Research Paper

The impact of the Public Sector Purchase Programme on lending to SMEs☆

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ABSTRACT

We study the impact of the Public Sector Purchase Programme (PSPP) between 2015 and 2018 on lending volumes in the Eurozone. We find a connection between purchases under the PSPP and: (i) lending volumes on types of loans mainly obtained by SMEs; (ii) loans below 1 million euros during the expansion phase of the program until the end of 2016, and loans above 1 million euros in its contraction phase; (iii) substantial changes in lending volumes in economies with high levels of public debt and distressed financial systems, and; (iv) types of loans mainly obtained by SMEs in more resilient economies. These findings point to the effectiveness of the credit channel as a transmission mechanism of unconventional monetary policy and support the decision of the ECB to reactivate the program at the end of 2019.

1. Introduction

This paper aims to assess the impact of the Public Sector Purchase Program (PSPP), a leading monetary instrument of the European Central Bank (ECB), on lending volumes, especially on loan categories mainly obtained by SMEs (Small and Medium Enterprises) in the Euro Area (EA). The PSPP was announced in January 2015 as part of the ECB's unconventional monetary policy (UMP) strategy to facilitate economic activity by reducing borrowing costs and improving lending conditions for households and non-financial corporations. The PSPP was one (and the main) of several asset-purchasing programs in the EA under the umbrella of that UMP between March 2015 and December 2018. Although the ECB restarted net purchases under this program in 2019, in this paper, we focus on its first phase (2015–18) since: (i) the second phase is still underway; (ii) the COVID pandemic led to extreme variations in key macroeconomic variables which have not returned to their average historical levels.

The PSPP aimed, primarily, at easing borrowing conditions for non-financial corporations and households. As of 2015, SMEs represented 99.8% of the non-financial corporations in the EA. In turn, those firms contributed to 60% of the turnover and 70% of employment among all those enterprises in the EA (ECB, 2015). Their relevance to the European economy justifies our focus on the program's effects on credit availability in categories of loans mainly obtained or sought by such enterprises. However, because we do not have access to (publicly available) data on lending volumes by firm size, we evaluate the program's effects on loans above

and below €1M, the ECB's threshold that separates large from small loans, and place particular emphasis on the latter type which, according to the survey on the access to finance of enterprises (SAFE) in 2015, are the predominant loans obtained by SMEs.[1]

Several papers have considered the effects of unconventional monetary policy in the US and the EA on several economic dimensions, and thus, the effectiveness of different transmission channels. However, the empirical literature on the effects of the PSPP is still relatively small. At this stage, it has been focused, on the one hand, on the program's broad effects on economic growth and inflation (Gambetti and Musso, 2020), and on the other hand, on its effects on bond returns and the yield curve (Lemke and Werner, 2020; Altavilla et al., 2021b; Belke and Gros, 2021) and its impact on banks' risk profile (Soenen and Vennet, 2022). Those works, primarily, explore the effectiveness of portfolio-rebalancing and signaling transmission mechanisms while pointing to the indirect utilization of credit channels. In most cases, the emphasis falls on either a channel's activation (through changes in yields and securities term structure) or the macroeconomic and financial outcomes, aspects whose reaction is lagged and confounded by different forces. To the best of our knowledge, none of those works explicitly evaluates whether the objectives of the PSPP as announced by the ECB – the reduction of borrowing costs and facilitation of credit for households and non-financial corporations – were met and how the effects may have differed by type of loan, period, and geography.

This paper makes two contributions. The first contribution is to fill in a gap in the literature on the PSPP and its effects on the bank loan supply in the euro area. The second contribution is to outline caveats on the activation of the credit channel with important policy implications. In that sense, we start by considering the connection between purchases under the PSPP and banks' lending on loans categories predominantly obtained by SMEs, and thus, implicitly attempt to find evidence that the program met some of its main goals (facilitate lending conditions and improve credit availability). We note that similar attempts to evaluate the impact of asset purchasing programs (APPs) on lending in the US (Gagnon et al., 2011; Rodnyansky and Darmouni, 2018) and EA (Gibson et al., 2016; Altavilla et al., 2021a) have highlighted the importance of the type of assets targeted and the volume of purchases. Considering the weight of sovereign debt on banks' balance sheets and the magnitude of this program's purchases, we would anticipate a significant correlation between the PSPP and lending volumes.[2] Furthermore, Altavilla et al. (2021a) found that APPs led to an increase in a bank loan supply, but without exploiting variation across time and countries. We find evidence supporting the same hypothesis for the PSPP. Compared to empirical evidence on other APPs, we further disentangle the connection between the program's purchases and changes in lending by type of loan, focusing on loans predominantly obtained by SMEs.

We find that the PSPP had a positive impact on loans below €1M during its expansion phase (2015–16) and loans above €1M during its contraction phase (2017–18). Such evidence points to the adoption by banks of more conservative and risk-averse lending strategies in the early stages of the PSPP until the liquidity levels in the EA returned to their baseline levels from 2012. Such a picture clashes, however, with the common assumption that there should not be significant differences in lending by amount and type if banks are risk-neutral and default risks (e.g., longer maturities, the purpose of the loan, or the firm's financial and operational characteristics) are reflected on adequate spreads and collaterals. In parallel, we observe that purchases under the PSPP were particularly important in restoring credit levels in countries with high levels of public debt and more distressed financial systems which, we believe, could have been an objective of the ECB (especially, if we think that the PSPP has reinforced the perception of an implicit guarantee by the ECB on governments' with high debt levels). However, SMEs in more resilient economies could have benefited more from the program.

While transmission channels of conventional monetary policy have been extensively studied and are fairly understood at this point, the same cannot be said about unconventional policies. Identifying and studying those channels is unsurprisingly important in predicting and measuring the effects of UMP. An illustration of its importance can be found, for example, in the quantitative easing (QE) programs managed by the Federal Reserve (FED) between 2008 and 2013. Those programs failed to raise inflation expectations (the intended transmission channel) and created an opportunity for some investors to profit. The result was an increase in asset prices, an unwanted scenario considering that 85% of those assets were held by the top 20% earners (and 60% of those assets by the top 5% earners). The improved economic outlook that followed was then considered almost unrelated to the final rounds of those programs (O'Brien, 2013). We add to the existing literature by discussing the importance and effectiveness of the credit channel as a transmission mechanism of UMP into the real economy.

In the remainder of the paper, we proceed as follows. In Section 2, we revise the literature on unconventional monetary policy and monetary transmission channels. In Section 3, we describe the data and empirical strategy. In Section 4, we discuss our results. In Section 5, we conclude the paper and highlight some of its limitations.

2. Unconventional monetary policy in Europe

2.1. Early ECB programs

The ECB's unconventional monetary strategy, initially, revolved mainly around quantitative easing programs, initiated in 2008 at the peak of the Great Recession given the exposure of the EA to large volumes of US asset-backed securities and a certain dependency

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[1] The SAFE survey gathers data on the determinants affecting the ability of European enterprises to finance their activity. It has taken place every six months since June 2009. The questions are framed to investigate the immediate past semester, and the respondents are owners, managers, directors, or CFOs who answer questions online or over the phone.

