

ECB Euro Liquidity Lines*

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Central bank liquidity lines have gained importance as a cross-currency liquidity management tool with the intention to prevent threats to financial stability. We provide a complete timeline of ECB liquidity line announcements and quantify their signaling effect. The premium to borrow euros in FX markets is estimated to decrease by 51 basis points upon announcement. Moreover, we test for spillbacks and find that bank stock prices increase by around 2.1 percent in euro-area countries highly exposed via banking linkages to currencies targeted by liquidity lines. The mechanism behind this novel result is illustrated in a stylized bank default model.

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1. Introduction

Central bank swap and repo lines have been used extensively in the last two decades to provide foreign-currency liquidity across jurisdictions. These liquidity lines have two components, called legs. The first consists of an agreement between a source central bank and a recipient one. When a swap line is active, the recipient central bank can access the source central bank's currency in exchange for its domestic currency at the spot exchange rate, up to a maximum amount, and at a fixed interest rate, which is below the market rate. At maturity, the same amount of money is exchanged among the two counterparties at the same fixed spot exchange rate.¹ In this way, the recipient central bank can inject liquidity into the domestic market via repo lines with the domestic financial institutions—which is the second leg of the line. Ultimately, these liquidity injections prevent market pressure on the domestic currency, if currency needs were to be met by private agents, or avoid exhausting domestic reserves, if needs were to be met by reserves' sell-off (Aizenman, Jinjarak, and Park 2011).

In this *do ut des* agreement, on the one hand, the recipient central bank can support the liquidity needs of its domestic banking system. On the other hand, by reducing foreign liquidity shortage, the source central bank prevents negative spillovers in the form of financial instability. Note that the source central bank is exempted from bearing the risk of default of the institutions accessing the credit in the recipient country, which is entirely borne by the recipient central bank, reflecting its comparative advantage in monitoring these institutions. The transaction does not involve exchange rate risk for any of the two counterparts, since the forward exchange rate is fixed. Finally, the agreement can be arranged as a swap or repo line.² In the latter case, the recipient central bank has to pledge assets denominated in the source-country currency as collateral to the source central bank to have access to the currency.

¹Although these arrangements are referred to as central bank swap lines, they have different features with respect to foreign exchange (FX) swaps in private markets. De facto, the former provides a collateralized loan of the source central bank's currency.

²Bahaj and Reis (2023) provide an in-depth discussion of the institutional framework and mechanisms of the central bank liquidity lines.

The objective of this paper is to analyze the effect of European Central Bank (ECB) euro liquidity lines. The euro represents the second most important currency in the international monetary system.³ Just during the first month of the COVID-19 pandemic, the ECB had established eight new euro liquidity facilities and most of them have been extended twice, as of September 2022. In spite of this, the ECB liquidity line network and the effectiveness of these tools are, to the best of our knowledge, mostly unknown. We provide a description of the deployment of this tool by the ECB, creating a timeline of swap and repo line announcements based on ECB press releases. We test for the signaling effect of the ECB euro liquidity lines in reducing liquidity tensions and generating positive spillbacks to euro-area (EA) countries. We use announcement dates instead of the actual activation of the line for two reasons: first, the announcement is publicly available, and therefore any signaling effect will appear on that date. Second, if these lines serve as a prevention tool, the announcement should be sufficient to provide confidence in the functioning of the foreign exchange swap market and increase liquidity. Schnabel and Panetta (2020) underline that these liquidity arrangements do not need to be actually used to be effective.

As shown in Bahaj and Reis (2022), by providing an outside option to the FX market, central bank liquidity lines put a ceiling on deviations from covered interest parity (CIP), lowering recipient-country agents' funding costs. Moreover, by the expectations theory of the term structure, this argument also holds in the case of the mere announcement of a liquidity line, which ultimately caps the price of forward agreements. To test empirically the effectiveness of ECB euro liquidity lines, we follow Bahaj and Reis (2022) and Cetorelli, Goldberg, and Ravazzolo (2020). We measure the euro funding costs in FX markets using the daily deviations of the covered interest parity before and after the announcement of a euro liquidity line on currencies targeted by the line versus a control, non-targeted group. Similar to Bahaj and Reis (2022), our identification relies on a difference-in-differences (DID) strategy. Considering the lines the ECB established with small European countries, we find

³ According to the ECB, the euro represents around 36 percent of the share of global payments at the end of 2022 and around 20 percent of the share in global holdings of foreign reserves.

that the mere announcement of euro swap and repo lines reduces the euro funding cost in foreign exchange swap markets by 51 basis points. This effect corresponds to about 40 percent of one standard deviation of the residuals.

Turning to the spillback effects, we rationalize the mechanism of transmission in a stylized model. The announcement of a central bank liquidity line decreases the default probability of recipient-country financial intermediaries by reducing their euro refinancing cost. This increases the expected payoff of the source-country credit to the recipient bank, increasing the source-country bank's value and eventually its stock market price. We test the prediction of the model leveraging on the heterogeneity across euro-area countries. Banks in different EA jurisdictions can be affected heterogeneously depending on their exposures to foreign markets via the domestic banking sector, proxied by the share of cross-border claims of EA banks toward countries that receive liquidity lines. By introducing the exposure of the banking sector in EA countries in a DID framework, we estimate the differential effect of these announcements on the change in euro-area banks' stock prices. Consistent with our model, we find that EA countries with the most exposed banking sectors benefit the most from the announcement of the lines since they experience a relative increase in their stock prices of about 2.1 percent in a four-day window around the announcement. In other words, more exposed banks see their market valuation increase after the announcement. Overall, the analysis suggests that the signaling effect of central bank liquidity facilities is effective in generating a positive direct effect on foreign FX markets as well as spillovers on the source country.

This paper is connected to the economic literature looking at the beneficial effects of swap lines. Several papers have studied how central bank liquidity lines have lubricated both money markets and foreign exchange swap markets in the Global Financial Crisis (GFC) (Carré and Le Maux 2020; Obstfeld, Shambaugh, and Taylor 2009) as well as in the more recent COVID-19 crisis (Aldasoro et al. 2020). Consistent with the central role of the USD in the global financial markets, most of these arrangements have provided liquidity in this currency. Indeed, Federal Reserve (Fed) USD swap lines played an effective lender-of-last-resort function in FX markets by putting a ceiling on deviations from the CIP (Baba and Packer 2009; Bahaj

and Reis 2022; Moessner and Allen 2013, among others). This mechanism also worked during the COVID-19 crisis (Bahaj and Reis 2020; Cetorelli, Goldberg, and Ravazzolo 2020). Aizenman, Ito, and Pasricha (2022) show that trade and banking linkages with the U.S. are positively associated with access to Fed swap and repo lines during the COVID-19 crisis. Fed liquidity facilities announcements during 2020 have led to an appreciation of the recipient countries' currency with respect to the USD, while dollar auctions by major central banks have expansionary effects on other economies. Using micro-level data on FX forward and swap transactions, Ferrara et al. (2022) find that dealers that draw on swap lines reduce their demand for dollars at the forward leg in the FX market and increase their supply of dollars to non-financial institutions, improving market liquidity. Moreover, Bahaj and Reis (2022) find that Fed liquidity lines have a positive spillback effect on the source country by encouraging capital inflows into USD-denominated assets. In this way, while swap and repo lines can be thought of as a by-product of globalization in financial markets since they responded to the liquidity needs of an integrated global financial system, they also proved to be useful to reinforce the international role of the source currency in the international monetary system as well as in international trade. People's Bank of China's 38 swap lines in less than a decade are a clear example of alternative use of such tools (Bahaj and Reis 2026).

The paper is structured as follows: Section 2 provides an overview of the ECB repo and swap lines network across time; Section 3 presents the data used in the analysis; Section 4 presents the empirical analysis of the direct effect of ECB liquidity line on the euro funding costs in FX markets; Section 5 introduces our stylized model, explaining one of the mechanisms behind the positive spillback effect of these facilities, and tests it empirically.

2. ECB Liquidity Lines

Historically, central banks' liquidity lines have been used for three main objectives: (i) defend a peg system (Bordo, Humpage, and Schwartz 2015) or, more broadly, fund FX interventions (Bahaj and Reis 2023), (ii) offer a financial stability tool, which in the case of the Fed becomes a global liquidity backstop (Bahaj and Reis 2022,

among others), (iii) enhance the international use of the domestic currency (Bahaj and Reis 2026).

The first objective led to the establishment in 1962 of the Fed reciprocal currency agreements, i.e., swap lines, first with the Bank of France and by the end of the same year with nine other key central banks. Under the Bretton-Woods system, the Fed intervened in forward foreign exchange markets to reestablish confidence in the USD and to defend its gold peg. At the end of the 1990s, this tool was discontinued. The global swap network regained importance as a cooperation tool across central banks only following the September 11 terrorist attack and more extensively in 2007 and 2008 with the Global Financial Crisis (GFC).⁴ In this context, central banks' liquidity agreements transformed the Fed into the global lender of last resort, limiting fire sales and helping contain the risk of market contagion.

The G10 central banks contributed to this coordinated effort to expand the USD liquidity provision capacity.⁵ In 2011, the network agreed on extending the scope of these swap lines to provide liquidity in each jurisdiction in any of their currencies. By 2013 these temporary bilateral liquidity swap arrangements were converted into a standing agreement with an unlimited withdrawal amount.

Not only did the ECB participate in such a network⁶ and establish swap lines with the People's Bank of China, the Bank of England, and the Swiss National Bank to provide foreign-denominated liquidity, but between October 2008 and August 2022 it established 14 new swap and repo lines to provide euro liquidity. The ECB has continued to renew and expand its euro facilities particularly during the COVID crisis. Euro lines have been extended both in terms of the time frame and the volume, and their pricing conditions changed.

⁴The evolution of the USD swap lines has been described in Goldberg, Kennedy, and Miu (2011), McCauley and Schenk (2020), and Moessner and Allen (2010), among others.

⁵Participating central banks were the Federal Reserve, the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank.

⁶Since 2011 the agreement also enabled central banks of the network of temporary bilateral liquidity swap arrangements to provide liquidity operations, should they be needed, in Japanese yen, British pound sterling, Swiss francs, Canadian dollars, and euros, in addition to U.S. dollars.

Counterparts were mostly EU countries outside the EA (Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Latvia, Poland, Romania, and Sweden); however, since March 20, 2020, liquidity lines agreements were signed also with non-EU countries (Serbia, San Marino, Albania, and Republic of North Macedonia).⁷ In addition, on June 25, 2020, as part of the pandemic-related crisis response, the ECB announced the establishment of the EUREP, a new and initially temporary Eurosystem repo facility to provide euro liquidity to a broader set of non-euro-area central banks.

Figure 1 provides a complete picture of all ECB liquidity lines announcements until August 2022.⁸ The timeline comprises announcements related to new agreements, time and volume extensions, and changes in the conditions. The latter may regard changes within the first leg of the line, i.e., on the agreement between the two central banks. An example is the March 15, 2020 announcement, which decreased the rate on the standing U.S. dollar liquidity swap arrangements by 25 basis points. However, they may also refer to changes in the second leg of the line, which refers to the open market operations that the recipient central bank put in place to provide liquidity to the domestic financial system. For example, it may entail a change in the frequency or the maturity of the liquidity-providing operations.⁹

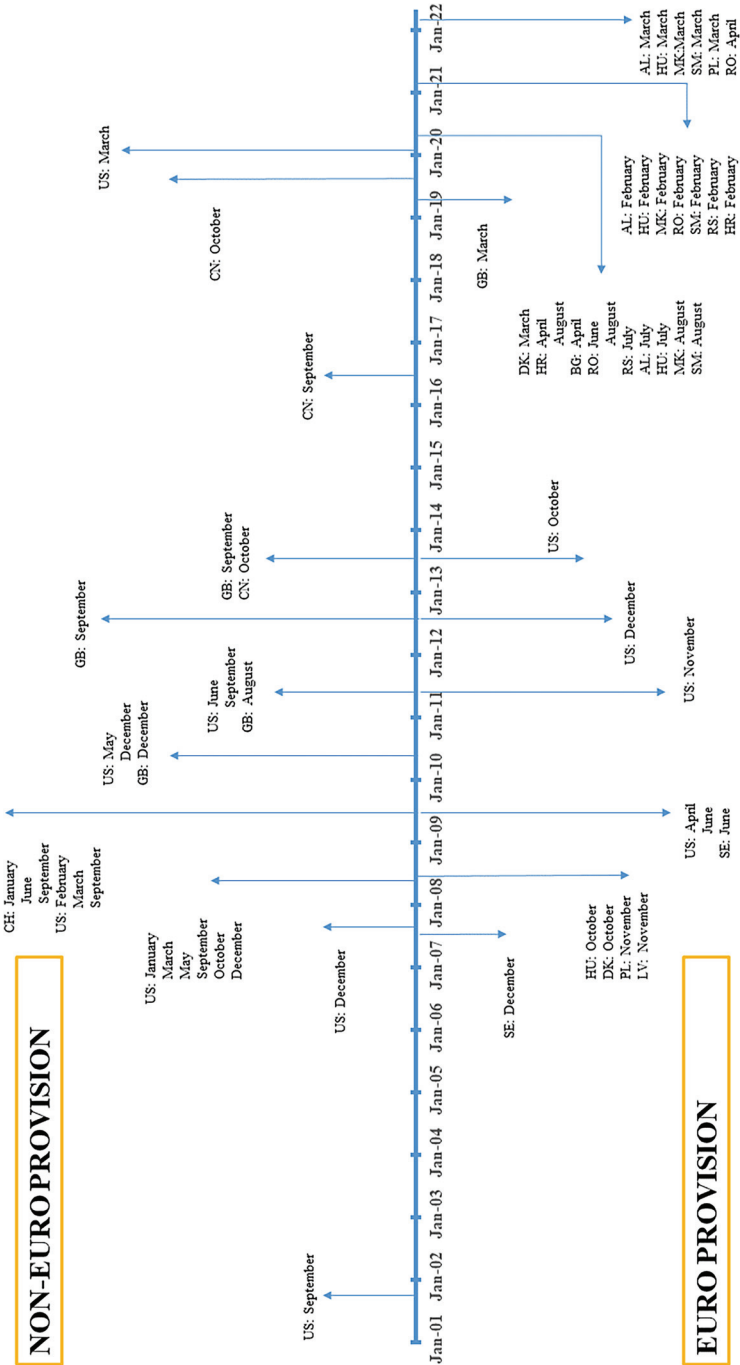
Although most of the lines within the network of the bilateral agreements among the G10 countries' central banks are reciprocal in nature, often these lines have been explicitly motivated by the need of providing USD liquidity. To capture the actual intention of the ECB in providing liquidity in euros versus other currencies, Figure 1 distinguishes between euro and non-euro lines based on the

⁷Previous to October 2008, in 2007, the ECB established its first euro swap line with the central bank of Sweden. However, this event is not included in the analysis since the goal of this paper is to estimate the signaling effect of these lines and the latter has been announced in the ECB press releases much later than the actual decision.

