
$$

Let us analyze separately the payoffs of investing in a short-, medium- and long-term bond. Let $h \in (0, 1)$ denote the haircut on collateral, and R the interest rate on the LTRO loan. Since we want to focus on the relative preference for different maturities, and not on the desirability of the carry trade *per se*, we assume that $\eta < 1 + R$, so that an unconstrained carry trade is always profitable at any maturity. We assume that there is storage with return unity.[2]

A short-term bond costs η at $t = 0$ and is completely riskless, yielding 1 at $t = 1$. The bank invests by borrowing $h\eta$. Since the collateral matures before the loan, the bank is requested to deposit $h\eta$ at $t = 1$. Since $1 > h\eta$, this margin call is inconsequential and the bank does not need to raise any external liquidity. It receives the margin call deposit at $t = 2$, and repays the loan plus interest. The total profit from this trade is

$$\pi_S = -\eta + h\eta + (1 - h\eta) + [h\eta - (1 + R)h\eta] = 1 - \eta - Rh\eta$$

Given the bank's initial capital, $k < \eta^3$, it can purchase a quantity equal to $\frac{k}{(1-h)\eta}$, and so the profit of this trade is equal to

$$\pi_S = \frac{k}{1-h}\left[\frac{1}{\eta} - 1 - Rh\right]$$

Similarly, we can show that the profits for investing in medium and long-term bonds are given by

$$\pi_M = \frac{k}{1-h}\left[\frac{1 + \alpha r h \rho^- \eta}{\eta^2} - 1 - Rh - \alpha r h\right]$$
$$\pi_L = \frac{k}{1-h}\left[\frac{\alpha\rho^-\eta + (1-\alpha)\rho^+\eta + \alpha r h(\rho^-)^2\eta^2}{\eta^3} - 1 - Rh - \alpha r h\right]$$

We can show that $\pi_L \leq \pi_M$ if

$$\alpha r h \rho^- \eta(1 - \rho^-\eta) \geq \alpha\rho^- + (1-\alpha)\rho^+ - 1$$

So that, if the probability of a downwards revaluation (and the magnitude of that revaluation) is high enough, and exceeds the return benefits of investing in a long-term bond, the investor may prefer to invest in a medium-term bond. We can derive similar conditions, under which $\pi_L \leq \pi_S$. They are mainly related to liquidity risk: the short-term investment exposes the

[2] Basically, the investor can save for a net return of zero and borrow for a net cost of r.

bank to no type of liquidity risk whatsoever. The medium-term bond exposes the bank to margin call risk, with probability α. The long-term bond exposes the bank to both margin call *and* funding liquidity risk at the final period, since the bond's payoff (its price on the secondary market) may be uncertain. Since there is no discounting, the unconstrained, risk-neutral investor would simply prefer the bond that offers the ex-ante higher return, which is the long-term bond by assumption. Due to liquidity risk, emanating both from margin calls and uncertain prices at loan maturity, the investor may prefer to invest at the shorter term.[3]

D LTRO Uptakes

At either of the two allotment dates intermediaries could obtain and use long-term central bank liquidity for two reasons: they could increase their *total* borrowing from the ECB or rollover previous central bank borrowing at the longer (3-year) LTRO maturity. The possibility of using the LTRO to rollover previous central bank borrowing is explicitly mentioned in the operation announcement: "Counterparties are permitted to shift all of the outstanding amounts [...] into the first 3-year LTRO allotted on 21 December 2011." Consider the Portuguese bank that borrowed 93.5 at the LTRO. Suppose that it was already borrowing 50 from the central bank in November 2011, *before* the LTRO liquidity provision. Having obtained 93.5 at LTRO, it could have decided, for example, to (i) use 50 to entirely rollover, at the longer 3-year maturity, the previous short-term debt with the ECB and (ii) increase its total exposure to the monetary authority of 43.5 ("new borrowing").

In Table D.1, we disentangle short- and long-term borrowing from the ECB and provide more detail on existing debt and net uptakes. In the first allotment, short-term borrowing from the ECB decreased by €19.9 billion while 16 banks tapped the LTRO for €20.2 billion. In the second allotment, short-term borrowing decreased by €18 billion while long-term borrowing increased €26.8 billion, leading to a total ECB borrowing increase from €47.6

[3] Our analysis is robust to adding an additional period, so that the investor would obtain a certain payoff from the long-term bond. This would, however, still entail funding risk at loan maturity, since the investor would need to either sell the bond (as in our set-up) or raise costly external funds to repay the loan.