[2] Altavilla et al. (2017) considers a representative sample of EA banks and reports that, on average, 6% of their main assets were kept in the form of sovereign debt. To put that figure into context, the share of lending to firms was around 20% of banks' main assets, and the exposure to credit default swaps (CDS) was around 2.5%.
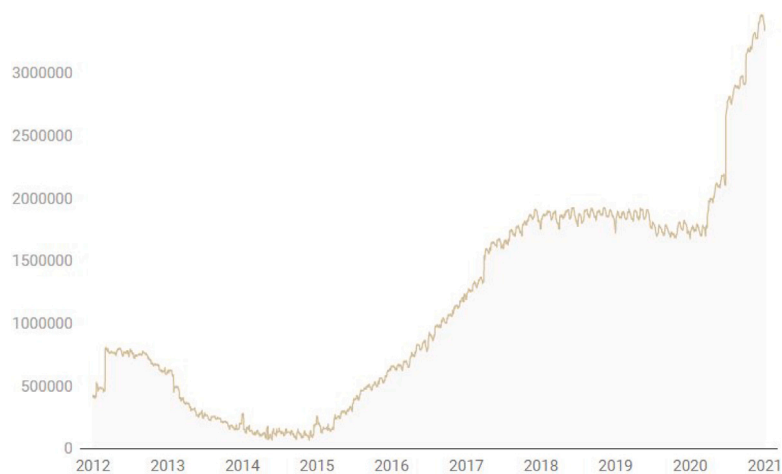
Fig. 1. Daily excess liquidity in the euro area (in millions of euros).
Source: ECB Statistical Data Warehouse.

on the dollar supply. The financial crisis and those risks amplified the consequences of the EA's credit and housing bubbles, most prominently observed in Greece, Ireland, and Spain, which were mainly responsible for liquidity shortages and credit losses (Lane, 2012).

That context, however, is insufficient to justify the subsequent high levels of sovereign debt in the EA. Jäger and Grigoriadis (2017) point out three other reasons that may have contributed to the macroeconomic downturn and increase in sovereign debt in the EA: (i) the assumption that EA countries would eventually converge with Germany, resulting in similar sovereign bond spreads across the euro area; (ii) the adoption of a single currency placed on domestic fiscal authorities the responsibility of carrying out counter-cyclical policies; (iii) southern European countries experienced relatively low-interest rates before the crisis and became excessive net borrowers. For those reasons, the stability and growth pact, which was supposed to mitigate excessive imbalances, proved to be a deficient tool (Lane, 2012).

In line with the FED's strategy during the Great Recession, the ECB initially relied on conventional monetary tools, such as the rates for main refinancing operations, overnight deposits, and marginal lending. However, the inability of those instruments to promote borrowing and improve the economic outlook led the ECB to engage in less conventional policies. Those changed its balance sheet composition (qualitative easing) and size (quantitative easing). Among them were two asset purchase programs: the Covered Bond Purchase Programme (CBPP) and the Securities Market Purchase Programme (SMP).

The CBPP was divided into two waves (CBPP1 and CBPP2). Under that program, the ECB acquired €76B in covered bonds between 2009 and 2012. Its objective was twofold. On the one hand, it aimed to improve the banking system's liquidity and, consequently, the general economic outlook. On the other hand, its announcements intended to provide signals on which the private sector could anchor its expectations on credit availability, subsequently affecting business operations and investment decisions. We find evidence supporting the importance of the latter channel in Cingano et al. (2016) who observe that the liquidity shortage in 2007 led to a reduction in lending volumes by Italian banks which accounted for a 40% decrease in private sector investment. A similar argument is found in Ryan et al. (2014), where it is shown that financing constraints on small enterprises help to explain most of the variations in the employment cycle during the Great Recession. They also highlight the importance of an expectations transmission channel, pointing to a link between credit supply and the timing of monetary interventions. By comparison, the SMP, launched in 2010, had a slightly different objective. Its goal was to correct imbalances in the secondary market for sovereign bonds, which ultimately would affect the efficiency of the monetary policy transmission channel.

Overall, Gibson et al. (2016) evaluate favorably the role of both the CBPP and SMP in reducing sovereign spreads, raising covered bond prices, and improving the banking system's liquidity. However, the two waves of the CBPP seem to have produced distinct effects. Markmann (2018) indicates that the impact of CBPP2 on the Eurozone yields, although positive, was substantially smaller than that of CBPP1. The differences in purchases (€60B under CBPP1 against €16B under CBPP2) and the targeted assets may help explain these differences.

2.2. Most recent ECB programs

In 2015, the ECB launched a series of asset purchasing programs (APPs) aimed at fighting persistently low inflation rates and low liquidity levels of the banking system despite the residual interest rates and previous APPs (see Figs. 1 and 2). At the time, the combination of low prices and the gradual recovery of economic activity pointed to an unwanted long-term trend of low inflation as observed in the US.

The ECB strategy, initially, was established on two asset purchasing programs launched in 2014: the Asset-Backed Securities Purchase Program (ABSPP) and the third Covered Bond Purchase Program (CBPP3). That strategy was expanded in 2015 with the
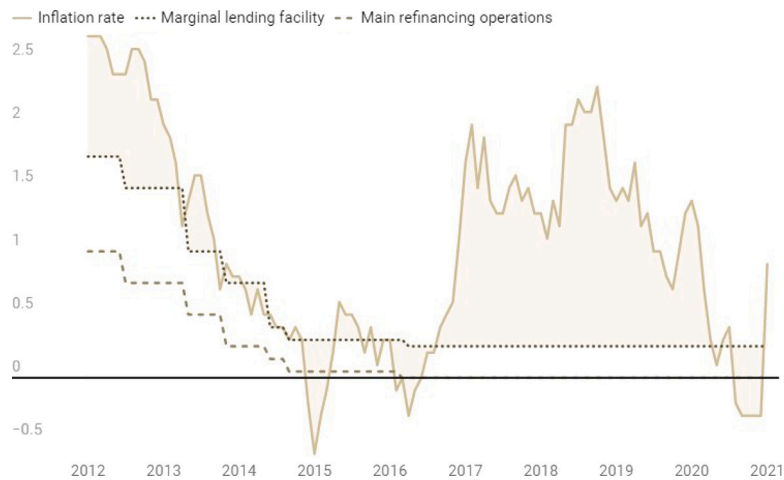
Fig. 2. Inflation rate in the euro area and main lending facilities (%).
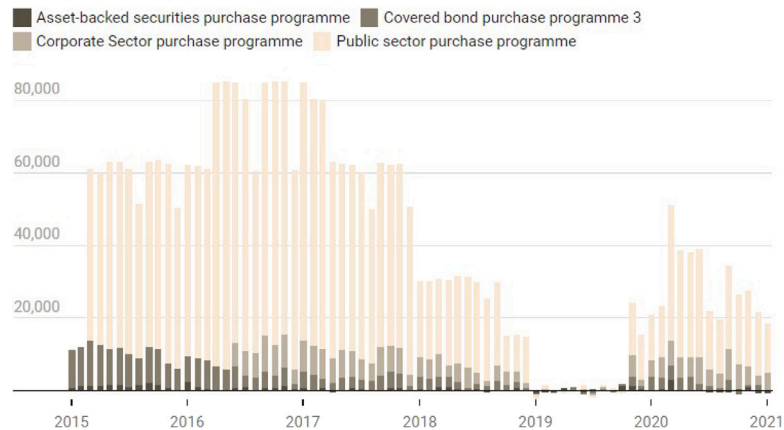*Source:* ECB Statistical Data Warehouse.