⁸The timeline does not include the EUREP facility since the respective country-specific announcements are not public. This remains the case under the ECB's permanent framework for euro liquidity lines (January 2024) and the standing EUREP facility (February 2026), under which the ECB discloses only aggregate weekly drawings across repo lines.

⁹The timeline does not include discontinuations of central bank lines or maturities of liquidity-providing operations with the domestic financial system.

Figure 1. ECB Liquidity Facility Announcements



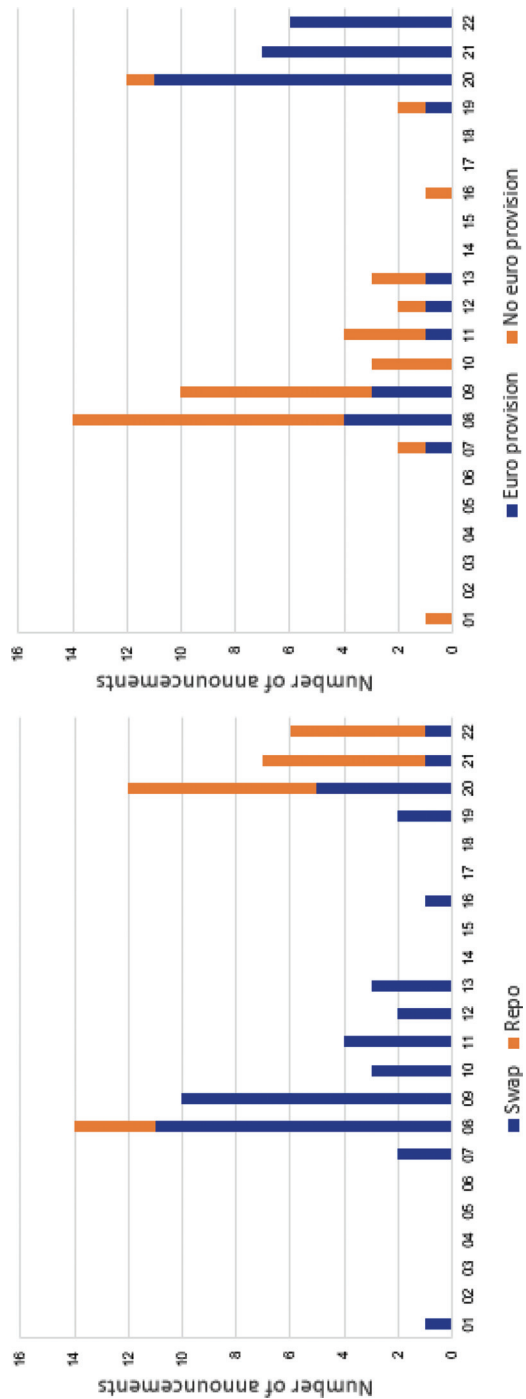
Note: The figure reports the announcements of ECB liquidity facilities. Above the timeline, announcements related to lines between the ECB and other central banks for the provision of foreign currencies (such as USD, GBP, CHF, CNY) are reported. Below the timeline, ECB euro liquidity facilities are recorded.

information reported in the ECB press releases. Announcements related to the former are reported below the timeline, while announcements related to the latter are above the timeline. As the chart shows, euro liquidity lines are mainly clustered around crisis episodes, suggesting the ECB liquidity lines have been mainly used as a liquidity backstop. However, some of these have also been used in the context of the exchange rate mechanism (ERM II), a peg system to the euro, which is a prerequisite for any EU member state to join the euro area—as in the case of Bulgaria on April 22, 2020. Differently from the People’s Bank of China, the ECB has not leveraged on euro liquidity facilities to provide incentives for the internationalization of its currency. Bahaj and Reis (2026) show that the creation of People’s Bank of China RMB swap lines between 2009 and 2018 triggered the jump-start of RMB’s international status. In fact, it increased the probability of using the RMB and its share in the country’s payments. Although we don’t formally test whether the announcements of the euro liquidity lines have increased the probability of using the euro for sales invoicing, there are two main factors that bring us to discard that the ECB has intended to use the liquidity lines for the internationalization of the euro, so far. First, the network is very much geographically concentrated, either in EU countries or countries in close proximity that would use the euro for some of their transactions anyway.¹⁰ Second, the line announcements are concentrated around episodes of actual or potential market turbulence or crisis. Appendix A.3 reports the full timeline of ECB liquidity facilities, specifying additional characteristics of each line announcement.

Figure 2, panel A, shows the total number of announcements by year conditional on the type of facility, swap or repo. Repo facilities require adequate collateral in euro-denominated assets and feature a higher lending rate compared to swap lines. Figure 2, panel B, reports the yearly number of announcements of lines explicitly motivated by the need of providing euro liquidity versus other currencies, such as the U.S. dollar or Swiss franc. Taken together, these two panels underline a shift in the role of the ECB. Initially, the lines served mainly as facilities to enhance USD liquidity in

¹⁰As mentioned, we do not consider the EUREP facility.

Figure 2. ECB Liquidity Facility Announcements



Note: The left panel shows the breakdown of the total number of announcements with respect to the type of facilities. Blue bars denote swap lines, while orange ones refer to repos. The right panel distinguishes between euro, in blue, and non-euro provisions, in orange, according to the explicit motivation provided in the ECB press releases.

the EA via swap lines. During the Global Financial Crisis, both ECB euro and non-euro lines increased predominantly due to the increasing number of swap line extensions with G10 countries. However, the pandemic triggered increasing ECB interventions as regional lender of last resort providing euro-denominated loans to European countries outside the euro area, mainly via repos.

With respect to the conditions, except for the swap lines within the G10 network, most of the facilities were temporary during our sample period, with a maximum amount of allotment at an interest rate specified in each agreement.

Finally, with respect to the activation of the lines, the available information is scarce. Based on recipient countries' sources of information, at least the liquidity lines with the Magyar Nemzeti Bank, the Sveriges Riksbank, and the Bank of England have already been used, although in small amounts.

3. Data

For the purpose of this analysis, we consider all euro liquidity lines reported in the ECB press releases.¹¹ We exclude (i) countries that are targeted by the lines but use the euro as the main currency, such as San Marino; (ii) the G10 network, due to the *de iure* reciprocal nature of the swap lines, to avoid confounding the effect of a euro liquidity line with the impact of USD or other currencies provisions; (iii) the agreements with the National Bank of the Republic of North Macedonia, the National Bank of Romania, and the Bank of Albania, due to data limitation for the construction of the dependent variable; (iv) agreements that were not publicly announced or were not included in the ECB press releases, as is the case for the December 2007 agreement with Sveriges Riksbank and the November 2008 agreement with the Bank of Latvia, since the signaling effect might be diluted. The final sample then comprises 12 liquidity line announcements with seven counterparts whose currencies have been targeted by the lines: Bulgaria, Denmark, Croatia, Hungary, Poland, Serbia, and Sweden. The liquidity lines in our sample were established between October 2008 and March 2022. None of the liquidity lines established prior to October 2008 fit our selection

¹¹The timeline is available at ECB liquidity lines - Timeline.

criteria, due to lack of public announcement (December 2007, Sweden), or reciprocity within the G10 network (all other events prior to October 2008).

The included events are the following:

- October 16, 2008: Repo agreement with the Magyar Nemzeti Bank (HU) to support the bank's instruments of euro liquidity provision.
- October 27, 2008: Swap agreement with the Danmarks Nationalbank (DK) to improve liquidity in euro short-term markets.
- November 21, 2008: Repo agreement with the National Bank of Poland (PL) to support the NBP's instruments of euro liquidity provision.
- June 10, 2009: Activation of the swap agreement signed with the Sveriges Riksbank (SE) on December 20, 2007 with the aim of facilitating the functioning of financial markets and providing euro liquidity to the latter if needed.
- March 20, 2020: Reactivation of the swap line with Danmarks Nationalbank (DK) to provide euro liquidity to Danish financial institutions.
- April 15, 2020: Precautionary swap agreement with the Central Bank of Croatia (HR) to provide euro liquidity to Croatian financial institutions in order to address possible market dysfunction.
- April 22, 2020: Precautionary swap agreement with the Bulgarian National Bank (BG) to provide euro liquidity.
- July 17, 2020: Repo agreement with the National Bank of Serbia (RS) to provide euro liquidity to Serbian financial institutions to address possible euro liquidity needs in the presence of market dysfunctions due to the COVID-19 shock.
- July 23, 2020: Repo agreement with the Magyar Nemzeti Bank (HU) to provide euro liquidity to Hungarian financial institutions to address possible euro liquidity needs in the presence of market dysfunctions due to the COVID-19 shock.
- August 28, 2020: Extension of the repo facility with the Central Bank of Croatia (HR) to provide euro liquidity to financial institutions in the two countries via their respective national central banks to address possible euro liquidity needs in the presence of market dysfunctions due to the COVID-19 shock.

- February 4, 2021: Extension of the temporary swap and repo lines with non-euro-area central banks (HR, RS, HU) to address possible euro liquidity needs in non-euro-area countries in presence of market dysfunctions due to COVID-16.
- March 28, 2022: Swap agreement with Narodowy Bank Polski (PL), and extension of temporary repo lines with central banks of Hungary (HU) to prevent spillover effects in euro-area financial markets and economies that might adversely affect the smooth transmission of the ECB's monetary policy in the context of heightened geopolitical tensions triggered by the Russian invasion of Ukraine.

Finally, as a robustness check, we add two countries whose currencies have never been targeted by ECB liquidity lines: Norway and Iceland. They represent an interesting robustness check because, although both are small countries, close EU partners, and have experienced financial distress, they have not been targeted by the lines.

To test the effectiveness of the ECB euro liquidity line, we consider the change in the euro funding cost in FX markets. In a frictionless FX market, the covered interest parity holds and the implied euro interest rate in the FX market equals the euro money market interest rate. If the CIP does not hold, the FX swap basis spread provides a measure of the premium paid by foreign agents to borrow euros for a specified time period in the FX market compared to the euro money market. In other words, a positive basis represents relatively high costs for euro funding in the FX market. Following Bahaj and Reis (2022), the euro basis is defined as

$$B_t = \ln(F_t) - \ln(S_t) - (r_t - r_t^*), \quad (1)$$

where F_t is the one-week market forward rate of the euro against the rest of the currencies, S_t is the equivalent spot rate, r_t stands for the interest rate of the euro deposits, and r_t^* is the interest rate for deposits in each of the foreign currencies considered.¹² We

¹²Under covered interest parity, the no-arbitrage condition $\frac{F_t}{S_t} = \frac{1+r_t}{1+r_t^*}$ holds. Equation (1) follows from taking logs and using the approximation $\ln(1+r) \approx r$, valid for small r .

use one-week euro currency deposits when possible, and build back some series for some countries using the equivalent interbank interest rate. All data are obtained from Refinitiv databases on a daily frequency. We prefer to use OIS rates, but due to data availability constraints in some cases, we use EURIBOR (euro-area interbank offered rate) rates instead. Table A.6 in Appendix A.4 shows the main descriptive statistics for CIP deviations. Furthermore, since recipient-country idiosyncratic factors may drive the FX basis in times of financial turbulence, we purge the basis from country-specific factors closely related to the occurrence of financial crises, such as sovereign defaults, and banking runs, or currency crashes.

In other words, in the econometric specification, our main dependent variable is defined as the residuals res_{jt} of country-by-country regressions of the basis on country-specific characteristics collected in the vector $\Omega_{j,t}$:

$$basis_{jt} = \alpha_j + \beta \Omega_{jt} + res_{jt}. \quad (2)$$

Following Alonso-Alvarez and Molina (2023), Ω_{jt} includes the following battery of controls at different frequencies, sourced from Refinitiv. In terms of high-frequency data, we construct a volatility measure for the country-specific equity index as the 40-day standard deviation of the daily change of the domestic equity index. We also include the long-term yield of sovereign bonds, in local currency when possible, or using the Emerging Markets Bond Index (EMBI) instead. In terms of lower-frequency variables, we include the quarterly change in gross public debt as a percentage of GDP, the annual moving average of the current account balance as a percentage of GDP, countries' short-term external debt in percentage of international reserves, the inflation rate (year-on-year change of the consumer price index), and the level of central banks' international reserves in billions of USD. Finally, to proxy for the general economic performance and solvency of a country, we include the sovereign credit rating, as defined by Standard and Poor's, transforming its alphanumeric scale linearly, from 21 (AAA ratings) to 12 (BBB-, that is, the investment-grade level) and 0 (restricted defaults or selective defaults, RD and SD). Note that this approach is preferable to just controlling for country characteristics in the DID analysis on the basis since it relies on longer time series, while the DID is just

over a four-day window.¹³ Figures A.3–A.6 report the time series of the basis and the residuals.

In the last part of the paper, to assess the potential spillback effect on the EA, we consider EA banks' stock prices as a relevant metric, since they capture market valuations and expectations about bank-specific profitability. In the context of our analysis, the working hypothesis would be that the announcement of an ECB swap line with a third country outside the euro area reduces the risk of financial turbulence and/or the probability of default of banks or firms in that concrete market. This, in turn, improves the valuation of the highly exposed EA banks, and the stock price should increase. Equity prices are obtained on a daily frequency from Refinitiv, and we use the Datastream aggregate bank equity indices for each country. As in the case of the FX basis, we purge the equity indices from country-specific factors. Since in this last exercise the dependent variable is at the EA country level, we purge for variables that may affect the health of the banking sector of a given EA country. These are the short-term interest rate, defined as the three-month Treasury bill interest rate, or the closest maturity when the former is not available; the nominal effective exchange rate deviation, calculated as the difference between the observed nominal effective exchange rate and the exchange rate that would prevail if the real effective exchange rate were consistent with its long term mean, using the International Monetary Fund (IMF) nominal and real effective exchange rates; net foreign assets of domestic banks, defined as the difference between domestic banks' claims and liabilities with non-residents over GDP (as defined by the IMF's International Financial Statistics database); and the loan-to-deposit ratio, defined as domestic banks' claims on the private sector over the sum of deposits (transferable deposits included in broad money definition, other deposits included in broad money, and deposits excluded from broad money), as posted by the IMF's International Financial Statistics database. In Appendix A.1 we summarize the descriptive statistics for the stock market data as well as the banks included in the respective aggregates.