	Tot tapped (bn €)			No. banks			
	Short	**LTRO**	**ECB Total**	**Short**	**LTRO**	**ECB Total**	**Tot Assets**
Nov11	45.7	−−	45.7	18	−−	18	552.1
Dec11	25.8	20.2	46.0	19	16	21	551.9
Feb12	27.4	20.2	47.6	18	15	20	559.9
Mar12	9.4	47.0	56.4	16	23	23	557.2

Table D.1: ECB Borrowing around the LTRO. This table shows the amount borrowed and the number of borrowing banks for the different types of ECB borrowing facilities during the allotment period. The first three columns show the amount borrowed from: shorter term operations (MROs and LTROs), 3-Year LTROs, and total ECB borrowing around the months of the first and second LTRO allotment. The following three columns show the number of banks participating in each type of operation. The final column is the value of total assets in billion €.

billion to €56.4 billion. In November 2011, 18 banks were borrowing from the ECB. All of these access at least one of the LTROs: 15 tap LTRO1 and all tap LTRO2. Five additional banks tap LTRO even though they were not borrowing from the ECB before. In Figure D.1 and Figure D.2, we plot the time series of total ECB borrowing and total LTRO borrowing, normalized by bank total assets and in billion euros, respectively.

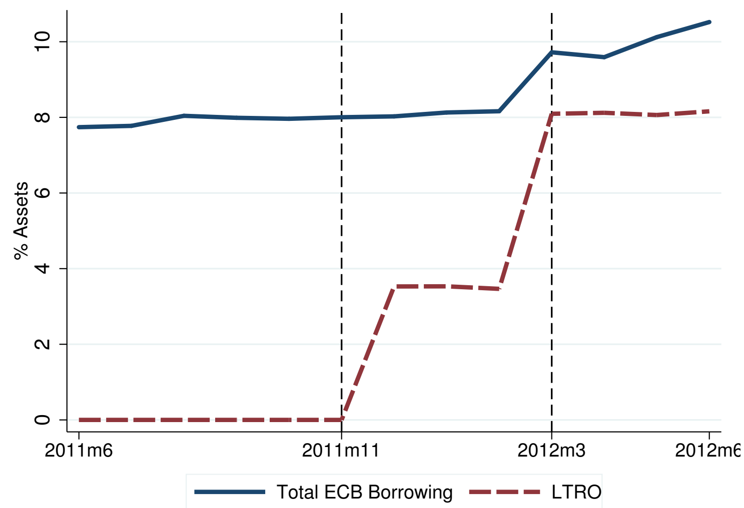

Figure D.1: ECB Borrowing. This figure plots the evolution of total ECB borrowing (solid line) and LTRO borrowing (dashed line) normalized by total assets by our sample banks from June 2011 to June 2012. The two vertical dashed lines delimit the allotment period.

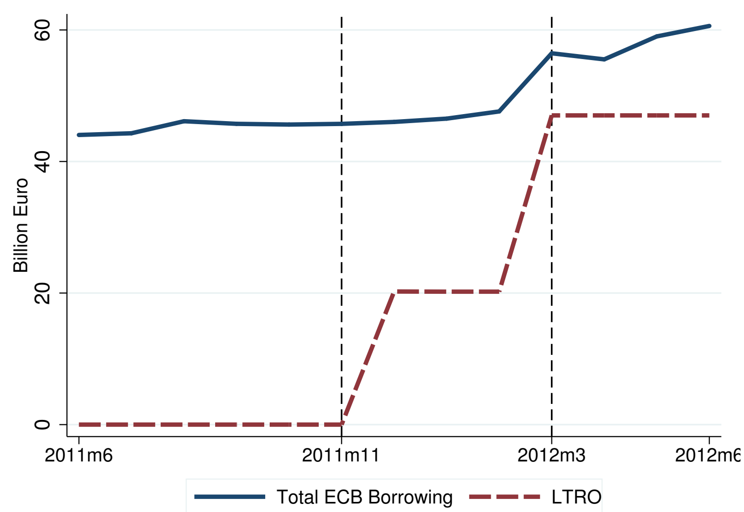

Figure D.2: ECB Borrowing, Billion euro. This figure plots the evolution of total ECB borrowing (solid line) and LTRO borrowing (dashed line) in billion euro by our sample banks from June 2011 to June 2012. The two vertical dashed lines delimit the allotment period.