Fig. 3. Monthly net purchases (in millions of euros) under each Asset Purchasing Program managed by the ECB since 2015.
Source: ECB (https://www.ecb.europa.eu/mopo/implement/app).

Public Sector Purchase Program (PSPP) targeting sovereign debt in the EA. The monthly purchasing target of these APPs was €60B which, based on initial projections, would have led to the ECB accumulating €1.15T in private and public securities (proportional to 11% of the real GDP in the EA in 2014). Initially, their maturity was set until September 2016. However, there was an explicit intention to keep these APPs until one could identify a positive trend in inflation in the medium/long term. The inability to observe such a trend dictated an extension and reorganization of those APPs.

By the end of 2015, the ECB had extended those programs until 2017 with an estimated additional cost of €360B. In March 2016, the ECB launched yet another program, the Corporate Securities Purchase Program (CSPP), with an estimated volume of purchases of €240B (equivalent to 2% of the EA real GDP). That program increased the overall volume of monthly purchases by the ECB from €60B to €80B (see Fig. 3). Nonetheless, by 2016, the disappointing inflation perspectives forced the ECB, once again, to extend those programs, this time, until the end of 2017, with an estimated cost of €540B (about 5% of the real GDP of the EA in 2015). Those APPs were gradually shut down by 2018, even though some, such as the PSPP, were later reactivated.

The literature on the economic effects of the PSPP is still relatively small and mainly focused on its impact on government bond yields and other securities. Among the most noteworthy papers, Altavilla et al. (2021b) find effects of up to 6.5 basis points on 10-year sovereign bond yields per ECB's purchases proportional to 1% of the EA's GDP, identifying two transmission channels (duration and credit risk). Lemke and Werner (2020) point to the positive impact of the announcement of the PSPP in 2015 on German government bond yields, which they attribute to the re-balancing of portfolios and not to a signaling/expectations channel. Similar effects from that program's announcements on the risk premium of peripheral bonds are reported by Belke and Gros (2021).
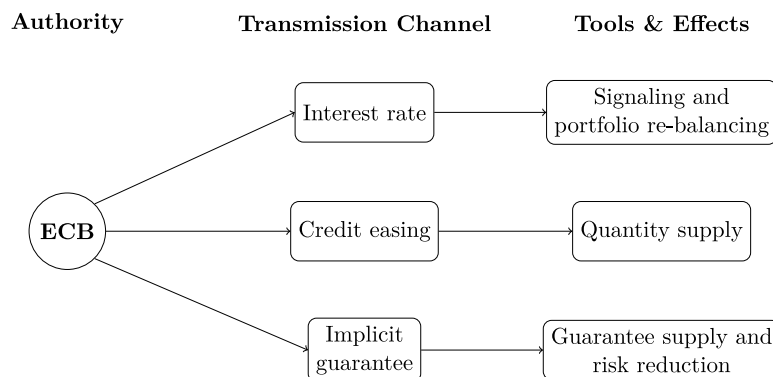
Fig. 4. Transmission channels.

2.3. Transmission channels

We can identify three channels through which an APP stimulates economic activity and controls the inflation rate (Fig. 4). These are the interest rate, credit easing, and implicit guarantee channels. In this paper, we mainly focus on the second one.

Most of the literature on conventional monetary policy has looked at the effectiveness of the credit channel as a transmission vehicle (e.g., Bernanke and Blinder, 1992; Gertler and Gilchrist, 1994; Kashyap and Stein, 2000; Jiménez et al., 2012). However, the literature on unconventional monetary policy has looked, instead, predominantly at the effectiveness of the interest rate channel. In that case, two different tools seem to be activated. On the one hand, purchases under an APP can create excess demand for a group of securities in the secondary market (in the case of the PSPP, government bonds) which flattens their yield curve. In that case, investors are likely to adjust their portfolio and target other securities, which often also reduces the yields on those markets. On the other hand, announcements provide clear signals and guidance on future short-term interest rates which, in turn, affect long-term rates (e.g., see Eser and Schwaab, 2016; Moessner, 2018; Ambler and Rumler, 2019). On that latter mechanism, a less explored channel assumes that purchases by a monetary authority, which is not subject to insolvency risk, extend an implicit guarantee on issuers of the acquired securities. In such cases, those purchases provide a stable source of capital for relative issuers and signal to potential buyers in the primary market that a strong institutional buyer is present in the secondary market (Benigno et al., 2023).

The remaining channel – credit easing – has been equally signaled by the FED and the ECB as the transmission vehicle for their unconventional monetary policies to directly or indirectly improve the economic outlook and affect the level of prices by improving credit supply. On the one hand, purchases under an APP reduce the yields of targeted assets (and, consequently, possibly the yields of other securities), in turn, dictating a reorganization of a bank's balance sheet since (i) lower yields reduce the cost of borrowing (especially, when such assets are used to securitize loans); (ii) loans became relatively more profitable, and; (iii) securities with long maturities were converted into immediate liquidity. On the other hand, banks face borrowing constraints depending on the share of risk-weighted assets in their balance sheets in proportion to their level of capital. When an APP targets riskier assets, the result is an improvement in borrowing constraints and a reduction of credit spreads.

In the case of the PSPP, we explore the effectiveness of the credit channel as a transmission vehicle since one of the program's intended outcomes was, precisely, an improvement in the liquidity levels of the banking system, especially since firms are particularly vulnerable to credit supply shocks (e.g., see Carbo-Valverde et al., 2016). We focus on credit availability on loans mainly sought by SMEs according to the SAFE survey given their relevance to the European economy as highlighted in the introduction to this paper introduction.

Hypothesis 1. Purchases under the PSPP are positively correlated with variations in lending volumes, especially, on loans that are mostly obtained by SMEs

Until 2016Q4, the volume of purchases under the PSPP remained constant or even increased, coinciding with the expansion phase of the program. After that, there was a gradual reduction in monthly purchases until the program's shutdown at the end of 2018. It is sensible to assume that the decision to gradually terminate the program (made at the beginning of 2017) was based on positive signs and the recovery of the credit market. At that stage, considering that the liquidity levels in the financial system were at the baseline levels from 2012, the risk profile of the securities in banks' balance sheets was high, and short-run yields above the long-term rates, we would expect additional purchases under the program at that point to be more likely to be converted into credit compared to the early stages of the program.