¹³Since the inclusion of low-frequency variables may create concerns about jumps in the data, as a robustness check we exclude them from the specification, and the results hold.

Finally, to construct a measure of EA countries' banking-sector exposure to foreign countries, we use the Bank for International Settlements Consolidated Banking Statistics on a quarterly basis. In particular, we consider total claims of each EA domestic bank on foreign banking sectors, all maturities, and all instruments and currencies, measured on a guarantor basis. The exposure of the banking sector of EA country j to non-EA country i is calculated as the share of claims on country i over total claims of domestic banks of country j on all countries. For example, Italy's exposure to Bulgaria is proxied by the share of Italian banks' total claims on Bulgarian banks over the total of cross-border claims of Italian banks. When missing, data are imputed using linear interpolations. The EA country exposure is then calculated as the average exposure toward the countries targeted by a liquidity facility. Based on this measure, we construct a dummy that allows us to classify EA countries' banking sectors as highly exposed to non-EA countries if the average exposure of EA country j in the quarter prior to the announcement t is higher than the 75th percentile of the cross-country and event distribution. On the contrary, we defined an EA country banking sector as lightly exposed if its exposure is lower than the 75th percentile threshold. Table A.9 in Appendix A.4 tabulates the exposure dummy across countries and announcements. As a robustness check, we also use (i) the 65th percentile as the relevant threshold and (ii) the continuous exposure measure without any threshold.

4. Direct Effect: Euro Funding in FX Markets

4.1 Mechanism

Bahaj and Reis (2022) show how an active liquidity line caps the forward price in FX swaps. Intuitively, central bank liquidity lines provide recipient-country banks with a cheaper outside option to the FX market, which improves the bargaining terms that the recipient-country banks obtain from the traders. Through the term structure, this argument holds also in the case of the mere announcement of a liquidity line, which ultimately caps the price of forward agreements.¹⁴ To see this, assume there is a trader who has

¹⁴We thank an anonymous referee for pointing this out.

access to one-day swap agreements and one-week swap agreements at time t . The liquidity announcement lowers the expected price of the future one-day agreements since there is a probability that the line will be activated, capping the swap price. Consequently, the announcement decreases also the price of one-week swaps at t .¹⁵

This section, first, presents the methodology used to estimate the signaling effect of ECB euro liquidity facilities on the euro funding cost in FX market, as measured by CIP deviations; second, it reports the results; and, finally, it provides evidence of the robustness.

4.2 Empirical Strategy

As in Bahaj and Reis (2022), our empirical strategy is based on a high-frequency DID approach. The high-frequency dimension of the approach consists of considering changes in financial variables in a short window around the announcement. It contributes to identifying the causal effect of central banks' actions since (i) markets react only to unexpected announcements and (ii) the short time window helps to exclude other confounding factors. Specifically, we consider a window spanning two days before and one day after the announcement. In addition, the DID aspect is required for two reasons. First, since these events are sporadic, it is more informative to focus on specific episodes of financial stress when the volume of trading in swap contracts increases and the equilibrium is constrained by the FX swap supply curve. Second, as underlined in Section 2 as well as in the list of events considered, the ECB euro lines have been motivated by existing FX market dysfunction. This indicates a potential intrinsic correlation with confounding global factors, such as the contemporaneous worsening of global financial conditions. To avoid biased estimates, we compare the effect in the treatment group with an adequate control group.

In our context, the selection of the comparison group for the DID analysis merits some attention. The ECB euro liquidity lines have targeted most of the currencies of central banks in the geographical vicinity of the euro. This is a standard case of multiple periods and groups, where the treatment is staggered over time

¹⁵This is proofed in Appendix C.

(Athey and Imbens 2022; Callaway and Sant’Anna 2021 among others). However, the treatment is not an absorbing state since we consider announcements and not implementations. Therefore, our identification strategy is as follows. For each announcement date, we compare treated countries, i.e., countries whose currency is targeted by the announcement of an ECB line, with a counterfactual that includes currencies that are targeted at previous or future dates.¹⁶ This strategy is similar to Fadlon and Nielsen (2021), where the authors identify the effect of health shocks in labor supply using as control group households targeted on a future date. In other words, we define a currency as treated if it is targeted by the ECB line at time t , but this same currency is considered non-treated in other periods $\hat{t} \neq t$. The idea behind this is that these countries have been targeted at least once, so they share similar characteristics under the eligibility lens of the ECB. Nevertheless, this approach could raise concerns that non-targeted countries in episode t might be affected by past liquidity line announcements. However, since we consider a short window around the announcement, we also prevent that subsequent announcements could contaminate the current one.¹⁷ Once defined the window and the control group, the identification ultimately relies on the randomness of the timing of the announcement within the window considered.¹⁸

Since we have a reduced amount of events, we collapse the panel around these announcements following previous contributions (see Bertrand, Duflo, and Mullainathan 2004), and we compute the treatment effect using the two-way fixed-effects DID estimator. More formally, we consider the following setup, in which y_t^T denotes the mean outcome of the targeted countries at time t , y_t^{NT} is the mean outcome of non-targeted countries, and t is the date of the announcement of a liquidity line. We can retrieve the treatment effect β_t by

¹⁶In the robustness we add two currencies never targeted by ECB lines.

¹⁷If liquidity line announcements had long-lasting effects that contaminate the control group and the new announcement increased the probability that agents assign to the renewal of the line in the control-group country, then our estimates would actually constitute a lower bound.

¹⁸In the robustness subsection we test for anticipation and we find no such evidence.

Figure 3. Basis Density Before and After Announcement

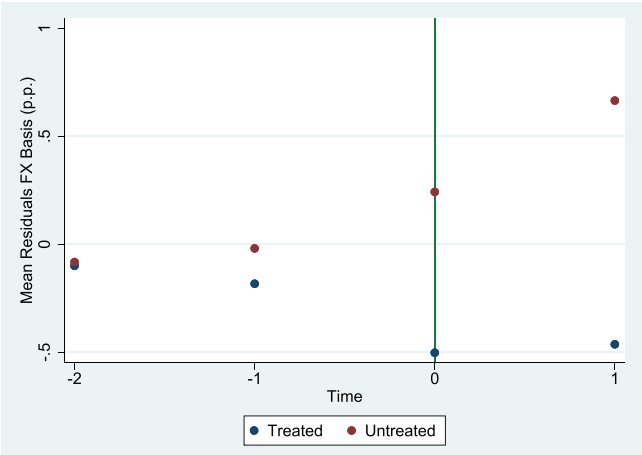
Note: Frequency distribution in a four-day window around the announcement. Country sample: Bulgaria, Denmark, Croatia, Hungary, Poland, Serbia, Sweden. For any announcement considered (see text in Section 3 for the list of events considered), the treated currency/ies is/are going to be the one/s targeted by the announcement, while the nontargeted currencies in the sample are untreated. Post-treatment is defined as the day of treatment and the day after, while pre-treatment is the two days prior to treatment.

comparing the outcome in t with the outcome in the previous period ($t - 1$), using the DID estimator:

$$\beta_t = (y_t^T - y_t^{NT}) - (y_{t-1}^T - y_{t-1}^{NT}). \quad (3)$$

First, as in Bahaj and Reis (2022), we inspect the distribution of the one-week FX swap basis spread around the facilities' announcements graphically. In Figure 3, we pool the observations to show the frequency distribution of the basis in this four-day window around the events for treated currencies (left panel) and for non-treated currencies (right panel). A country is considered treated in the window around event t if its currency is targeted by the ECB liquidity line announced in t , and it will be considered non-treated in the other events $\hat{t} \neq t$. As shown in Figure 3, the histogram for treated countries suggests a shift to the left. On the contrary, we do not observe

Figure 4. Residuals Before and After Announcement



Note: The figure shows the average evolution of the variable of interest in the four-day window around each announcement of an ECB liquidity line for the treated currencies versus non-treated. The variable is defined as the residual obtained from the regression of the FX basis on the recipient-country stock market volatility, change in public debt, current account balance, sovereign rating, sovereign yield, short-term debt, reserves, and inflation. For any announcement, the treated currency/ies is/are going to be the one/s corresponding to the announcement, while the rest of the currencies in the sample are used as controls. The events are pooled and the green vertical line indicates the day of the announcement.

such a shift in the non-treated group. This graphical inspection suggests that announcements of ECB liquidity lines are associated with a reduction of the cost of euro funding in the FX market.

To further reassert our grouping strategy and mimic our econometric specification, we purge the basis from country-specific relevant factors, as explained in Section 3, to control for country-specific factors that might contribute to diverging trends between control and treated currencies. Figure 4 shows the evolution of the residuals of the FX basis in the four-day window around the announcements of the treated versus the control group. The figure suggests a marked divergence at the time of the announcement ($t = 0$). Additionally, Figure A.1, in Appendix A.4, shows the evolution of the basis, which yields a similar picture.

Turning to the econometric specification, we exploit variation over two dimensions, as we do in the graphical inspection in Figure 3. The first is the time of the announcement; namely, we consider daily changes in the FX basis in the two days before the announcement versus the changes on the day of the announcement as well as the following day. Second is the variation between treatment versus the control group, i.e., currencies directly targeted by the swap line announcement relative to the rest. Equation (4) specifies this difference-in-differences (DID) framework via a two-way fixed-effect approach, where the daily change of the euro basis is regressed over a group variable for treated currencies at event e ($T_{i,e}$), which takes the value of one in the four-day interval around the announcement when the economies of concern are targeted by the ECB liquidity line, and zero for the non-targeted currencies; a period dummy ($Post_t$) that equals one on each of the days of the announcements and the following day (in t and $t + 1$), while it is zero in the two days before the announcement (in $t - 1$ and $t - 2$); as well as the interaction of the two ($T'_{i,e}Post_t$), which captures the differential effect of the line on the treated group at event e .

If the difference-in-differences estimation is implemented properly, there should be no need to control for global events that affect the treatment and control group similarly. To check for this, we include the following controls. Other ECB monetary policy decisions are captured by a dummy corresponding to the date of the ECB monetary policy meetings (mp_t). Moreover, we add a set of global controls included in a vector (Z_t), i.e., the Global Citi Economic Surprise Index and the EU high-yield spread.¹⁹

Finally, since we consider a collapsed panel, we include currency-event fixed effects $\mu_{i,e}$ to fully control for all currency-specific factors at the time of the announcement. Under this fixed-effect structure, $T_{i,e}$ is dropped because it is absorbed by the fixed effects. Standard errors are clustered at currency-event level. Finally, we include event-specific post dummies $Post_{t,e}$ to allow for a heterogeneous

¹⁹No further global volatility measures are included since the basis is already regressed on a country-specific measure of stock market volatility.

effect across events. The equation to be estimated is then given by Equation (4):

$$\begin{aligned} res_{i,t,e} = & \beta_1 T_{i,e} \times Post_t + \beta_2 T_{i,e} + \sum_e \beta_{3e} Post_{t,e} \\ & + \beta_4 mp_t + \varphi' Z_t + \mu_{i,e} + u_{i,t,e}. \end{aligned} \quad (4)$$

The effect of the ECB liquidity line is identified by β_1 , which is the group-time average treatment effect defined as the difference of the average treatment effect on the treated and control groups. The inclusion of the aforementioned global covariates controls for other events that could systematically occur in that short time window.

4.3 Results

Table 1 shows the results for the basis residuals. The euro funding cost decreases in a short window around the announcement by an average of 51 basis points in a sample of small EU countries (note that since the residuals are in percent the effect in the tables is in percentage points (pp) and we need to multiply it by 100 to interpret the effect in basis points). This effect corresponds to about 40 percent of one standard deviation of the residuals (see Table A.6 in Appendix A.4). The coefficient is invariant to controlling for monetary policy meetings and global controls. Hence, the differential evolution of CIP deviations between treatment and control groups does not appear to be explained by these variables, which strengthens the credibility of our identification strategy. The decrease in CIP deviations upon liquidity line announcements in treated countries underlines the regional importance of the ECB euro liquidity network.

Results are robust to a battery of robustness checks. First, we add Norway and Iceland to the sample. These countries can be considered comparable to some of the countries in our sample and have experienced financial distress although they have not been targeted by any ECB liquidity line. As in the baseline sample case, there is a marked divergence of the basis residuals at the time of the announcement and the following day. Empirical results are robust and reported in Table A.1, in Appendix A.2, although the magnitude of the effect reduces to 37 basis points.

Table 1. Effect of ECB Liquidity Swap Line Announcement

Dependent Variable: FX Basis Residuals		
	Baseline Sample	
	(1)	(2)
Treated $\times$ Post	−0.511** (0.030)	−0.511** (0.031)
MP Meetings		−0.211* (0.052)
EU High Yield		−0.967** (0.021)
Surprise Index		−0.00134 (0.193)
Observations	296	296
R^2	0.117	0.173
Currency $\times$ Event FE	Yes	Yes
PostMat	Yes	Yes
Note: The table reports the output of the two-way fixed-effects DID estimation on a collapsed panel which is composed by the four-day window around each ECB euro swap line announcement. Treated is defined as the currency targeted by the line in t , while the control group comprises the countries not targeted by the line announced in t . Sample composition is described in Section 4. p -values in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.		

Second, although our results are robust to the inclusion and exclusion of a battery of global controls, we further test for anticipation and potential pre-trends. We investigate whether the DID results are robust to a placebo test, in which we artificially move the announcement date three days before the actual event to detect anticipation (in case of a negative and significant effect) as well as to detect non-parallel pre-trends. By doing this, we ensure that the window in the placebo test does not include the day of the announcement. The results for the two samples can be found in Table A.3, Appendix A.2. Since the effect is always very far from being statistically significant, the results indicate no sign of anticipation and confirm the parallel pre-trends assumption.

Third, we reestimate the equation by considering the basis as dependent variable instead of the residuals. In addition to global controls, we include two country-specific covariates that change daily: stock market volatility and sovereign yield. Results are confirmed again under this setup as shown in Table A.2 in Appendix A.2.

Fourth, we check the robustness of the results using different window sizes. While augmenting the window size obliges us to drop additional events, the results remain similar (see Figure A.9 in Appendix A.4).