E ECB Collateral Framework and the LTRO

Eligible collateral at the ECB falls in two broad asset classes: marketable assets and non-marketable assets. The first comprises debt instruments such as unsecured bonds, asset-backed securities, and covered bank bonds. The second class includes fixed-term deposits from eligible monetary policy counterparties, credit claims (bank loans), and non-marketable retail mortgage-backed debt instruments.[4] The LTRO period was characterized by an expansion of the eligible collateral. On the day of the announcement of the operations, the ECB also announced collateral availability by allowing riskier asset-backed securities and allowing national central banks (NCBs) to temporarily allow additional credit claims that satisfy their specific criteria, as long as the risks of this acceptance were assumed by the NCB.

On February 9, twenty days before the second allotment, BdP detailed the criteria for Portugal regarding these additional credit claims. Portfolios of mortgage-backed loans and other loans to households, as well as of loans to non-financial corporations became increasingly pledgeable as collateral. The expansion of these rules also suggests banks were collateral scarce at the time of the first allotment. Although we do not have asset-level data on the holdings of these classes of assets by banks, we rely on aggregate measures of pledged collateral for each bank. These measures include non-marketable assets whose risk was borne by the Eurosystem, additional credit claims (ACCs), government guaranteed bank bonds (GG-BBs) issued from a government fund expanded around the time of the troika intervention in mid-2011, and other marketable assets.

[4] See Section 6 of ECB (2011) for additional details on the eligibility of assets as collateral in the Eurosystem.