Hypothesis 2. Purchases under the PSPP have a more significant effect on lending in the second phase of the program (2017–18) than in its first phase (2015–16).
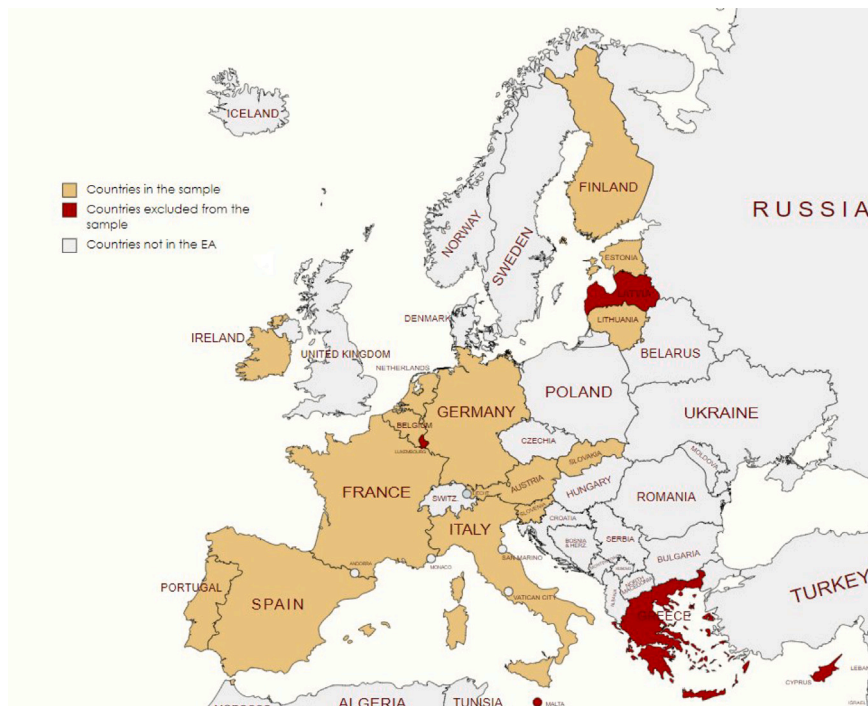
Fig. 5. Countries included and excluded from our sample.

We note that 80% of the purchases under the PSPP were carried out by national central banks (NCB) without any risk sharing. Considering the assets targeted (government bonds), we would expect the program to have produced stronger effects in countries with high levels of government debt (by reducing their yields and extending a guarantee from the ECB) and less resilient banking systems (where financial institutions faced higher borrowing constraints).

Hypothesis 3. Purchases under the PSPP had a more significant effect on lending in countries with higher levels of government debt and more distressed financial systems.

3. Data & empirical strategy

We evaluate the effectiveness of the credit channel as a transmission vehicle of the PSPP using information on aggregated lending volumes divided into three categories: (i) loans up to €0.25M; (ii) loans between €0.25M and €1M, and; (iii) loans over €1M. We consider data from 14 countries in EA: *Austria, Belgium, Estonia, Finland, France, Germany, Ireland, Italy, Lithuania, Netherlands, Portugal, Spain, Slovakia, and Slovenia*. We exclude five countries due to insufficient data: *Cyprus, Greece, Latvia, Luxembourg, and Malta* (see Fig. 5).

We investigate the impact of purchases under the PSPP on loans to corporations (excluding revolving loans, overdrafts, convenience, and extended credit card debt) in the EA. We disaggregate these loans into two categories: below and above €1M. Considering the left-hand side of Fig. 6, there seems to exist a reaction to the introduction of the PSPP in each lending category, with a trend that resists fluctuations in the leading business cycle of the EA (Germany).

Considering that SMEs indicated in the SAFE survey on 2015H1 (the initial period of analysis) that about 82% of their loans in the past six months were below €1M (Fig. 7), we dedicate part of our analysis to the discussion of the relationship between purchases under the PSPP and the evolution of loans below that threshold. This strategy allows us to meet one of our objectives – discuss the connection between purchases under the PSPP and credit availability on loan categories mostly obtained by SMEs – and circumvent the limitation arising from the absence of (publicly available) data on loans at the firm level.

A closer look at Fig. 7 shows that of the loans obtained by SMEs below €1M, approximately 74% were, in fact, below €0.25M. A finer disaggregation of loans below €1M in the right panel of Fig. 6 shows that the PSPP may have been especially effective in promoting lending volumes below that threshold. Hence, in the third stage of our empirical analysis, we discuss the relationship between the PSPP and lending volumes below €0.25M and between €0.25M and €1M.

We formally investigate the relationship between lending volumes and purchases under the PSPP by estimating a fixed-effects model,

$$\Delta Y_{i,t} = \beta_0 + \beta_1 \Delta \mathrm{PSPP}_{i,t} + \lambda B_{i,t} + \gamma E_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t}, \tag{1}$$
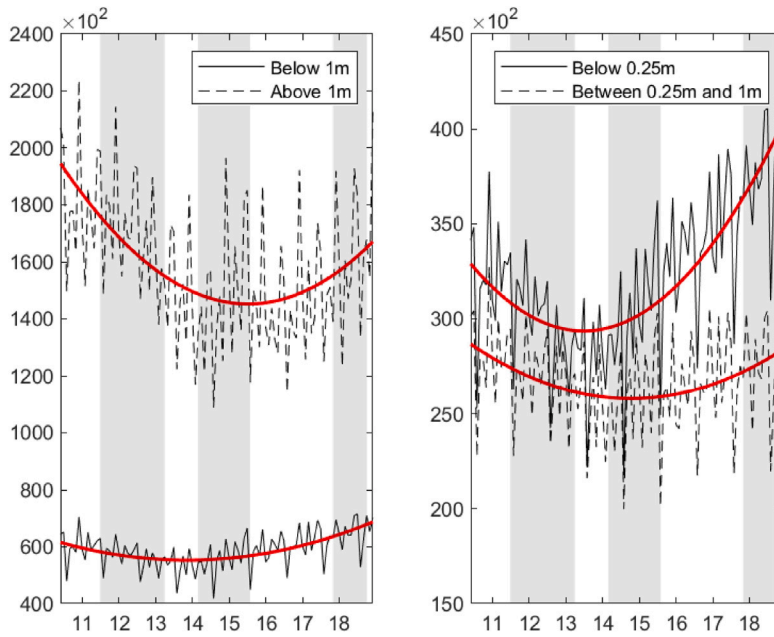
Fig. 6. Bank business volumes: Loans to corporations of various sizes (other than revolving loans and overdrafts, convenience, and extended credit card debt) in the EA in euros. The shaded area is the OECD-based recession indicator for Germany following the peak through the trough. The horizontal axis indicates the year.
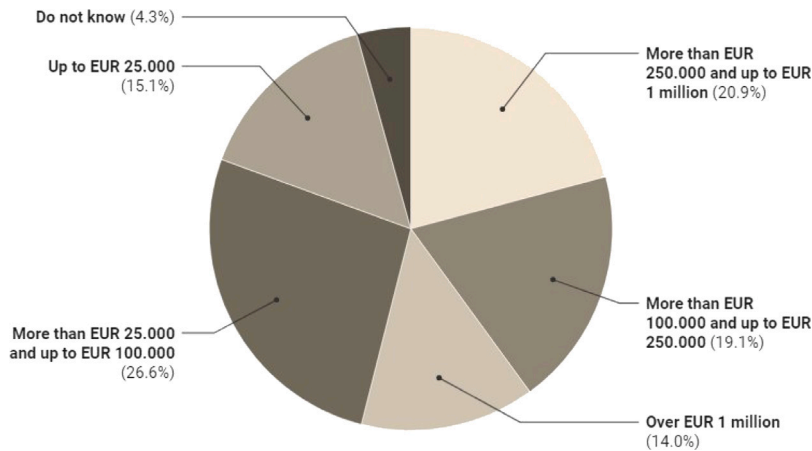
Fig. 7. Size of the last bank loan obtained, renegotiated or attempted in the past six months by an SME according to the SAFE questionnaire in the first half of 2015.