Fifth, we use a simple procedure to check for possible heterogeneities with respect to the intensity of treatment. This is discussed in Callaway, Goodman-Bacon, and Sant'Anna (2024), who show that heterogeneous treatment effects can be estimated by regressing outcome changes on a saturated set of “dose indicators,” where the doses in our case would correspond to the maximum volume of the liquidity line relative to (i) the size of the recipient-country central bank’s balance sheet, and (ii) international reserves of the recipient country. The latter is a natural variable to compare to the size of liquidity lines, as these, upon activation, directly increase international reserves at the disposal of the central bank to intervene in FX markets if necessary.

Let our dose measure be denoted by A_e . For the purpose of this robustness check, we estimate our baseline specification with four treatment indicators corresponding to the quartiles of A_e , $Q(A_e)$:

$$\begin{aligned}
 res_{i,t,e} = & \sum_{q=1}^4 \beta_{1,q} T_{i,e} \times \mathbf{1}(Q_{q-1}(A_e) < A_e \leq Q_q(A_e)) \\
 & \times Post_t + \sum_e \beta_{3e} Post_{t,e} + \sum_{q=1}^4 \beta_{2,q} T_{i,e} \\
 & \times \mathbf{1}(Q_{q-1}(A_e) < A_e \leq Q_q(A_e)) \\
 & + \beta_4 mpt + \varphi' Z_t + \mu_{i,e} + u_{i,t,e},
 \end{aligned} \tag{5}$$

with $Q_0(A_e) = \min(A_e)$, $Q_4(A_e) = \max(A_e)$, and $Q_1(A_e)$, $Q_2(A_e)$, $Q_3(A_e)$ the first, second, and third quartile of A_e , respectively. The results are reported in Table A.4 in Appendix A.2, and provide some support for a role of the size of the liquidity line. The estimated treatment effect is substantially larger—approximately six to seven times greater—when the relative size of the liquidity line exceeds the third

quartile of the distribution (i.e., when the intervention is relatively large), compared to cases where it falls below the first quartile (i.e., when the intervention is relatively small).

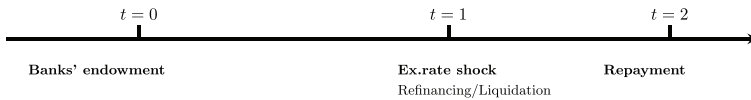
Sixth, we estimate the treatment effect for each event separately using three different estimators: the standard two-way fixed-effects estimator we have employed so far, the Arkhangelsky et al. (2021) synthetic difference-in-differences (SDID) estimator, and the Abadie, Diamond, and Hainmueller (2015) synthetic control (SC) estimator. The latter two estimators first estimate regularized weights that optimally combine the control group observations to fit the trend of the treated units in the sample, before calculating the differencing estimator. Consistent with our previously employed strategy, treatment is defined as the day of the announcement and the day after. For each event, we keep 15 days previous to each announcement and drop any country from the control group that was treated during this time window. Figures A.7 and A.8 depict the estimated pre-trends from the Arkhangelsky et al. (2021) estimator. The average treatment effects and standard errors (in parentheses) are -0.679 (0.606) for the DID estimator, -0.259 (0.471) for the SDID estimator, and -0.484 (0.473) for the SC estimator. While the standard errors are relatively high (which is not surprising, since estimating the effect for each event separately leads to quite a low number of observations), the overall negative effect of the liquidity line announcement on the FX basis is confirmed.²⁰

Lastly, Appendix B presents alternative evidence from an event study using time-series regressions of the FX basis residuals on the post-treatment dummy and a vector of controls. The estimated effect is statistically significant and of similar magnitude as in the DID approach. The results are thus reconfirmed.

5. Spillbacks

In this section, we turn to the euro domestic market and test for spillbacks. First, we provide a theoretical argument on how the

²⁰Inference is problematic with one treated unit: We use bootstrap, since the jackknife is not defined and placebo methods outlined in Arkhangelsky et al. (2021) rely on homoskedasticity across units, which is clearly violated. We note, however, that bootstrap with just one treated unit might be less reliable. See Arkhangelsky et al. (2021) for further discussion.

Figure 5. Model Timeline (no liquidity line)

announcement of a liquidity line can increase source-country equity prices by decreasing the default probabilities of the recipient country's financial sector. Second, we test the prediction of the model empirically.

5.1 Mechanism

To illustrate how a liquidity line announcement can affect euro-area banks, we propose a stylized two-country three-period model. Each country has a representative bank. In the source country there is a euro-area bank and in the recipient country there is a local bank. The model features cross-border lending between the euro-area bank and local bank, with currency and maturity mismatches. In this context, an exogenous exchange rate shock generates a refinancing risk. The liquidity line announcement reduces the probability of default of the local bank facing the shock.²¹ Therefore, it increases the expected profits of the euro-area bank that holds claims in the recipient country. In turn, this increases its stock prices, generating positive spillbacks. Figure 5 illustrates the timeline of the model.

Endowment: Cross-Country Lending. At time $t = 0$, the euro-area bank is funded by E_0 units of equity and D_0 units of insured deposits. It holds one unit of one-period euro-denominated debt of the local banks and invested A_0 in a safe asset. The bank's balance sheet at time 0 is

$$A_0 + 1 = D_0 + E_0. \quad (6)$$

The bank is managed in the interest of equity owners, who are risk-neutral, enjoy limited liability, and have a discount factor of $\beta = 1$.

²¹The exchange rate shock is exogenous and independent of the liquidity line announcement in the model. While in reality there might be an additional positive spillback effect via the exchange rate, this is not necessary to obtain a positive spillback effect.

Shareholders receive the final asset value of the euro-area bank at $t = 2$ (if positive); no dividends are paid out before that time. We further assume that both deposits and safe assets are remunerated at a zero net interest rate, and that the bank's deposit base is constant ($D_1 = D_0$). These assumptions facilitate exposition without affecting the conclusions. The gross interest rate that the local bank has to pay to borrow from the euro-area bank is $1 + r_C$. All previous quantities are taken as exogenous from the model's perspective, as the exact quantities are irrelevant for the mechanism we wish to emphasize.²²

Meanwhile, the local bank has invested its euro-denominated debt in a euro-denominated loan maturing at time $t = 2$ with a safe net rate of return $r_L > r_C$.²³ It also has constant insured local-currency deposits D^* remunerated at net rate zero (for simplicity), which it has invested in a short-term investment I^* at a safe net return of r_I . Hence, the bank earns a safe amount $X = r_I D^*$ in local currency at $t = 1$ from this investment, implying that the recipient-country bank has funds $X + D^*$ (accrued earnings plus deposits) in local currency at $t = 1$. From the euro-area bank perspective, the $t = 0$ balance sheet and interest rates that the local bank faces are taken as exogenous. Similar to the euro-area bank, the local bank enjoys limited liability. The balance sheets of the local and the euro-area bank are illustrated in Table 2.

Exchange Rate Shock. The exchange rate S (euro per unit of local currency) is assumed to be an exogenous random variable. At $t = 1$, it is low with probability q , such that $S_L(X + D^*) < 1 + r_C$, or high with probability $1 - q$, such that $S_H(X + D^*) > 1 + r_C$. Recall that all these quantities are taken as exogenous, and neither will be affected by an unexpected announcement of a liquidity line between

²²Ex post it can be verified that there exist loan rates r_C such that it is optimal for both banks to enter the loan agreement.

²³Local banks might extend credits in source-currency denomination for various reasons, among them lower interest rates combined with underestimation of exchange rate risk (documented for, e.g., Hungarian households by Pellényi and Bilek 2009 and Indian firms by Acharya and Vij 2025), credits used to purchase or invest in foreign commodities (Caruana 2016) or portfolio allocation (Yeyati 2006).

Table 2. Model: Balance Sheets $t = 0$

Local Bank		EA Bank	
Assets	Liabilities	Assets	Liabilities
$L^* = 1$ (€, Matur. $t = 2$) I^* (LC)	1 (€, Matur. $t = 1$) D^* (LC)	A_0 (€) 1 (€)	D_0 (€) E_0 (€)

$t = 0$ and $t = 1$, the effects of which will be described below.²⁴ The exchange rate shock introduces exogenous liquidity risk for the local bank since it has to pay back the unit borrowed. If the realization of the exchange rate is low, it is unable to repay the loan to the euro-area bank using internal funds. The local bank could roll over the loan; however, to mimic the situation in which central bank liquidity lines are normally established, we assume that the market is dysfunctional and rollover is not possible.

Thus, in absence of central bank liquidity lines, the local bank only has the option to refinance the remaining debt at $t = 1$ through an FX swap. It is common knowledge that the effective cost b of refinancing one unit of debt using FX swaps is distributed according to $b \sim F_b^h$, $h \in \{nl, l\}$, where h indicates whether a liquidity line is in place (l) or not (nl).²⁵ The state dependence is discussed further below. The realization of b is learned at $t = 1$. The total cost C_s of refinancing via FX swaps is then

$$C_s(b) = (1 + b)[1 + r_c - S_L(X + D^*)] + D^*,$$

(7)

where $S_L(X + D^*)$ is the euro value of the local bank’s available funds, and D^* is its deposits. If the local bank refinances itself, it receives the repayment $1 + r_L$ of its euro-denominated loan at time $t = 2$. Otherwise, it is liquidated and receives a final payoff of zero,

²⁴In the case of the exchange rate, this is by assumption. All other quantities stated here are determined before the liquidity line is announced unexpectedly, such that they cannot be affected by the announcement.

²⁵A distribution of b obtains if as in Bahaj and Reis (2022) the local bank is randomly matched with a source-country trader and traders differ in their bargaining power. This is further explained below. While the distribution of δ_a remains fixed, a liquidity line provides an outside option to local banks, leading to the state dependence in the distribution F_b^h .

by limited liability. For simplicity, the expected exchange rate at time $t = 2$ is 1. Define then $\bar{b}$ as the maximum rate that the local bank would ever accept:

$$C_s(\bar{b}) = 1 + r_L. \quad (8)$$

Should the local bank fail to refinance the outstanding obligation with an FX swap, the euro-area bank has the right to liquidate the local bank. In this case, it receives the $t = 1$ liquidation value $\lambda_{L,1}$ euro of the long-term asset plus the bank's accrued earnings of $S_L X$ euro (deposits are owed to depositors). We assume that $\lambda_{L,1} + S_L X < 1 + r_C$, such that euro-area banks face loan default risk.

Effect on Euro-Area Bank Stock Prices without Liquidity Lines. To disentangle the effect of central bank liquidity lines on stock prices, we analyze first the counterfactual scenario without the announcement of the facility. Since equity owners are risk-neutral and do not discount the future, stock prices at the time of the liquidity line announcement, V_0 , are simply given by the expected value of time $t = 2$ equity, i.e., $V_0 = \mathbb{E}_0 V_2$. For simplicity, any funds at $t = 1$ are invested at the safe policy rate of zero, such that the euro-area bank's position in the safe asset at $t = 1$ is

$$A_1 = \begin{cases} S_L X + \lambda_{L,1} + A_0 & \text{if loan liquidated at } t = 1, \\ 1 + r_C + A_0 & \text{if loan repays at } t = 1. \end{cases} \quad (9)$$

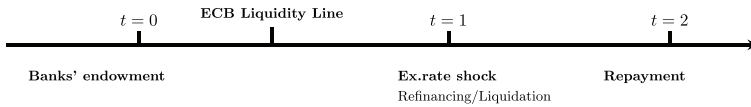
The value of equity at time $t = 2$ is then given by

$$V_2 = \max\{A_1 - D_0, 0\}, \quad (10)$$

since the bank has to repay depositors, but enjoys limited liability. Substituting the balance sheet constraint, Equation (6), yields

$$V_2 = \max\{A_1 - 1 + E_0 - A_0, 0\}. \quad (11)$$

To compute the stock price at the time of the liquidity line announcement, it remains to characterize in which cases the euro-area bank defaults. Default of the euro-area bank can only occur at $t = 1$, since all uncertainty is realized at that time. Note that while we take r_c as exogenous, the euro-area bank would never set a loan rate r_C that

Figure 6. Model Timeline (liquidity line)

would lead it to default in case of full repayment, therefore it must be that $(1 + r_C) - 1 + E_0 \geq 0$. Furthermore, due to the possibility of default, we must have $(1 + r_C) - 1 + E_0 > 0$.

Two cases may then be distinguished: In Case 1, the euro-area bank is perfectly safe:

$$S_L X + \lambda_{L,1} - 1 + E_0 \geq 0. \quad (12)$$

Refinancing at $t = 1$ is only possible via FX swaps. Therefore, the $t = 1$ default probability of the local bank is given by

$$p_1 = q [1 - F_b^h(\bar{b})], \quad (13)$$

and thus, in Case 1 euro-area bank stock prices are given by

$$V_0 = q(1 - F_b^h(\bar{b}))(S_L X + \lambda_{L,1}) + [(1 - q) + qF_b^h(\bar{b})](1 + r_c) - 1 + E_0. \quad (14)$$

In Case 2, the euro-area bank defaults if the local bank defaults at $t = 1$, that is, if

$$S_L X + \lambda_{L,1} - 1 + E_0 < 0. \quad (15)$$

In this case, euro-area bank stock prices are given by

$$V_0 = [(1 - q) + qF_b^h(\bar{b})][(1 + r_c) - 1 + E_0]. \quad (16)$$

The euro-area bank's stock prices depend on the default probability of the local bank and, therefore, on the distribution of the CIP deviations through F_b^h .

Effect on Euro-Area Bank Stock Prices with Liquidity Lines. Now consider the announcement of a liquidity line at time $t = 0$.

Figure 6 illustrates the timeline of the model. As explained above, we have assumed that both the euro area and the local policy rates

are zero. Then, the refinancing cost via FX swaps is $b = f - s$, where f and s are the log forward rate and the log spot rate (euro per unit of local currency), respectively. Hence, b is equivalent to the FX swap basis (net of the foreign interest rate on deposits, which we have assumed to be zero for the purpose of this model). The basis, as explained in detail in the following section, captures the premium that foreign agents have to pay to borrow euros in the FX markets. Bahaj and Reis (2022) show how an active liquidity line caps the forward price in FX swaps. Intuitively, central bank liquidity lines provide local banks with a cheaper outside option to the FX market, which improves the bargaining terms that the local banks obtain from the traders. In Bahaj and Reis (2022), differences in bargaining power $\delta_a \in [0, 1]$ between source-country traders leads to a distribution of forward rates $f(\delta_a)$ for a given spot rate s , and hence a distribution of the swap basis $b(\delta_a)$, with $b(0) < b(1)$. They show that an active liquidity line reduces $b(\delta_a)$ for every bargaining power $\delta_a > 0$, i.e., unless local banks have all bargaining power. The FX basis is therefore state-dependent: $b = b^h(\delta_a)$, with $b^l(\delta_a) < b^{nl}(\delta_a) \forall \delta_a > 0$ and $b(0) = b^l(0) = b^{nl}(0)$. It follows that the swap price distribution without liquidity line has first-order stochastic dominance over the distribution with liquidity line:

$$F_b^l(x) \geq F_b^{nl}(x). \quad (17)$$

The inequality is strict for all $x \in (b(0), b^{nl}(1)]$.