F Additional Figures

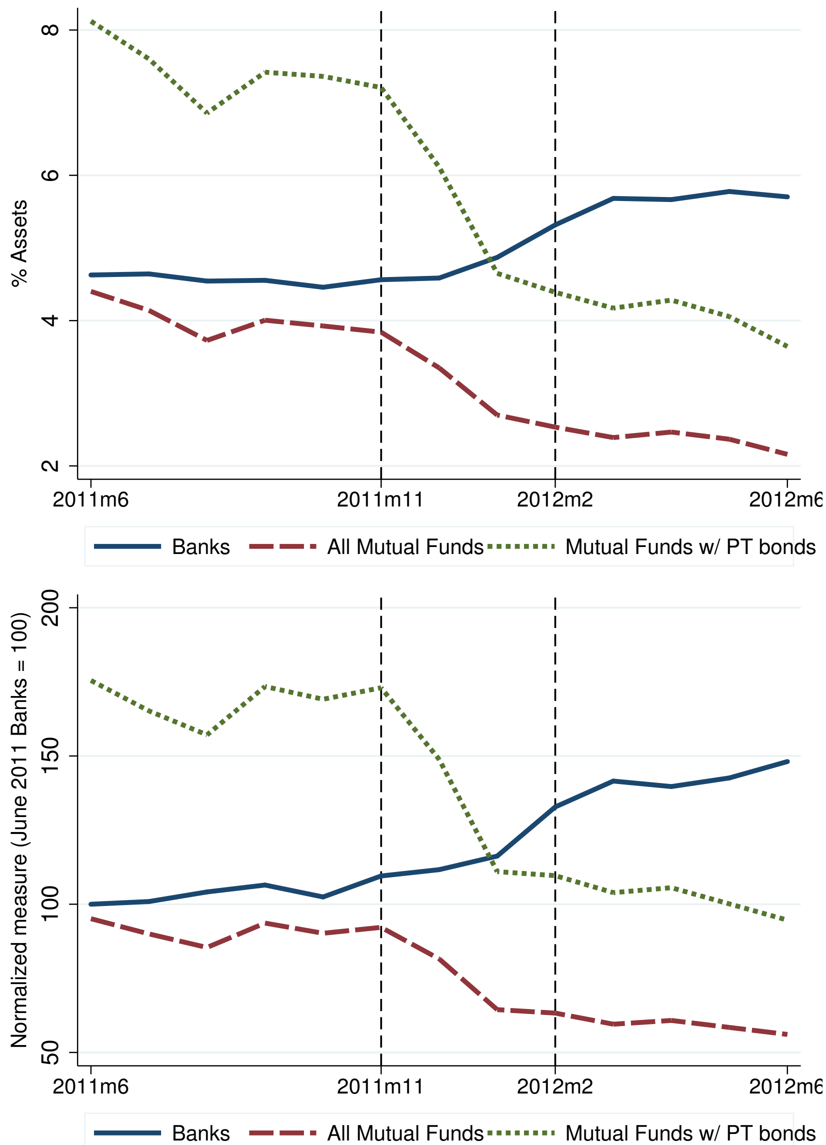

Figure F.1: Holdings of Domestic Government Debt, Robustness. This figure plots the evolution of the quantity of domestic government bonds held by banks (solid line), mutual funds (dashed line), and mutual funds that hold domestic government bonds at least once in the sample period (dotted line) from June 2011 to June 2012. In the top panel, holdings are normalized by total assets. In the bottom panel, we plot our dependent variable that normalizes holdings by both total assets and amount outstanding, as explained in Section 4.2 in the paper. The two vertical dashed lines delimit the allotment period.

G Additional Tables

	$\widetilde{\text{Holdings}}_{i,Short,t}$	$\widetilde{\text{Holdings}}_{i,Long,t}$	$\widetilde{\text{Holdings}}_{i,m,t}$	$\widetilde{\text{Holdings}}_{i,m,t}$
Post	-0.012	0.028***		
	(0.015)	(0.003)		
Post × Short			-0.039**	
			(0.016)	
Post × Short × Access				0.094***
				(0.026)
Entity FE	✓	✓		
Entity-Maturity FE			✓	✓
Entity-Time FE			✓	✓
Time-Maturity FE				✓
Sample	No Access	No Access	No Access	Full
Observations	3,934	3,934	7,868	9,654
R-squared	0.871	0.954	0.940	0.938

Table G.1: Access to ECB Liquidity and Government Bond Purchases, Robustness. This table replicates the results in Table (3) when we include all the institutions for which we have balance sheet information: the universe of banks and mutual funds in Portugal. In practice, this means that mutual funds which never hold domestic government bonds at any point in our samples are also included. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

	$\widetilde{\text{Holdings}}_{i,Short,t}$	$\widetilde{\text{Holdings}}_{i,Long,t}$	$\widetilde{\text{Holdings}}_{i,m,t}$	$\widetilde{\text{Holdings}}_{i,Short,t}$	$\widetilde{\text{Holdings}}_{i,Long,t}$	$\widetilde{\text{Holdings}}_{i,m,t}$	$\widetilde{\text{Holdings}}_{i,m,t}$
Post	0.083***	0.028***		-0.026	0.014*		
	(0.022)	(0.006)		(0.022)	(0.008)		
Post × Short			0.055***			-0.041	
			(0.021)			(0.028)	
Post × Short × Access							0.095***
							(0.035)
Entity FE	✓	✓		✓	✓		
Entity-Maturity FE			✓			✓	✓
Entity-Time FE			✓			✓	✓
Time-Maturity FE							✓
Sample	Access	Access	Access	No Access	No Access	No Access	Full
Specification	(2a)	(2b)	(3)	(2a)	(2b)	(3)	(5)
Observations	893	893	1,786	3,233	3,233	6,466	8,252
R-squared	0.764	0.828	0.905	0.785	0.847	0.865	0.869

Table G.2: Access to ECB Liquidity and Government Bond Purchases, Robustness. This table presents the results of specification (2a) in columns (1) and (4), specification (2) in columns (2) and (5), and specification (3) in columns (3) and (6). Column (7) shows the results for specification (5). The sample in columns (1)-(3) includes only institutions with access to ECB liquidity. The sample in columns (4)-(6) includes only institutions with no access to ECB liquidity. Column (7) shows an estimation on the full sample. The dependent variable in column (1) and (4) (column (2) and (5)) is the share of total short (long) term public debt outstanding held by financial entity i divided by the size of entity i relative to total asset of the financial sector. The dependent variable in column (3) and (6)-(7) is the share of public debt of maturity m outstanding held by entity i divided by the size of entity i relative to total asset of the financial sector. The key difference relative to the main text is that now *Short* is a dummy equal to one at time t if the bond matures at $t + 3$ years or before. All other variables are defined as in Table 2 and Table 3. The sample period runs monthly from June 2011 to June 2012. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

References

Crosignani, M., M. Faria-e-Castro, and L. Fonseca (2015): "The Portuguese Banking System during the Sovereign Debt Crisis," *Banco de Portugal Economic Studies*, 1, 43–80.

ECB (2011): *The Implementation of Monetary Policy in the Euro Area*, general Documentation on Eurosystem Monetary Policy Instruments and Procedures.