where Δ indicates a first-difference, $Y_{i,t}$ are lending volumes on loans above €1M, below €1M, between €0.25M and €1M, and below €0.25M in country i on period t, and $PSPP_{i,t}$ indicates the flow purchases under that program allocated to the country i in period t.[3] $B_{i,t}$ is a matrix of lagged (by one quarter) bank-level controls consolidated at the country level containing information on equity normalized by total assets and the ROA as benchmarks for leverage and profitability, respectively. These variables aim to control for two distinct traits (strength and riskiness of banks) that are important in monetary policy transmission to loan supply (Altavilla et al., 2021a). On the one hand, the less leveraged the bank (i.e., the higher the equity-to-assets ratio), the lower the private funding basis (e.g., deposits) that can be transformed into credit. On the other hand, the more profitable a bank is, the more likely is it to provide more favorable credit conditions, which should later positively impact lending volumes. $E_{i,t}$ is a matrix of macroeconomic controls containing information about the real GDP growth rate (controls for changes in the business cycle which

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[3] Rather than the stock of purchases made on a particular moment (e.g., the end of a quarter), we focus on the purchases made throughout the quarter (i.e., flow).

Table 1

Variables and definitions.

Name	Definition
Loans >1	Loans to corporations of over €1M [in millions €]
Loans <1	Loans to corporations up to €1M [in millions €]
Loans <.25	Loans to corporations up to €0.25M [in millions €]
LoansM	Loans to corporations between €0.25M and €1M [in millions €]
PSPP	Quarterly purchases (flow) under the PSPP [in billions €]
ROA	Net income/Total assets [%]
Equity/Assets	Total equity/Total assets [%]
Solvency	Total regulatory capital/Total risk-weighted assets [%]
Inflation	Inflation rate [%]
GDP	Quarterly real GDP growth rate (chain linked) [%]
Unemployment	Unemployment rate [%]

Table 2

Summary statistics.

Variable	Mean	St. Dev.	Min	Max	Obs
Loans >1	31,172	42,425	176	209,791	212
Loans <1	13,246	16,286	107	49,254	212
LoansM	5663	6599	72	20,671	212
Loans <.25	7581	10,645	26	37,903	212
PSPP	9.05	12.41	−.567	55.5	212
GDP	.008	.05	−.129	.194	212
Inflation	1.002	1.145	−1.33	4.43	212
Unemployment	8.519	3.752	3.166	23.786	212
ROA	0.471	0.449	−0.656	2.138	212
Equity/Assets	12.521	3.741	6.414	19.513	212
Solvency	17.915	2.701	11.451	23.819	212

correlates positively with the credit market) and inflation rate (as a leading variable and a proxy for monetary policy decisions by the ECB). α_i and δ_t control for country and time-specific factors, and $\varepsilon_{i,t}$ is the model's error.

The use of first differences is justified both from an econometric and economic perspective. On the one hand, the Im–Pesaran–Shin unit-root tests point to unit roots in all panels on lending volumes (except on loans between €0.25M and €1M) and the PSPP. On the other hand, in this context, using first differences seems more reasonable than using levels considering the volatile nature of lending volumes and the more consistent evolution of purchases under the PSPP (having also been used, for example, in Gibson et al. (2016) and Jäger and Grigoriadis (2017)). Moreover, we are interested in understanding whether changes in one variable map into changes in another instead of a contemporaneous correlation which, if significant, would be spurious given the dynamic nature of the credit market (i.e., we want to look at the past, not the present). We adopt a fairly conservative approach regarding the number of control variables considering the small sample size and degrees of freedom. Unfortunately, we do not have information, at the country level, on purchases under other asset purchasing programs managed by the ECB at the same time as the PSPP (namely, the ABSPP, CSPP, and CBPP3). Instead, we have only the total amount of securities purchased each month. The respective effect is equivalent to controlling for time effects when we use that total amount purchased as a constant for every country in our sample. For that reason, we omit those variables. However, we note that such an omission creates some identification issues on the effect of purchases under the PSPP on lending volume rates. For example, both Ertan et al. (2020) and Sclip (2022) report positive effects of the CSPP on perceptions of SMEs managers regarding access to credit and respective costs. Nonetheless, we believe that those concerns are minimized to a certain extent by the inclusion of country-level fixed effects and bank-level controls. In that sense, if other programs had a positive effect on banks' lending behavior, that would be captured by changes in lending in each country aside from the effect promoted by the PSPP (country fixed effects) and reflected on the assets in banks' balance sheets. Additionally, total purchases under the PSPP far exceeded those of other programs and directly targeted the banking sector. Therefore, it is sensible to assume that most of the variance in lending behavior to derive strictly from purchases under the PSPP. Finally, unfortunately, we are not able to introduce the lag of lending volumes on each category as an independent variable because it would lead to inconsistent estimates since the fixed-effects estimator does not correct for lagged fixed effects. In that case, we would need either to find a suitable instrument (which we, unfortunately, do not have) or estimate a GMM system. However, our sample is too small, and the number of instruments required would exceed by a long margin the number of groups (a common threshold for the number of instruments in a GMM).

As part of our robustness checks, we consider additional control variables at the bank (solvency ratio) and macroeconomic (unemployment rate) levels. A complete description of all variables and their respective summary statistics can be found in Tables 1 and 2.