As shown in Appendix C, by the theory of the term structure, this argument holds also in the case of the mere announcement of a liquidity line, which ultimately caps the price of forward agreements.

Based on the above, we can distinguish three regimes: In Regime 1, $\bar{b} < b(0)$ and the local bank defaults with probability $p_1^l = p_1^{nl} = q$, i.e., always when it receives the low exchange rate shock. Next, in Regime 2 the local bank defaults if it is matched with a trader with sufficiently high market power: $\bar{b} \in [b(0), b^{nl}(1))$ and $p_1^l, p_1^{nl} \in (0, q)$ with $p_1^l \leq p_1^{nl}$. Lastly, in Regime 3, the local bank never defaults: $\bar{b} \geq b^{nl}(1)$ and $p_1^l = p_1^{nl} = 0$.

The liquidity line announcement is therefore neutral in Regimes 1 and 3. In Regime 2, it decreases the default probability p_1 of the local bank unless it has all bargaining power.

This implies the following proposition:

PROPOSITION 1. *A liquidity line announcement in times of a freeze of the international interbank lending market leads to an increase in euro-area stock prices unless local banks exposed to a low exchange rate realization (i) never default, (ii) always default, or (iii) have all bargaining power in negotiating FX swap prices.*

5.2 Empirical Strategy

Since central bank liquidity lines are often announced in times of financial distress, the positive effect of announcements may merely cushion the negative effect of rising default probabilities due to financial distress in the recipient economy on euro funding costs and euro-area banks' balance sheets. Therefore, we might not expect to see a positive net effect of announcements in the data, but rather a positive counterfactual effect—calling for a difference-in-differences strategy. In the following exercise, we test for positive differential effects by exploiting the heterogeneous banking exposure of EA countries toward the countries considered in the treated versus control groups, in a similar fashion to Aizenman, Ito, and Pasricha (2022). While Aizenman, Ito, and Pasricha (2022) look at the impact of Fed lines on key financial variables of recipient economies, such as long-term interest rates and sovereign credit default spreads, we focus on source-country equity prices. We take advantage of the fact that some EA countries have stronger trade and banking ties with some of the countries whose currencies are targeted by ECB lines due to historical or geographical reasons. For instance, Italy has strong trade and therefore banking connections with Romania, Austria with Hungary, and so on. Therefore, we expect that an ECB announcement of a repo line with Romania will benefit Italy more than Spain, which does not have strong linkages with Romania.

While this beneficial effect may affect euro-area banks in various ways, we consider the stock price. This is an ideal measure since, by having the lowest payout priority, bank equity returns react to changes in (expected) bank profits regardless of how close a bank is to insolvency (Baron, Verner, and Xiong 2021). Consistent with our model, we expect that following an ECB liquidity line announcement the equity price of EA banks most exposed to the countries targeted by the line will increase relatively more than the less exposed banks. To account for this heterogeneous effect we consider the following

two dimensions: time (pre- versus post-announcement) and the exposure in terms of cross-border banking flows between EA source countries and non-EA counterparties. Therefore, our main explanatory variable of interest is the interaction between the dummy capturing the announcement and the following day ($Post_t$) and the exposure dummy ($Exp_{j,e}$). Furthermore, as in the case of the basis, we first purge the dependent variable for country-specific controls as explained in Section 3. Finally, we use changes and not the levels of the stock price residuals as the dependent variable, due to stationarity concerns.²⁶ We adjust the specification accordingly:

$$\begin{aligned} \Delta PriceRes_{j,t,e} = & \beta_1 Post_t \times EXP_{j,e} + \sum_e \beta_{2e} Post_{t,e} + \beta_3 EXP_{j,e} \\ & + \beta_4 mp_t + \varphi' Z_t + \mu_{j,e} + u_{j,t,e}, \end{aligned} \quad (18)$$

where $\Delta PriceRes_{j,t,e}$ is the change in the purged average log stock price of the banks in EA country j at time t in the event e , $EXP_{j,e}$ is a dummy equal to one if the average exposure of the EA country j to non-EA countries targeted by the line at event e is higher than the 75th percentile of the cross-country exposure distribution, and zero otherwise.²⁷ As in the analysis of the basis, the specification includes country-event fixed effects and a Post dummy per event. Z_t is a vector of global controls. Standard errors are clustered at country-event level.

The sample focuses on the same events of the previous exercise in order to ensure that the effect is not contaminated by liquidity lines in USD or other currencies that may happen at the same time.

Figure A.2, Appendix A.4, shows the evolution of the change in the stock price in the 10-day window around each announcement. The highly exposed and less exposed countries follow a very close pattern. Table A.9, Appendix A.4, gives an overview of the EA countries classified as exposed at each announcement. As expected,

²⁶Unit-root tests for the individual time series as well as panel unit-root tests suggest that stock prices contain a unit root. This is not surprising, as it is a common feature of financial data.

²⁷In order to simplify the notation, the exposure dummy is indexed by country and event. Precisely, it is constructed based on the country j average share in portfolio holdings by the banking sector of EA countries, in the quarter prior to the announcement t , as explained in Section 3.

Table 3. Spillbacks of Announcement to EA Banks

	(1) Banking Exposure p75	(2) Banking Exposure p65	(3) Continuous
Post × Exp	0.0210** (0.02)	0.0187** (0.04)	0.0341** (0.01)
VIX	0.000600 (0.73)	0.000633 (0.72)	0.000505 (0.77)
EU High Yield	0.0389 (0.15)	0.0390 (0.15)	0.0388 (0.15)
MP Meetings	−0.0251** (0.03)	−0.0252** (0.03)	−0.0249** (0.03)
Observations	252	252	252
R ²	0.320	0.315	0.364
Currency × Event FE	Yes	Yes	Yes
PostMat	Yes	Yes	Yes
Note: The table reports the output of the two-way fixed-effects DID estimation on a collapsed panel which is composed by the four-day window around each ECB euro liquidity line announcement. The exercise focuses on ECB lines toward EU countries to reduce potential overlapping concerns with USD liquidity lines. In columns 1 and 2 Exposure (<i>Exp</i>) is a dummy that equals one if the share of claims of the banking sector of EA-country <i>j</i> toward the recipient country banking sector of the country targeted by the line in <i>t</i> is higher than the 75th percentile (first column) or 65th percentile (second column) of the distribution across EA countries at the moment of announcement in <i>t</i>. In column 3, Exposure is continuous. The EA sample comprises AT, BE, DE, ES, FI, FR, IR, PT, IT. <i>p</i>-values in parentheses. *<i>p</i> < 0.10, **<i>p</i> < 0.05, ***<i>p</i> < 0.01.			

Italy and Austria are on average more exposed than any other EA countries to ECB liquidity line recipients.

5.3 Results

Table 3 presents the results from estimating Equation (18). Consistent with the proposition of the model discussed in Section 5.1 (Proposition 1), the announcement of an ECB euro liquidity line increases stock prices of banks located in EA countries more exposed to the targeted currencies relative to banks located in less exposed

EA countries.²⁸ In the baseline specification the effect is 2.1 percent (column 1 of Table 3), corresponding to approximately 0.6 standard deviations of stock price variations. As a robustness check, instead of constructing the exposure dummy based on the 75th percentile of the distribution, we (i) reduce the threshold to the 65th percentile—Table 3, column 2—and (ii) use a continuous exposure variable—Table 3, column 3. Estimates confirm an increase in banks' stock prices. Further, the results are robust to different window sizes (Figure A.10). The model of Section 5.1 rationalizes this effect, showing that decreased euro funding costs of banks in the recipient economy due to the introduction of a liquidity line (which we provided evidence for in Section 4.3) decreases the default probability of recipient-country banks and hence increases the payoff that euro-area banks expect to receive on loans to these recipient-country banks. By improving euro-area banks' profitability, ECB liquidity lines therefore contribute to financial stability in the euro area as well. Future research at bank level may further exploit the heterogeneity in the treatment effect that ECB liquidity lines might have.

6. Conclusion

Central bank liquidity lines in times of distress function as a backstop facility, preventing episodes of liquidity shortage to turn into global financial stability problems. In line with the stated policy goal to use such swap lines as a backstop, the ECB has expanded considerably its network of swap lines during episodes of global financial stress (the Global Financial Crisis and the COVID-19 crisis).

While previous contributions have focused on the effects of USD liquidity lines, this paper presents original descriptive and empirical evidence for the case of the ECB. Concretely, we show that ECB euro liquidity lines have been effective in decreasing the premium paid by foreign agents to borrow euros in FX markets in a narrow window around the announcement. Furthermore, this paper provides evidence of positive spillbacks to the euro area generated by these

²⁸The proposition implies a positive average effect, except under the extreme assumptions that *all* banks in the targeted country either have full bargaining power in negotiating FX swap prices, or are expected to be safe with certainty, or fail with certainty in the face of adverse exchange rate shocks. Clearly, these are empirically implausible cases.

facilities in the form of relatively higher bank equity prices, which are associated with better market valuations of future profitability, in euro-area countries highly exposed via banking linkages to countries whose currencies are targeted by liquidity lines. We show how such a spillback effect on profits can arise in theory, and provide empirical evidence consistent with our theoretical predictions.

From our descriptive analysis, we notice that the ECB has provided FX insurance to central banks in its vicinity, mainly non-EA EU countries. Therefore, in contrast with the Fed, its role has been more of a regional lender of last resort than a global one. This difference seems to be driven by the different trade ties of the U.S. and the EU with the rest of the world, as supported by the evidence found in Aizenman, Ito, and Pasricha (2022) for the U.S. An unanswered question is then whether these arrangements can also boost the usage of the euro as an international currency, as has been stated in some official speeches (see Schnabel and Panetta 2020). In general, now that these lines have become a well-established tool—the ECB made its liquidity-line framework permanent in January 2024 and converted the EUREP into a standing facility open in principle to all central banks in February 2026—market participants may anticipate that liquidity in euro FX markets will be sufficient and CIP deviations may be small even in times of crisis.

Appendix A

A.1 Data Sources

Stock prices are sourced from Datastream (Refinitiv) and are country aggregates from the following banks:

- Germany: Deutsche Bank, Commerzbank, Aareal, Deutsche Pfandbriefbank, Procredit, and Umweltbank
- France: BNP, Crédit Agricole, Société Generale, Natixis, Nord CCI, Ile de France, Brie Picardie, and Crédit Foncier
- Italy: Intesa, Unicredit, Generali, BPM, BPER, Finecobank, Monte dei Paschi, Credito Emiliano, Illimity, Sondrio, Profilo, Sistema, and Piccolo credito
- Spain: Santander, BBVA, Caixabank, Bankinter, Sabadell, Liberbank, and Unicaja

- Belgium: KBC, Banque Nationale de Belgique, and KBC Ancora
- Austria: Erste, Raiffeisen, BAWAG Group, Oberbank, BKS, Addiko Bank, and Bank für Tirol und Vorarlberg
- Finland: Nordea and Aktia
- Ireland: Bank of Ireland and Permanent THB
- Portugal: Banco Comercial Portugues

A.2 Regression Tables

Table A.1. Effect of ECB Liquidity Swap Line Announcement

Dependent Variable: FX Basis Residuals				
	Baseline Sample		Extended Sample	
	(1)	(2)	(3)	(4)
Treated $\times$ Post	−0.511** (0.030)	−0.511** (0.031)	−0.373* (0.051)	−0.373* (0.052)
MP Meetings		−0.211* (0.052)		−0.0415 (0.754)
EU High Yield		−0.967** (0.021)		−0.553 (0.261)
Surprise Index		−0.00134 (0.193)		−0.00197** (0.020)
Observations	296	296	392	392
R^2	0.117	0.173	0.060	0.078
Currency $\times$ Event FE	Yes	Yes	Yes	Yes
PostMat	Yes	Yes	Yes	Yes
Note: The table reports the output of the two-way fixed-effects DID estimation on a collapsed panel which is composed by the four-day window around each ECB euro swap line announcement. Treated is defined as the currency targeted by the line in t , while the control group comprises the countries not targeted by the line announced in t . Sample composition is described in Section 4. p -values in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.				

**Table A.2. Effect of ECB Liquidity
Line Announcement (baseline sample)**

Dependent Variable: FX Basis	
	(1)
Treated $\times$ Post	−0.411** (0.026)
EU High Yield	−1.102** (0.023)
MP Meetings	−0.234** (0.027)
Surprise Index	−0.00117 (0.323)
Stock Exchange Volatility	2.465 (0.383)
Sovereign Yield	−0.838 (0.176)
Observations	304
R^2	0.204
Currency $\times$ Event FE	Yes
PostMat	Yes
Note: The table reports the output of the two-way fixed-effects DID estimation on a collapsed panel which is composed by the four-day window around each ECB euro swap line announcement. Treated is defined as the currency targeted by the line in t , while the control group comprises the countries not targeted by the line announced in t . Sample composition is described in Section 4. p -values in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.	

**Table A.3. Effect of ECB Liquidity
Line Announcement (placebo)**

Dependent Variable: FX Basis Residuals				
	Baseline Sample		Extended Sample	
	(1)	(2)	(3)	(4)
Treated × Post	−0.0984 (0.745)	−0.0987 (0.745)	−0.0124 (0.969)	−0.0127 (0.969)
MP Meetings		0.0629 (0.844)		0.265 (0.449)
EU High Yield		−0.346 (0.468)		−0.127 (0.759)
Surprise Index		0.00812 (0.286)		0.0103 (0.205)
Observations	296	296	392	392
R^2	0.043	0.055	0.035	0.042
Currency × Event FE	Yes	Yes	Yes	Yes
PostMat	Yes	Yes	Yes	Yes
Note: The table reports the output of the two-way fixed-effects DID estimation on a collapsed panel which is composed by the four-day window around each ECB euro swap line announcement. For the purpose of the placebo exercise, the date of the announcement has been anticipated by three days, consequently moving the window ahead of the actual announcement, preventing any overlap with true window. Treated is defined as the currency targeted by the line in t, while the control group comprises the countries not targeted by the line announced in t. Sample composition is described in Section 4. The extended sample adds Iceland and Norway to the control group. p-values in parentheses. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.				