In Fig. 8, we observe that the behavior of the flow of purchases under the PSPP by country is consistent with the aggregate picture in Fig. 3. Without a surprise, bigger economies (e.g., Germany, France, and Italy) with larger absolute levels of debt received a more substantial share of support under the program.
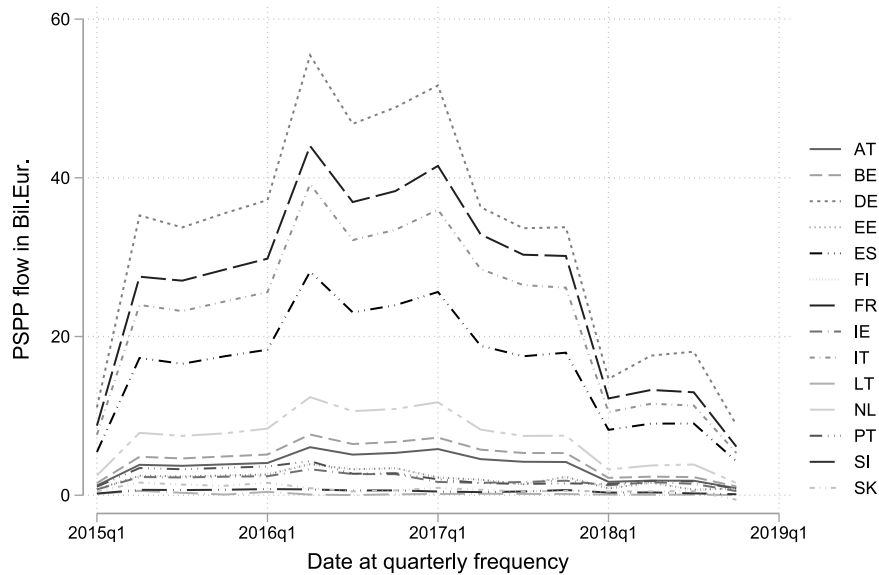
Fig. 8. PSPP flow in billions of Euros (breakdown by country).

Although we do not directly test for causality, the use of quarterly aggregates allows for a retrospective analysis over a reasonable horizon of the relationship between lending volumes and purchases under the PSPP. Eventually, one concern relates to the possibility of reverse causality between lending volumes and the PSPP. However, we are confident that such a problem is unlikely to affect significantly our results. Although we would expect the resilience of the credit market to influence the ECB's monetary policy decisions, purchases under the PSPP were initially defined even before the program was in place (i.e., they followed a relatively rigid schedule defined before observing changes in lending volumes). As reported in Fig. 3, purchases remained stable for long periods, and the total monthly amount of purchases was revised only three times during the period of analysis. Additionally, if purchases under the PSPP were, in fact, endogenous to lending volume rates, that scenario would introduce moral hazard in secondary markets where investors could use lending information as a signal to guide their investment decisions (e.g., by holding short positions on government debt after an increase in lending volumes). We believe the ECB considered that aspect and its implications when devising and implementing the PSPP. Finally, accounting for country and time-specific effects and bank-level controls also helps minimize concerns over the hypothetical endogeneity of monetary policy to lending rates as they capture country-specific lending conditions while the PSPP was meant, primarily, to be conducted considering patterns for the whole EA. This context makes us confident that any possible endogenous link between the variables is not substantial in our model. In any case, considering our sample size, we also do not have a way of checking its impact through dynamic panel models for the reasons pointed out above (i.e., the inability to accommodate the required number of instruments).

Considering Hypothesis 3, we divide countries into two clusters based on the results of a hierarchical clustering method. Those clusters are based on differences in debt-to-GDP (as the benchmark for the assets targeted under the PSPP) and equity-to-assets (as a proxy for financial resilience considering one of the program's objectives).[4] The two resulting clusters are:

- **Cluster 1** [*mix of low government debt and strong financial resilience*]: Germany, Estonia, Finland, Lithuania, Netherlands, and Slovakia;
- **Cluster 2** [*mix of high government debt and weak financial resilience*]: Austria, Belgium, Spain, France, Ireland, Italy, Portugal, and Slovenia.

4. Results

The results in Table 3 show a significant correlation between purchases under the PSPP and lending volumes on loans above and up to €1M, thus supporting our Hypothesis 1 and the role of banking institutions in the transmission of unconventional monetary policy as discussed in Hammerman et al. (2019) (focusing on the ECB's strategy) and both Gagnon et al. (2011) and Rodnyansky and Darmouni (2018) (looking at the FED's strategy). The correlation is particularly significant on loans above €1M, where an increase

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[4] In a hierarchical clustering method, we employ a measure of similarity (in our case, we opted for Euclidean distance (L2)) to create clusters based on the distance between observations from one or more variables (debt-to-GDP and equity-to-assets). The method works by first computing the proximity matrix between countries based on the Euclidean distance between debt-to-GDP and equity-to-assets. Each country is then assigned to a cluster, and clusters are merged until we obtain the desired number (two in our case).

Table 3

Relationship between the PSPP and loans volumes above and up to €1M.

	(1) Loans <1	(2) Loans <1	(3) Loans <1	(4) Loans <1	(5) Loans >1	(6) Loans >1	(7) Loans >1	(8) Loans >1
PSPP	68.52*	66.90*	69.06*	73.36*	163.8**	170.4**	168.8**	175.2**
	(35.31)	(33.28)	(34.56)	(34.67)	(61.92)	(60.13)	(60.60)	(62.96)
ROA (t-1)		−130.3	188	401.9		880.3	804.4	1183.8
		(145.1)	(118.8)	(246.5)		(1413.0)	(1577.5)	(1521.6)
Equity/Assets (t-1)		−233.6*	−196.9	−285.2*		−629.8	−645.3	−817.7
		(115.9)	(132.5)	(156.1)		(491.4)	(548.2)	(695.1)
GDP			6183.1*	5950.2*			−2764.0	−3179.0
			(3100.1)	(3210.3)			(11704.0)	(11630.9)
Inflation			−206.9	−174.1			−210.7	−160.1
			(205.2)	(192.8)			(461.3)	(464.2)
Solvency (t-1)				−149.6				−301.7
				(106.0)				(452.1)
Unemployment				423.8				643.8*
				(405.9)				(341.0)
Observations	210	210	210	210	208	208	208	208
R^2	0.036	0.316	0.333	0.357	0.028	0.340	0.340	0.349
# countries	14	14	14	14	14	14	14	14
Country FE	✗	✓	✓	✓	✗	✓	✓	✓
Time FE	✗	✓	✓	✓	✗	✓	✓	✓

Notes: Standard errors clustered at the country level in (). Lending volumes, PSPP, inflation, and unemployment are defined in first-differences; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4

Relationship between the PSPP and loans volumes above and up to €1M (by period).

	(1) Loans >1 15Q1-16Q4	(2) Loans >1 17Q1-18Q4	(3) Loans <1 15Q1-16Q4	(4) Loans <1 17Q1-18Q4
PSPP	83.61	540.4***	108*	60.76**
	(178.4)	(167)	(53.94)	(22.97)
ROA (t-1)	−1000.9	3056.4	−1199.6	668.0
	(1608.1)	(2422.3)	(1021.5)	(389.7)
Equity/Assets (t-1)	−250.9	−1011.1	−404.8	−405.8***
	(1019.2)	(676.2)	(339.3)	(124.9)
GDP	2762.3	−749.3	4667.9	8480.7
	(4833.5)	(19449.4)	(2717.2)	(5357.8)
Inflation	972.1	−900.8*	109.9	−610.3
	(942.7)	(450.6)	(457.3)	(366.6)
Observations	98	110	98	112
R^2	0.348	0.430	0.391	0.348
# countries	14	14	14	14
Country FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓

Notes: Standard errors clustered at the country level in (). Lending volumes, PSPP, and inflation are defined in first-differences; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

in €1B in the pace of purchases under the PSPP results in an increase of €169M in the variation of lending on that type of loan (i.e., given the *acceleration* of the volume of purchases under the PSPP in €1B, lending above €1M *accelerates* by approximately 16.9% of that amount).[5] Nonetheless, an effect of €69M on loans below €1M is still noteworthy considering that the average lending volume in that credit category is 2.4x smaller than in loans above €1M.

The estimates are robust when we gradually control for bank and economic level aspects which can affect the lending behavior of a financial institution. At this level of disaggregation, only macroeconomic aspects seem to be significantly correlated with lending. In particular, the growth rate of GDP on loans below €1M, and the unemployment rate on loans above €1M.[6]

Concerning the impact of the PSPP on lending volumes during its expansion and contraction phases, the results in Table 4 point to a possible double-edged effect. Looking back at Fig. 1, we see that the liquidity levels of the banking system reached their baseline

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[5] We use the term "*acceleration*" to reflect the fact that each variable is expressed in first differences.

[6] The absence of a stark difference between the PSPP's estimates with and without controls in Table 3 may eventually raise some concerns about whether the parameter of interest is appropriately identified. However, on the one hand, we note, as discussed in the previous section, that our choice of controls is rather intuitive and sensible, and that such variables have been used in other papers testing the effects of unconventional monetary policy, such as Gibson et al. (2016) or Rodnyansky and Darmouni (2018). On the other hand, we also observe a large and gradual increase in the within r-squared as we include additional controls, signaling that such variables are capturing to an effective degree the noise in the credit market.

Table 5
Lending volumes per cluster of countries.

	(1) Loans >1 Cluster 1	(2) Loans >1 Cluster 2	(3) Loans <1 Cluster 1	(4) Loans <1 Cluster 2
PSPP	79.12*	256.2***	25.12*	89.43
	(32.03)	(71.57)	(11.77)	(56.31)
GDP	−16238.3	14064.6	1211.0	13449.3*
	(25656.6)	(10355.4)	(5382.8)	(6151)
ROA (t-1)	−779.1	2069.7	19.36	177.8
	(1639.1)	(2880.3)	(148.8)	(288.8)
Equity/Assets (t-1)	−915.4	351.6	−175.6	−5.405
	(614.6)	(438.1)	(93.95)	(264.6)
Inflation	508	−650.3	120.2	−438.9
	(654.2)	(1181.5)	(263.7)	(277.0)
Observations	88	120	90	120
R^2	0.316	0.447	0.296	0.469
# countries	6	8	6	8
Country FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓

Notes: Standard errors clustered at the country level in (); lending volumes, PSPP, and inflation are defined in first-differences; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

levels from 2012 by roughly 2016Q4. The statistical significance of the PSPP only on *accelerating* loans below €1M between 2015Q1-2016Q4 makes us hypothesize that banks, during the PSPP's expansion phase, may have adopted a more conservative lending strategy by focusing on a class of loans sought by SMEs, and thus, requiring a lower level of credit allocated to each borrower (and potentially minimizing the risk-weighted assets in their credit portfolio). Once that baseline level was hit, it could have provided the necessary incentive for banks to leverage their transformation ratio. That is fundamentally the intuition underlying Hypothesis 2 and is consistent with the evidence of the impact of the ECB's APPs on the liquidity of the European banking system in Altavilla et al. (2018). Despite the weakly significant effect of purchases under the PSPP on loans below €1M during the phase of expansion of the program, we note that those estimates are not statistically different from the coefficients on loans above €1M (highlighting the possible tight management of credit levels and risk during that first phase). In the contraction phase, the transmission of effects appears to be more significant, especially on loans above €1M where 54% of each *acceleration* of €1B under the PSPP is converted into credit. This result also agrees with evidence on higher levels of excess liquidity being positively related to lending growth during a period of negative deposit facility rate and implementation of APP (Altavilla et al., 2018).

In terms of heterogeneity in the impact of the PSPP across countries, consistent with Hypothesis 3, we find evidence of a substantial conversion of purchases under the PSPP into loans above €1M in cluster 2 (equivalent to 26% per each €1B) according to Table 5. That cluster contains countries with higher government debt levels and several financial institutions that were in financial distress. Examples include BES, BCP, BPI, and BANIF in Portugal; BANKIA and Banco Popular in Spain; Banca Monte dei Paschi di Siena, Banca Popolare di Vicenza and Veneto Banca in Italy; Fortis, Dexia, and KBC in Belgium. These results are consistent with Rodnyansky and Darmouni (2018) findings in the US, where they report heterogeneous effects of FED's QE programs among financial institutions depending on their resilience and respective liquidity. They are also consistent with the evidence in Altavilla et al. (2021a) in the EA

Because 3/4 of the SMEs in the SAFE survey reported having obtained loans below €0.25M in 2015, we examine the effect of the PSPP into two sub-categories of loans: between €0.25M and €1M, and below €0.25M. In Table 6, we find that the PSPP was especially effective in boosting the type of loans obtained by most SMEs, as predicted in Hypothesis 1. In particular, for each €1B in purchases under the PSPP, it accelerated the lending of such loans by 7.8%, which is substantially higher than the 3.9% rate in loans between €0.25M and €1M. However, as reported in Table 7, its effects are mainly statistically significant during the program's expansion phase. These results offer further evidence that the initial stream of liquidity that banks obtained from the PSPP may have been transferred to firms in the form of small loans.

At this level of disaggregation, once again, the estimates are robust when controlling for banking and economic variables affecting and shaping lending behavior by financial institutions. As in Table 3, the GDP growth rate significantly correlates with lending on one type of credit (between €0.25M and €1M). However, on SMEs' preferred type of loan, bank-level variables, instead, significantly affect their availability. In particular, as predicted when outlining our empirical strategy, a profitable quarter (benchmarked by the ROA) positively correlates with lending while the opposite happens when equity weighted by the value of all assets increases (thus, hinting at the possibility that other sources of funding, such as deposits relative to a bank's assets, are less abundant).

We conclude with an observation justified by the results in Table 8 and Hypothesis 3. We note that purchases under the PSPP are only significantly correlated with loans in countries in cluster 1. The effects are proportional to €98M and €8.8M on loans below €0.25M and loans between €0.25M and €1M, respectively. These results indicate that the direct effects of the PSPP could have mainly reached SMEs in countries with lower levels of government debt and more resilient banking systems. However, lending in cluster 2 significantly correlates with the business cycle in such countries. Therefore, we anticipate that the effect on credit availability to SMEs in those economies was indirect through an improvement of general economic conditions, namely the GDP and price levels, dimensions positively affected by the ECB's UMP as discussed in Hohberger et al. (2019), Gambetti and Musso (2020), and Lhuissier and Nguyen (2021).

Table 6

Finer breakdown on loans up to €1M.