Table A.4. Effect of ECB Liquidity Line Announcement

	Dependent Variable: FX Basis Residuals					
	(1)	(2)	(3)	(4)	(5)	(6)
Treated × Post	−0.511** (0.030)	−0.511** (0.031)				
Treated × Post Q1 (CB)			−0.222** (0.036)	−0.222** (0.037)		
Treated × Post Q2 (CB)			0.128 (0.148)	0.128 (0.150)		
Treated × Post Q3 (CB)			−0.719 (0.239)	−0.719 (0.241)		
Treated × Post Q4 (CB)			−1.496*** (0.005)	−1.496*** (0.005)		
Treated × Post Q1 (Reserves)					−0.233** (0.031)	−0.233** (0.032)
Treated × Post Q2 (Reserves)					0.123 (0.282)	0.123 (0.285)
Treated × Post Q3 (Reserves)					−0.961* (0.064)	−0.961* (0.065)
Treated × Post Q4 (Reserves)					−1.401** (0.049)	−1.401* (0.051)

(continued)

Table A.4. (Continued)

A.3 Timeline and Main Features of ECB Lines (Announcements)

The timeline reported in Table A.5 is based on ECB press releases. Due to space constraints, the table omits some information and links, but can be found here: [ECB liquidity lines - Timeline](#).

- The timeline does not include information on the Term Auction Facility nor the EUREP.
- Swap time extensions refer to central bank swap lines and domestic central bank repo operations against ECB-eligible collateral with domestic financial institutions to redistribute the liquidity.
- The timeline does not include discontinuations of lines or maturities.
- The column “Reciprocal” means that, in at least one of the counterparts’ press releases, there is an explicit reference to the fact that the agreement is reciprocal.
- The column “Euro Provision” indicates whether in the press release there is a clear intention of providing euro liquidity. Note that, although some agreements might be reciprocal, their actual intention is to provide liquidity in only one currency denomination.
- Publicly announced: “p” indicates lines or changes announced in ECB press releases on the same date the decision was taken, “np” lines or changes announced ex post.
- Federal Reserve (*) indicates operations and agreements in the context of the multi-central-bank agreements between the Federal Reserve, European Central Bank, Bank of England, Bank of Japan, and Swiss National Bank.
- Federal Reserve (**) indicates episodes when swap lines also enable central banks of the network of temporary bilateral liquidity swap arrangements to provide liquidity operations, should they be needed, in Japanese yen, British pound sterling, Swiss francs, Canadian dollars, and euros, in addition to U.S. dollars.
- Sveriges Riksbank (§) indicates that the arrangement was not publicly announced in 2007. The activation of the line

was announced in 2009, and the link refers to the activation announcement.

- (§§) indicates data sourced from other ECB documents different from press releases. This announcement is not included in the analysis since we assume that the main channel of communication for the signaling effect consists of press releases.
- Leg 1 reports the maximum length of drawing in the context of the first leg of the agreement, i.e., between two central banks.
- Leg 2 reports the maturities of operations with domestic counterparts, i.e., the repo facilities between recipient-country central bank to the domestic banking sector.

Table A.5. Timeline and Main Features of ECB Lines

Date	Country	Counterpart	Euro Provision	Reciprocal	Announcement	Expiration	Leg 1	Leg 2	Maximum Amount
Sep.13, 2001	USA	Federal Reserve	No	No	Swap	Oct. 13, 2001	—	—	USD 50 bn
Dec. 12, 2007	USA	Federal Reserve (*)	No	Yes	Swap	—	—	28 and 35 Days	USD 20 bn
Dec. 20, 2007	SWE	Sveriges Riksbank (§)	Yes	Yes	Swap	—	3 Months	—	EUR 10 bn
Jan. 10, 2008	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	—	—	28 Days	USD 20 bn
Mar. 11, 2008	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	—	—	28 Days	USD 15 bn
May 2, 2008	USA	Federal Reserve (*)	No	Yes	Swap Volume Expansion	—	—	28 Days	USD 25 bn
Sep. 18, 2008	USA	Federal Reserve (*)	No	Yes	Swap Volume Expansion	—	—	1, 28, and 84 Days	USD 40 bn
Sep. 26, 2008	USA	Federal Reserve (*)	No	Yes	Swap Volume Expansion	Over the Quarter End	—	1–7 Days	USD 35 bn
Sep. 29, 2008	USA	Federal Reserve (*)	No	Yes	Swap Volume Expansion	Apr. 30, 2009	—	—	USD 120 to 240 bn
Oct. 13, 2008	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Jan. 31, 2009	—	7, 28, and 84 Days	—
Oct. 15, 2008	CHE	Swiss National Bank	No	No	Swap	Jan. 31, 2009	—	7 Days	—
	USA	Federal Reserve (*)	No	Yes	Foreign Exchange Swaps	Jan. 31, 2009	—	—	—
Oct. 16, 2008	HUN	Magyar Nemzeti Bank	Yes	Yes	Expansion of Collateral Pool Repo	—	—	—	EUR 5 bn

(continued)

Table A.5. (Continued)

Date	Country	Counterpart	Euro Provision	Reciprocal	Announcement	Expiration	Leg 1	Leg 2	Maximum Amount
Oct. 27, 2008	DNK	Danmarks Nationalbank	Yes	Yes	Swap	—	—	—	EUR 12 bn
Nov. 11, 2008	LVA	Latvijas Banka (§§)	Yes	No	Repo	—	—	—	EUR 1 bn
Nov. 21, 2008	POL	Narodowy Bank Polski	Yes	No	Repo	—	—	—	EUR 10 bn
Dec. 19, 2008	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Mar. 31, 2009	—	7, 28, and 84 Days	—
Jan. 16, 2009	CHE	Swiss National Bank	No	No	Swap Time Extension	Apr. 30, 2009	—	7 Days	—
Feb. 3, 2009	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Oct. 30, 2009	—	—	—
Mar. 19, 2009	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Jun. 30, 2009	—	7, 28, and 84 Days	—
Apr. 6, 2009	USA	Federal Reserve (*)	Yes	Yes	Swap Volume Expansion	Oct. 30, 2009	—	—	EUR 80 bn
Jun. 10, 2009	SWE	Sveriges Riksbank	Yes	Yes	Swap Activation of 2007 Line	—	3 Months	—	EUR 3 bn (EUR 10 bn Max)
Jun. 25, 2009	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Sep. 30, 2009	—	7 and 84 Days	—
			Yes	Yes	Swap Time Extension	Feb. 1, 2010	—	—	—
	CHE	Swiss National Bank	No	No	Swap Time Extension	Oct. 31, 2009	—	7 Days	—

(continued)

Table A.5. (Continued)

Date	Country	Counterpart	Euro Provision	Reciprocal	Announcement	Expiration	Leg 1	Leg 2	Maximum Amount
Sep. 24, 2009	CHE	Swiss National Bank	No	No	Swap Time Extension	Jan. 31, 2010	—	7 Days	—
	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Jan. 31, 2010	—	7 Days	—
May 10, 2010	USA	Federal Reserve (*)	No	Yes	Swap Reactivation	—	—	7 and 84 Days	—
Dec. 17, 2010	GBR	Bank of England	No	Yes	Swap	Sep. 30, 2011	—	—	GBP 10 bn
Dec. 21, 2010	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Aug. 1, 2011	—	7 Days	—
Jun. 29, 2011	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Aug. 1, 2012	—	7 Days	—
Aug. 25, 2011	GBR	Bank of England	No	Yes	Swap Time Extension	Sep. 28, 2012	—	—	GBP 10 bn
Sep. 15, 2011	USA	Federal Reserve (*)	No	Yes	Swap Time Extension	Mar. 1, 2012	—	7 Days and 3 Months	—
Nov. 30, 2011	USA	Federal Reserve (**)	Yes	Yes	Swap Time Extension and Rate Change (Leg 2)	Feb. 1, 2013	—	7 Days and 3 Months	—
Sep. 12, 2012	GBR	Bank of England	No	Yes	Swap Time Extension	Sep. 30, 2013	—	—	—
Dec. 13, 2012	USA	Federal Reserve (**)	Yes	Yes	Swap Time Extension	Feb. 1, 2014	—	7 Days and 3 Months	—
Sep. 16, 2013	GBR	Bank of England	No	Yes	Swap Time Extension	Sep. 30, 2014	—	—	—
Oct. 10, 2013	CHN	People's Bank of China	No	Yes	Swap	Oct. 8, 2016	—	—	CNY 350 bn EUR 45 bn

(continued)

Table A.5. (Continued)

Date	Country	Counterpart	Euro Provision	Reciprocal	Announcement	Expiration	Leg 1	Leg 2	Maximum Amount
Oct. 31, 2013	USA	Federal Reserve (**)	Yes	Yes	Swap Time Extension (***)	Until Further Notice	—	7 Days and 3 Months	—
Sep. 27, 2016	CHN	People's Bank of China	No	Yes	Swap Time Extension	Oct. 25, 2019	—	—	CNY 350 bn EUR 45 bn
Mar. 5, 2019	GBR	Bank of England	Yes	Yes	Swap Activation of 2010 Line	—	—	7 Days	—
Oct. 25, 2019	CHN	People's Bank of China	No	Yes	Swap Time Extension	Oct. 8, 2022	—	—	CNY 350 bn EUR 45 bn
Mar. 15, 2020	USA	Federal Reserve (*)	No	Yes	Swap Rate Change	—	—	7 Days and 84 Days	—
Mar. 20, 2020	DNK	Danmarks Nationalbank	Yes	Yes	Swap Reactivation Swap Volume Expansion	As Long as Needed	—	—	EUR 24 bn
Apr. 15, 2020	HRV	Hrvatska Narodna Banka	Yes	No	Swap	Dec. 31, 2020	3 Months	—	EUR 2 bn
Apr. 22, 2020	BGR	Bulgarian National Bank	Yes	No	Swap	Dec. 31, 2020	3 Months	—	EUR 2 bn
Jun. 5, 2020	ROU	Banca Nationala a României	Yes	No	Repo	Dec. 31, 2020	3 Months	—	EUR 4.5 bn
Jul. 17, 2020	SRB	Narodna Banka Srbije	Yes	No	Repo	Jun. 30, 2021	3 Months	—	EUR 1 bn
	ALB	Bank of Albania	Yes	No	Repo	Jun. 30, 2021	3 Months	—	EUR 0.4 bn

(continued)

Table A.5. (Continued)

Date	Country	Counterpart	Euro Provision	Reciprocal	Announcement	Expiration	Leg 1	Leg 2	Maximum Amount
Jul. 23, 2020	HUN	Magyar Nemzeti Bank	Yes	No	Repo	Jun. 30, 2021	3 Months	—	EUR 4 bn
Aug. 18, 2020	MKD	Narodna Banka na Republika Severna Makedonija	Yes	No	Repo	Jun. 30, 2021	3 Months	—	EUR 0.4 bn
	SMR	Banca Centrale della Repubblica di San Marino	Yes	No	Repo	Jun. 30, 2021	3 Months	—	EUR 0.1 bn
Aug. 28, 2020	ROU	Banca Nationala a României	Yes	No	Repo Time Extension	Jun. 30, 2021	3 Months	—	EUR 4.5 bn
	HRV	Hrvatska Narodna Banka	Yes	No	Swap Time Extension	Jun. 30, 2021	3 Months	—	EUR 2 bn
	ALB	Bank of Albania	Yes	No	Repo Time Extension	Mar. 31, 2022	3 Months	—	EUR 0.4 bn
	HRV	Hrvatska Narodna Banka	Yes	No	Swap Time Extension	Mar. 31, 2022	3 Months	—	EUR 2 bn
	HUN	Magyar Nemzeti Bank	Yes	No	Repo Time Extension	Mar. 31, 2022	3 Months	—	EUR 4 bn

(continued)

Table A.5. (Continued)

Date	Country	Counterpart	Euro Provision	Reciprocal	Announcement	Expiration	Leg 1	Leg 2	Maximum Amount
Feb. 4, 2021	MKD	Narodna Banka na Republika Severna Makedonija	Yes	No	Repo Time Extension	Mar. 31, 2022	3 Months	—	EUR 0.4 bn
	ROU	Banca Nationala a României	Yes	No	Repo Time Extension	Mar. 31, 2022	3 Months	—	EUR 4.5 bn
	SMR	Banca Centrale della Repubblica di San Marino	Yes	No	Repo Time Extension	Mar. 31, 2022	3 Months	—	EUR 0.1 bn
Mar. 28, 2022	SRB	Narodna Banka Srbije	Yes	No	Repo Time Extension	Mar. 31, 2022	3 Months	—	EUR 1 bn
	ALB	Bank of Albania	Yes	No	Repo Time Extension	Jan. 15, 2023	3 Months	—	EUR 0.4 bn
	HUN	Magyar Nemzeti Bank	Yes	No	Repo Time Extension	Jan. 15, 2023	3 Months	—	EUR 4 bn
	MKD	Narodna Banka na Republika Severna Makedonija	Yes	No	Repo Time Extension	Jan. 15, 2023	3 Months	—	EUR 0.4 bn
	SMR	Banca Centrale della Repubblica di San Marino	Yes	No	Repo Time Extension	Jan. 15, 2023	3 Months	—	EUR 0.1 bn
	POL	Narodowy Bank Polski	Yes	No	Swap	Jan. 15, 2023	3 Months	—	EUR 10 bn
Apr. 27, 2022	ROU	Banca Nationala a României	Yes	No	Repo Time Extension	Jan. 15, 2023	3 Months	—	EUR 1 bn

A.4 Additional Tables and Figures

Table A.6. Summary Statistics

Country	Mean		SD		N	
	Basis	Residuals	Basis	Residuals	Basis	Residuals
BG	−0.006	−0.005	0.748	0.698	3638	3587
DK	0.11	0.003	0.443	0.436	3638	3522
HR	−0.195	0	1.521	1.194	3638	3284
HU	0.658	0.018	1.292	1.195	3638	3458
IS	0.267	−0.086	3.601	2.571	3638	3522
NO	−0.173	0.009	0.755	0.76	3638	3522
PL	−0.013	0.034	1.346	1.332	3638	3587
RS	−0.022	0	2.059	1.767	2915	2735
SE	−0.11	−0.003	1.379	1.398	3638	3522
All	−0.044	−0.003	1.5	1.218	64761	61784

Note: Unbalanced panel from October 1, 2008 to September 10, 2022.