	(1) LoansM	(2) LoansM	(3) LoansM	(4) LoansM	(5) Loans <.25	(6) Loans <.25	(7) Loans <.25	(8) Loans <.25
PSPP	39.88**	34.95*	35.50*	38.83*	69.38***	75.16**	77.15***	78.79***
	(16.88)	(17.40)	(18.42)	(18.62)	(20.59)	(25.96)	(25.18)	(24.98)
ROA (t-1)		−12.28	125.7	213.3		4.691	183.2*	287.9*
		(58.60)	(78.57)	(135.1)		(146.8)	(97.78)	(148.8)
Equity/Assets (t-1)		−36.62	−19.64	−9.588		−155.7*	−127.7	−181.6*
		(42.03)	(50.07)	(70.73)		(74.09)	(79.25)	(91.04)
GDP			2965.8*	2740.1*			4574.8	4537.9
			(1397.6)	(1423.8)			(3061.0)	(3145.1)
Inflation			−40.24	−16.57			91.83	104.8
			(108.8)	(92.88)			(178.0)	(174.8)
Solvency (t-1)				3.188				−91.10
				(53.45)				(59.71)
Unemployment				284.2				140.5
				(219.2)				(233.8)
Observations	196	196	196	196	210	210	210	210
R^2	0.057	0.307	0.325	0.371	0.075	0.322	0.340	0.347
# countries	14	14	14	14	14	14	14	14
Country FE	×	✓	✓	✓	×	✓	✓	✓
Time FE	×	✓	✓	✓	×	✓	✓	✓

Notes: Standard errors clustered at the country level in (); lending volumes, PSPP, inflation, and unemployment are defined in first-differences; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7

Finer breakdown on loans up to €1M by period.

	(1) LoansM 15Q1-16Q4	(2) LoansM 17Q1-18Q4	(3) Loans <0.25 15Q1-16Q4	(4) Loans <0.25 17Q1-18Q4
PSPP	49.08*	29.70	136.3***	27.62*
	(24.23)	(20.76)	(29.00)	(13.32)
GDP	2268.8*	4727.5	2966.5	7082.7
	(1276.2)	(2861.2)	(1999.4)	(4957.3)
ROA (t-1)	−208.2	278.2	−941.7	470.1
	(435.6)	(210.4)	(670.7)	(315.1)
Equity/Assets (t-1)	−10.17	−117.6*	−347.4	−296.8***
	(115.5)	(63.10)	(222.2)	(71.44)
Inflation	148.1	−235.0	540.7*	−364.1
	(156.5)	(143.1)	(299.4)	(279.2)
Observations	95	101	98	112
R^2	0.372	0.339	0.479	0.343
Number of countries	14	14	14	14
Country FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓

Notes: Standard errors clustered at the country level in (); lending volumes, PSPP, and inflation are defined in first-differences; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Conclusion

In this paper, we provide novel evidence on the effects of the PSPP, a leading instrument of the unconventional monetary policy strategy of the ECB, on liquidity levels in the banking system and economic activity. Overall, we find a positive relationship between purchases under that program and lending volumes above and below €1M (the ECB's threshold separating large from small loans).

While the liquidity in the banking sector was below the baseline levels from 2012, banks seem to have adopted a more conservative and perhaps risk-averse lending strategy. This hypothesis is supported by the positive effect of the PSPP only on loans below €1M between 2015Q1 and 2016Q4, in line with previous findings in the literature. That lending strategy necessarily involves a lower commitment per borrower (which is ideal from a credit risk management considering that the level of credit allocated to each borrower is constrained by a bank's capital level) through a type of loan that, on average, represents a smaller share of the credit portfolio of each financial system in the EA. When that baseline level of liquidity was achieved, purchases under the PSPP seemed to have been channeled mainly as loans above €1M. In particular, we find a 54% conversion of each euro in purchases into loans in that category. This large conversion rate, we believe, based on the evidence in Altavilla et al. (2017), is justified by the significant weight of sovereign debt on EA banks' balance sheets (justifying a conversion of the asset portfolio into more liquid securities) as well as the substantial share of assets in the form of loans to non-financial corporations (which seem, in that sense, to constitute one of the preferred forms of investment). The program also seems to have had larger effects (in magnitude) in countries with more distressed financial systems and larger levels of sovereign debt. Such a result is consistent with the evidence at the bank

Table 8
Finer breakdown of loans up to €1M by cluster of countries.

	(1) LoansM Cluster 1	(2) LoansM Cluster 2	(3) Loans <0.25 Cluster 1	(4) Loans <0.25 Cluster 2
PSPP	8.855***	44.93	97.90***	39.78
	(1.908)	(27.46)	(8.706)	(31.54)
GDP	104.4	5984.0**	−1463.2	12098.9**
	(1274.3)	(2297.7)	(4324.0)	(3553.7)
ROA (t-1)	−2.163	133.1	122.3	134.5
	(130.2)	(165.3)	(155.7)	(189.5)
Equity/Assets (t-1)	−29.41	99.25	−137.8	−91.55
	(15.60)	(137.0)	(79.86)	(185.9)
Inflation	93.99	−209.6	249.3	−287.8*
	(68.10)	(198.1)	(169.0)	(129.9)
Observations	80	116	90	120
R^2	0.355	0.454	0.462	0.472
Number of countries	6	8	6	8
Country FE	✓	✓	✓	✓
Time FE	✓	✓	✓	✓

Notes: Standard errors clustered at the country level in (); lending volumes, PSPP, and inflation are defined in first-differences; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

level in Rodnyansky and Darmouni (2018) in the US and Altavilla et al. (2021a) in the EA. However, it could have benefited more SMEs in countries with more resilient financial systems, which may have limited the effectiveness and reach of the program.

The evidence of the transmission of PSPP to credit supply provides several policy implications. Firstly, it supports the ECB's decision to reactivate that program at the end of 2019, as it benefited the credit supply for SMEs. Secondly, our findings suggest that the level of liquidity plays an important role in the transmission of PSPP. Thirdly, the evidence of the asymmetric transmission to loans of different sizes and countries may help shape future policy design.

Our conclusions, however, are limited by the nature of our aggregate data, which can mask some of the heterogeneity at the individual level (e.g., per financial institution). The relatively small number of observations prevents us from explicitly modeling the possible dynamic nature of lending through a dynamic panel model (e.g., the Arellano-Bond estimator). However, we are confident that fixed effects and bank-level controls capture a substantial part of the influence from past lending. In any case, a finer-grained analysis constitutes a relevant direction for future research, especially, considering the aggregate evidence. Moreover, considering the gradual (but slow) economic recovery following the COVID pandemic, it would be relevant to understand the effectiveness of unconventional monetary policy tools, and how they helped the financial system to rebound successfully in the aftermath of the pandemic. Finally, an interesting direction for future research relates to the economic implications of the PSPP (e.g., Bartocci et al. (2021) points to positive effects of the CSPP on the EA's GDP), and thus, for example, whether the program also produced a more meaningful impact on different macroeconomic outcomes in countries with higher levels of debt and more distressed financial systems.

CRediT authorship contribution statement

Vlad Skovorodov: Developed the empirical analysis framework and collected data. **Rui Silva:** Developed the empirical analysis framework and collected data.

Ethics approval

No ethical approval was required for this research as it did not involve human or animal subjects.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jmacro.2024.103659.

Data availability

The data used in this research are available upon reasonable request from the corresponding author.

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