Table A.7. Summary Statistics

Variable	Mean	SD	Min.	Max.	N
MP Meetings	0.038	0.191	0	1	32019
Δ Public Debt Ratio	0.16	2.48	−10.52	18.66	31608
CAB	1.541	5.852	−22.09	23.38	32019
External Debt Ratio	247.5	332.8	1.083	1839	31235
Rating	A−	4	BB−	AAA	32019
Int. Reserves	43.59	32.45	2.947	156	31749
Inflation	2.599	2.844	−2.614	18.58	31933
VIX	19.99	9.519	9.14	82.69	32019
EU High Yield	5.023	3.433	2.341	23.61	32019
Surprise Index	3.685	65.59	−304.6	212.4	32019
Sovereign Yield	3.129	2.018	−0.792	15.01	31716
Stock Exchange Volatility	1.042	0.732	0.243	11.37	32019
Note: Unbalanced panel from October 1, 2008 to September 10, 2022. CAB is the current account balance. International reserves is the level of a central bank’s international reserves in billions of USD. The external debt ratio is measured as a percentage of international reserves.					

Table A.9. Banking Exposure Dummy by EA Country and Announcement, 75th Percentile Threshold

Announcement	AT	BE	DE	ES	FI	FR	IR	IT	PT
October 16, 2008		1				0	0	1	0
October 27, 2008		0				0	1	0	1
November 21, 2008		0				1	0	1	0
June 10, 2009		0				0	1	0	1
March 20, 2020	1	0	0	0	0	0	1	0	1
April 15, 2020	1	0	0	0	0	1	0	1	0
April 22, 2020	1	1	0	0	0	1	0	0	0
July 17, 2020	1	0	0	0	0	1	0	1	0
July 23, 2010	1	1	0	0	0	0	0	1	0
August 28, 2020	1	1	0	0	0	0	0	1	0
February 4, 2021	1	1	0	0	0	0	0	1	0
March 28, 2022	1	1	1	0	0	0	0	0	0

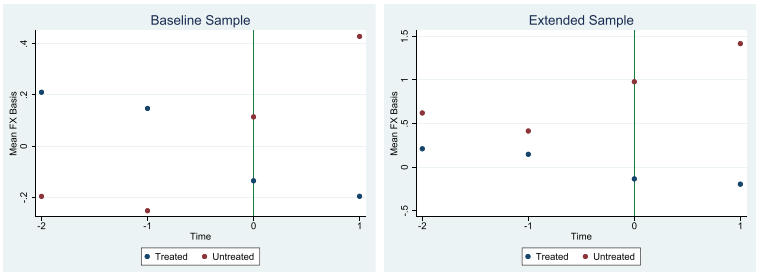
Note: Exposure is defined as the percentage of the banking-sector claims of EA country j on non-EA country i over total claims of domestic banks of EA country j globally. If the EA country exposure is higher than or equal to the 75th percentile of the cross-country distribution at the announcement date, the exposure dummy takes a value equal to one and zero otherwise. Empty cells indicate missing values.

Table A.10. Banking Exposure Dummy by EA Country and Announcement, 65th Percentile Threshold

Announcement	AT	BE	DE	ES	FI	FR	IR	IT	PT
October 16, 2008		1				0	0	1	0
October 27, 2008		0				0	1	0	1
November 21, 2008		0				1	0	1	0
June 10, 2009		0				0	1	0	1
March 20, 2020	1	0	1	0	0	0	1	0	1
April 15, 2020	1	0	0	0	0	1	1	1	0
April 22, 2020	1	1	1	0	0	1	0	0	0
July 17, 2020	1	1	1	1	1	1	1	1	1
July 23, 1010	1	1	1	0	0	0	0	1	0
August 28, 2020	1	1	0	0	0	1	0	1	0
February 4, 2021	1	1	0	0	0	1	0	1	0
March 28, 2022	1	1	1	0	0	0	0	1	0

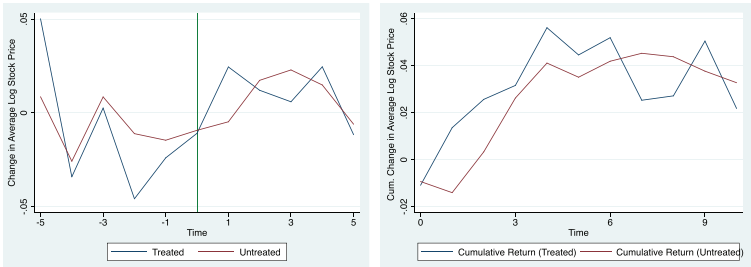
Note: Exposure is defined as the percentage of the banking-sector claims of EA country j on non-EA country i over total claims of domestic banks of EA country j globally. If the EA country exposure is higher than or equal to the 65th percentile of the cross-country distribution at the announcement date, the exposure dummy takes a value equal to one and zero otherwise. Empty cells indicate missing values.

**Figure A.1. Basis in Levels:
Averaged over Events 2008–20**



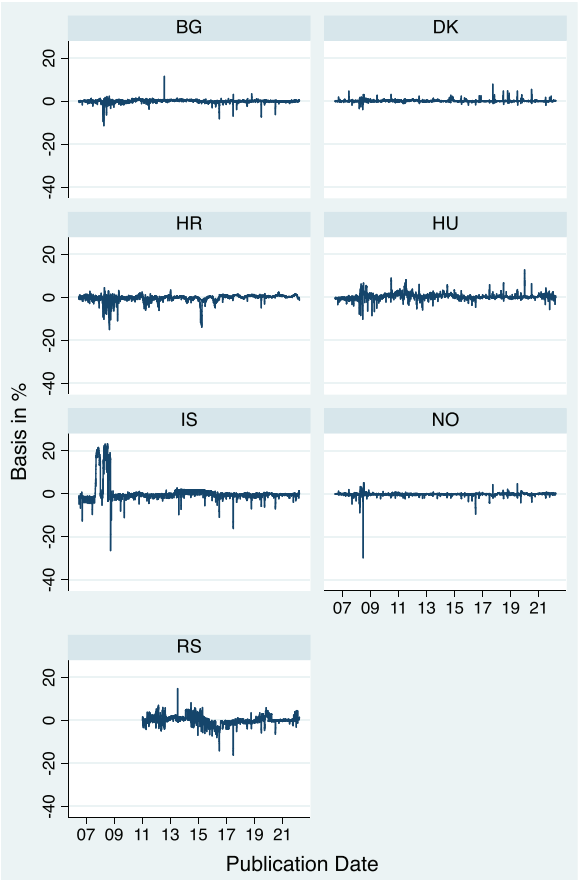
Note: The figure shows the average evolution of the FX basis in the four-day window around each announcement of an ECB liquidity line for the treated currencies versus non-treated. Each panel of the figure corresponds to a sample, as defined in Section 4. For any announcement, the treated currency/ies is/are going to be the one/s corresponding to the announcement, while the rest of the currencies in the sample are used as controls.

Figure A.2. Stock Price Changes



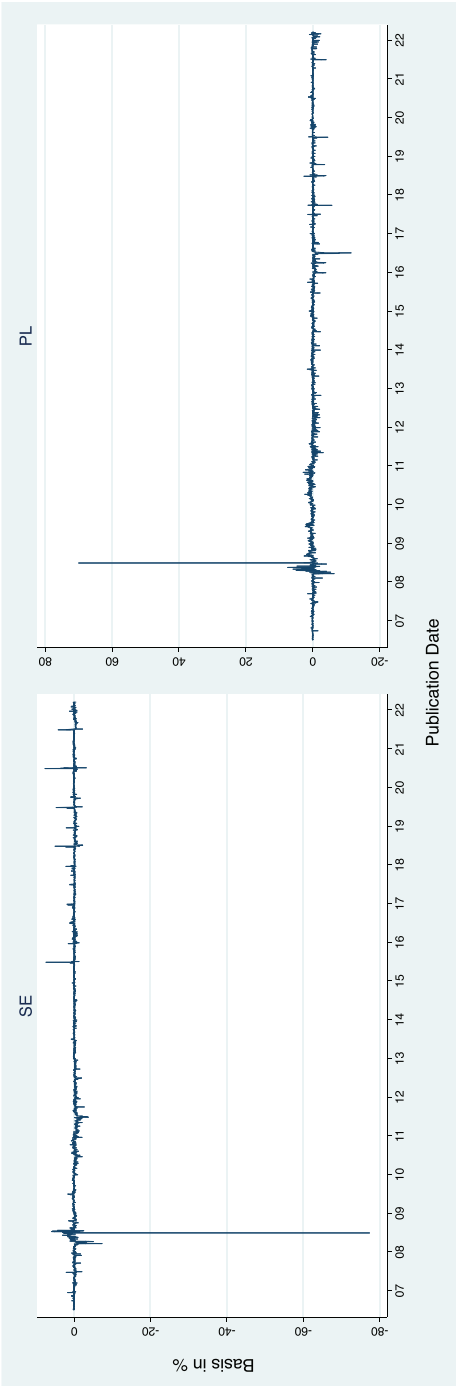
Note: The left panel shows the average evolution of the residuals of average bank stock prices in the 10-day window around each announcement of an ECB liquidity line for the treated currencies versus non-treated. The right panel shows the cumulative residuals since the announcement for the two groups. The residuals are obtained from regressing the average stock prices on the short-term rate, net foreign assets, loan-to-deposit ratio, and nominal effective exchange rate (NEER) deviations. Table A.9 indicates the treated and non-treated countries at each announcement considered.

Figure A.3. Time Series of CIP Deviations by Country



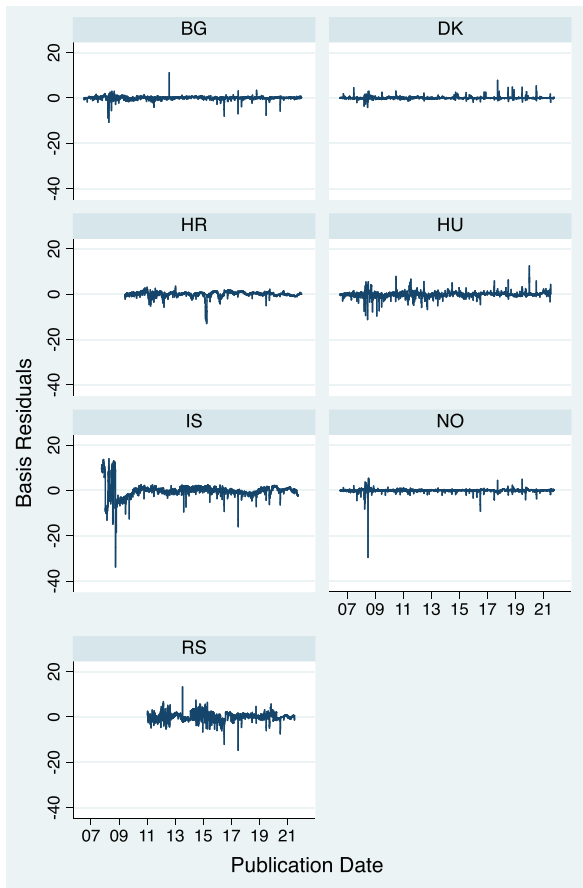
Note: Evolution of the FX basis over the sample period by country (Part I).

Figure A.4. Time Series of CIP Deviations by Country



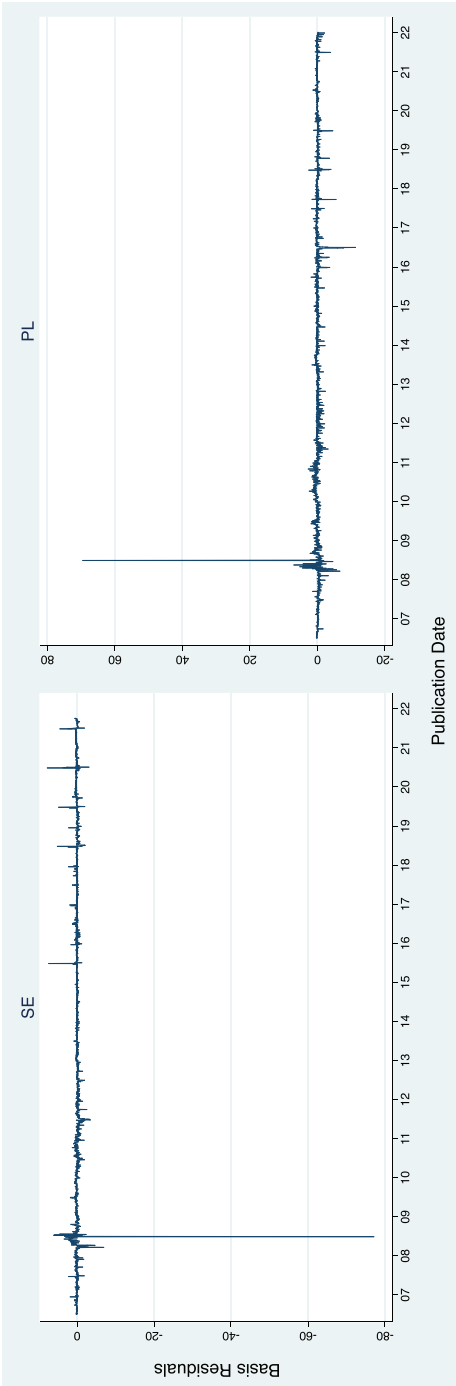
Note: Evolution of the FX basis over the sample period by country (Part II).

Figure A.5. Time Series of Residuals of CIP Deviations by Country



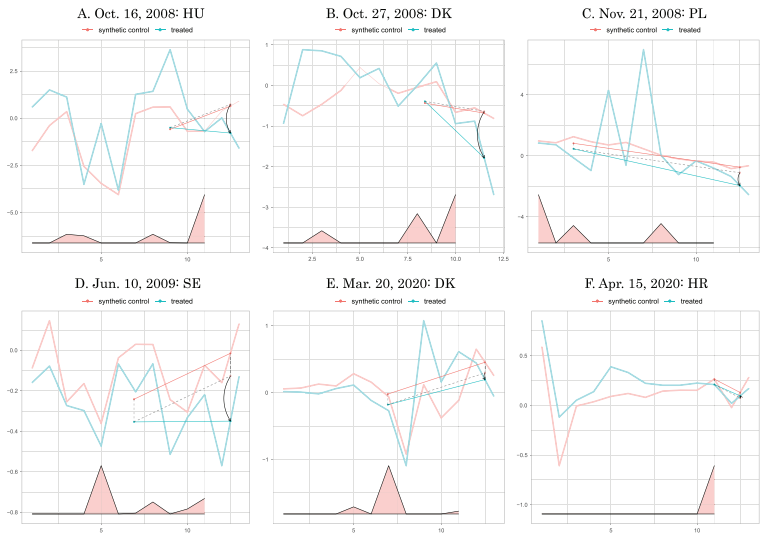
Note: Evolution of the residuals from country-by-country regressions of the FX basis on country-specific characteristics as explained in Section 4 (Part I).

Figure A.6. Time Series of Residuals
of CIP Deviations by Country



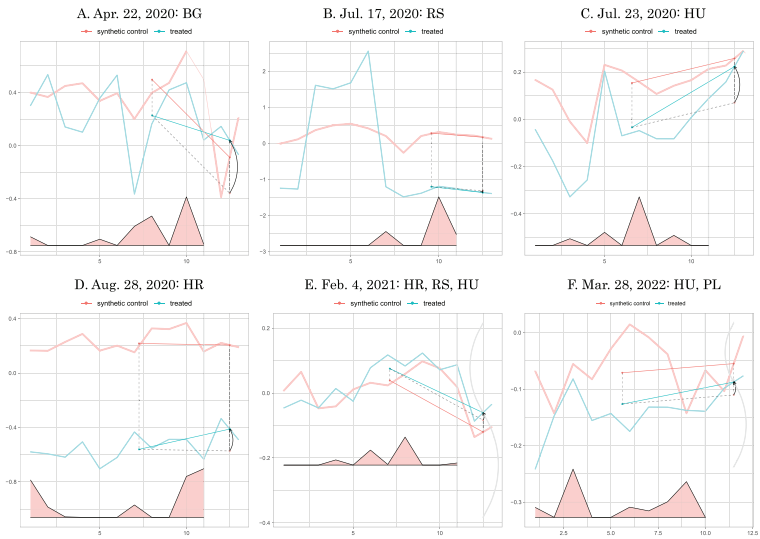
Note: Evolution of the residuals from country-by-country regressions of the FX basis on country-specific characteristics as explained in Section 4 (Part II).

Figure A.7. Pre-trends SDID (I)



Note: The figure shows estimates of the Arkhangelsky et al. (2021) SDID estimator for all events. The dependent variable is FX Basis Residuals. Treated currencies and treatment date are indicated below each graph. Treated is defined as the currency targeted by the line at t , while the control group comprises the countries not targeted by the line announced at t , and not targeted in the previous 15 days. The specification does not include further control variables.

Figure A.8. Pre-trends SDID (II)



Note: The figure shows estimates of the Arkhangelsky et al. (2021) SDID estimator for all events. The dependent variable is FX Basis Residuals. Treated currencies and treatment date are indicated below each graph. Treated is defined as the currency targeted by the line at t , while the control group comprises the countries not targeted by the line announced at t , and not targeted in the previous 15 days. The specification does not include further control variables.

Table A.11. Summary Statistics

Country	Mean				SD				N			
	Δ Public Debt Ratio	Int. Reserves	External Debt Ratio	Rating	Δ Public Debt Ratio	Int. Reserves	External Debt Ratio	Rating (Notches)	Δ Public Debt Ratio	Int. Reserves	External Debt Ratio	Rating
BG	0.2	21.94	59.52	BBB-	1.73	6.11	28.507	1	3638	3608	3587	3638
DK	0.12	72.98	303.196	AAA	1.35	12.03	87.22	0	3638	3608	3522	3638
HR	0.68	17.61	33.081	BB+	2.42	4.21	14.136	1	3638	3608	3587	3638
HU	0.27	37.32	58.542	BBB-	2.89	8.28	9.626	1	3458	3608	3587	3638
IS	0.12	5.62	616.201	BBB+	4.71	1.45	639.21	2	3587	3608	3522	3638
NO	-0.27	62.44	405.401	AAA	2.78	10.32	71.452	0	3638	3608	3522	3638
PL	0.03	104.67	48.372	A-	1.55	20.65	10.936	0	3638	3608	3587	3638
RS	0.37	12.66	7.24	BB	1.51	1.76	4.776	1	2735	2885	2799	2915
SE	-0.02	50.85	661.435	AAA	0.81	8.21	137.678	0	3638	3608	3522	3638
All	0.48	177.87	859.395	AA-	2.58	298.37	1669.279	4	64350	64200	62280	64761

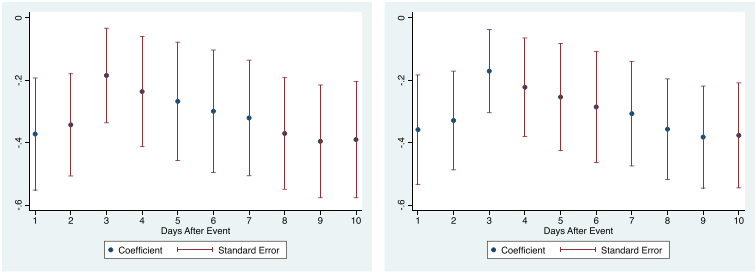
Note: Unbalanced panel from October 1, 2008 to September 10, 2022. International reserves is the level of a central bank's international reserves in billions of USD. The external debt ratio is measured as a percentage of international reserves.

Table A.12. Summary Statistics

Country	Mean				SD				N			
	CAB	Inflation	Sovereign Yield	Stock Exchange Volatility	CAB	Inflation	Sovereign Yield	Stock Exchange Volatility	CAB	Inflation	Sovereign Yield	Stock Exchange Volatility
BG	-1.08	2.57	2.37	0.86	5.324	3.55	1.42	0.56	3638	3631	3638	3638
DK	7.26	1.52	1.24	0.89	1.726	1.53	1.27	0.46	3638	3631	3638	3638
HR	-0.23	1.6	3.98	0.78	3.429	2.3	1.74	0.69	3638	3608	3335	3638
HU	0.32	3.29	4.4	1.33	2.613	2.65	1.48	0.73	3638	3631	3638	3638
IS	0.2	4.33	5.84	1.02	6.747	3.44	1.64	1.16	3638	3631	3638	3638
NO	9.22	2.34	2.2	1.27	4.568	1.2	0.95	0.8	3638	3631	3638	3638
PL	-2.16	2.76	2.9	1.09	2.503	3.02	1.16	0.54	3638	3631	3638	3638
RS	-5.85	3.93	4.15	1	2.374	3.53	1.58	0.57	2915	2908	2915	2915
SE	4.72	1.33	1.35	1.13	1.344	1.69	1.12	0.61	3638	3631	3638	3638
All	1.8	2.12	2.61	1.01	6.45	2.4	1.81	0.68	64761	64455	64458	64761

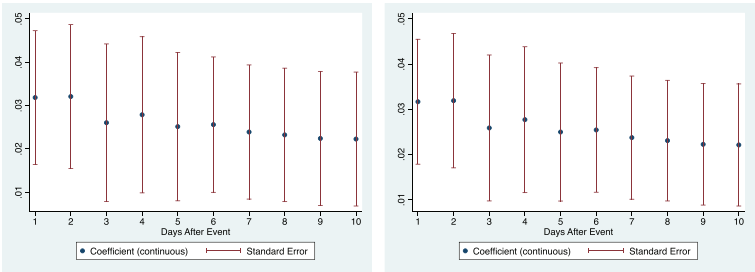
Note: Unbalanced panel from October 1, 2008 to September 10, 2022. CAB is the current account balance.

Figure A.9. Main Effect: Window Size



Note: The figure shows the coefficient β_1 as well as its standard error from estimating our baseline specification Equation (4). In the left panel, we include one day prior to the announcement in the regression, in the right panel two days. Four events are dropped from the sample to prevent overlap: April 15, 2020 and April 22, 2020; July 17, 2020 and July 23, 2020. The same events enter the sample across all window sizes.

Figure A.10. Spillback Effect: Window Size



Note: The figure shows the coefficient β_1 as well as its standard error from estimating Equation (18) using the continuous banking exposure measure (see Section 5). In the left panel, we include one day prior to the announcement in the regression, in the right panel two days. Four events are dropped from the sample to prevent overlap: April 15, 2020 and April 22, 2020; July 17, 2020 and July 23, 2020. The same events enter the sample across all window sizes.

Appendix B. Time-Series Regression

This appendix presents the results of an event study using fixed-effects estimates for the baseline and the extended country-sample of the following regression:

$$Res_{jt} = \alpha_j + \beta_1 post_{jt} + \beta \mathbf{X}_{jt} + \gamma \mathbf{W} + u_{jt}, \quad (\text{B.1})$$

where $post_{jt}$ is the main explanatory variable. It takes the value equal to one in the day of the announcement and in the following day for the treated country and zero otherwise; j indexes country, t time, $\mathbf{W}$ are monthly dummies, and $\mathbf{X}_{jt}$ is a vector of controls. This equation is estimated using fixed effects and heterogeneous robust standard errors; however, results are robust to using Driscoll-Kraay standard errors.

The results are quantitatively similar to the DID estimates presented in Section 4. Moreover, the results are robust and the estimates are slightly higher when we include week $\times$ year dummies instead of monthly fixed effects.

Table B.1. Event Study

	Baseline Sample		Extended Sample	
	(1)	(2)	(3)	(4)
Post	−0.447* (0.064)	−0.432* (0.066)	−0.484** (0.023)	−0.458** (0.020)
MP Meetings	−0.0373 (0.437)	−0.0387 (0.425)	0.00842 (0.871)	0.00538 (0.916)
EU High Yield		−0.0279 (0.507)		−0.0358 (0.297)
Surprise Index		0.00000882 (0.987)		−0.000350 (0.470)
Observations	13720	13720	17961	17961
R^2	0.045	0.046	0.074	0.074
MonthFE	Yes	Yes	Yes	Yes
CurrencyFE	Yes	Yes	Yes	Yes
Note: The table reports the output of the time-series regressions. Post takes the value of one on the day of the announcement and the day after for the currency targeted by the line in t, and zero otherwise. The extended sample adds Iceland and Norway to the control group. The model includes a fixed effect for every month in the sample, as well as currency fixed effects. p-values in parentheses. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.				

Appendix C. Proofs

C.1 Announcement Effect

The following proof shows that by the term structure, the mere announcement of ECB liquidity lines reduces the euro funding cost on the FX market.

Let $S^l(n, n+1)$ and $S^{nl}(n, n+1)$ denote the price of a swap agreement at time n maturing at time $n+1$ in the presence of a liquidity line and in absence of a liquidity line, respectively. As shown in Bahaj and Reis (2022), the price of swap agreements in presence of an active liquidity line is lower: $S^l(n, n+1) < S^{nl}(n, n+1)$. Consider now a trader choosing between entering an agreement at time 0 and maturing at time N at price $S(0, N)$, or rolling over short-term agreements. At time 0 there is no liquidity line in place, but there is a probability α_h , $h \in \{a, na\}$ that a liquidity line will be activated at any time between 0 and N , which depends on whether a line was announced ($h = a$) or not ($h = na$). Naturally, $\alpha_a > \alpha_{na}$.

The expected cost of rolling over agreements or purchasing a long-term agreement should be identical by no arbitrage, therefore:

$$S^{nl,na}(0, N) = \mathbb{E}_0 \sum_{n=1}^N (1 - \alpha_{na}) S^{nl}(n-1, n) + \alpha_{na} S^l(n-1, n) \quad (\text{C.1})$$

$$S^{nl,a}(0, N) = \mathbb{E}_0 \sum_{n=1}^N (1 - \alpha_a) S^{nl}(n-1, n) + \alpha_a S^l(n-1, n). \quad (\text{C.2})$$

It follows that

$$\begin{aligned} & S^{nl,a}(0, N) - S^{nl,na}(0, N) \\ &= \mathbb{E}_0 \sum_{n=1}^N (\alpha_a - \alpha_{na}) [S^l(n-1, n) - S^{nl}(n-1, n)]. \end{aligned} \quad (\text{C.3})$$

Hence, since $\alpha_a > \alpha_{na}$ and $S^l(n-1, n) < S^{nl}(n-1, n)$, it follows that $S^{nl,a}(0, N) < S^{nl,na}(0, N)$. ■

C.2 Proposition 1

Denote the euro-area bank's stock prices by V_0^{nl} if no liquidity line is announced, and V_0^l if a line is announced.

For Case 1, note that from Equation (14) we have

$$V_0^l - V_0^{nl} = q [F_b^l(\bar{b}) - F_b^{nl}(\bar{b})] [1 + r_c - S_L X - \lambda_{L,1}] \geq 0, \quad (\text{C.4})$$

while for Case 2, from Equation (16) we have

$$V_0^l - V_0^{nl} = q [F_b^l(\bar{b}) - F_b^{nl}(\bar{b})] [r_c + E_0] \geq 0. \quad (\text{C.5})$$

As discussed in the main text, $1 + r_c - S_L X - \lambda_{L,1} > 0$ by assumption, to ensure that euro-area banks face loan default risk. From Equation (17) we have $(F_b^l(\bar{b}) - F_b^{nl}(\bar{b})) \geq 0$. It follows that

$$F_b^l(\bar{b}) > F_b^{nl}(\bar{b}) \implies V_0^l - V_0^{nl} > 0.$$

We have explained in the main text that the minimum of $b(\delta_a)$ is attained at 0, and the maximum at 1. Further, $b(0) = b^l(0) = b^{nl}(0)$ and $b^l(1) < b^{nl}(1)$. The latter result is shown in Bahaj and Reis (2022).

By the properties of a cumulative distribution function (CDF), we then have $F_b^l(b(0)) = F_b^{nl}(b(0)) = 0$ and $F_b^l(b^l(1)) = 1$, $F_b^{nl}(b^{nl}(1)) = 1$. Therefore, $F_b^l(b^{nl}(1)) = F_b^{nl}(b^{nl}(1)) = 1$. The difference between the two CDFs can then be summarized as follows:

$$F_b^l(\bar{b}) - F_b^{nl}(\bar{b}) \begin{cases} = 0 & \text{if } \bar{b} \leq b(0), \\ > 0 & \text{if } \bar{b} \in (b(0), b^{nl}(1)), \\ = 0 & \text{if } \bar{b} \geq b^{nl}(1). \end{cases} \quad (\text{C.6})$$

Proposition 1 follows directly. ■

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