SAME ACTIONS, DIFFERENT EFFECTS: THE CONDITIONALITY OF MONETARY POLICY INSTRUMENTS

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ABSTRACT

This paper explores the signaling effect of central bank announcements clarifying the reaction function of policy interventions. We exploit the unique setting provided by ECB asset purchase programs. We find that the same action – purchases of identical assets – undertaken under different titles generates different responses. PSPP affects inflation swaps whereas PEPP impacts sovereign spreads, so that only the variables associated with the communicated rationale of each program react. We highlight the importance of clarifying the conditional path of policy instruments for the transmission of monetary policy. We also provide evidence of this signaling channel from other ECB and BoE announcements.

KEYWORDS

Asset prices, central bank communication, central bank reaction function, intermediate objectives, asset purchases, forward guidance.

JEL

G12, E52, E58.

Same Actions, Different Effects: The Conditionality of Monetary Policy Instruments *

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Abstract

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1. Introduction

Monetary policy decisions are transmitted to the economy through various channels. One of them, the signaling channel, has received much attention recently. Central bank announcements can affect private beliefs because they provide signals about the future policy path, news about the economy, or policymakers' preferences and reaction function. Policy announcements that clarify the reaction function of a given policy intervention can inform the public about the link between the policy instrument and a given objective-variable and thus convey a signal about the dynamics of that objective-variable that policymakers are willing to tolerate.

This paper aims to investigate empirically this specific transmission mechanism of the signaling channel when policymakers clarify the reaction function of a given policy by communicating an explicit rationale. We document an original pattern of monetary policy by exploring central bank quantitative easing policies that consist of purchases of identical assets but with different objectives. Consider a central bank that purchases identical assets from similar counterparties, but uses two separate programs to do so. This paper investigates the impact of these two asset purchase programs on asset prices. So far, the literature has focused on the fact that quantitative easing programs purchasing different targeted securities produce different effects (see e.g. Krishnamurthy et al., 2011, 2018, D'Amico et al., 2012), whereas we assess whether purchases of similar assets can have differentiated effects. We aim to understand the channel and mechanism through which these different programs operate.

Two of the asset purchase programs of the European Central Bank (ECB) provide a unique setting to explore this question. During the pandemic, the ECB has increased the monthly pace of its asset purchases under the Public Securities Purchase Programme (PSPP) which was launched in 2015. It also launched another asset purchase program called the Pandemic Emergency Purchase Programme (PEPP). Both programs purchase essentially identical assets: sovereign bonds of euro area countries. This paper explores why the ECB considered having two separate programs by comparing their respective financial market effects. This question became even more relevant when the ECB announced at its meeting on 16 December 2021 that it would stop net purchase flows for one program (the PEPP) and increase net purchase flows for the other (the PSPP). The implicit assumption behind this decision was that both programs are substitutes and produce similar effects (see the press conference on that day).[1] This paper assesses whether this is the case.

Using a standard event-study methodology, we assess the effects of the two asset purchase programs on a number of asset prices: long-term nominal sovereign bond rates, sovereign bond spreads, stock prices, inflation swaps and the euro exchange rate. We first document that both programs have similar effects on most of these variables at the time of each initial announcement and that these effects dissipate for most variables with the subsequent announcements as PSPP and PEPP purchases evolve. This is consistent with the literature highlighting the diminishing returns of asset purchase program announcements (for a comprehensive review, see Kuttner, 2018). A novel result – and the first contribution of this paper – is that PSPP and PEPP announcements have differentiated effects on two of these financial market variables: inflation swaps and euro area sovereign spreads. PSPP announcements have a strong positive impact on inflation swaps but little effect on sovereign

[1] "We have decided that we will discontinue the Pandemic Emergency Purchase Programme (PEPP) on the due date (…). We did not want to have a transition that would be hurting (…) which is the reason why we decided to increase the volume of purchases under the APP", Christine Lagarde, 16 December 2021 press conference.

spreads: only the initial PSPP announcement affects sovereign spreads, not the subsequent ones. Conversely, PEPP announcements have no impact on inflation swaps, but a strong negative effect on sovereign spreads.[2] These differentiated effects are robust to various specifications, in particular controlling for pre-existing market conditions. We find that ECB announcements of purchases of identical assets under different titles do not produce similar effects. An important result of this paper is that the PSPP and the PEPP are not substitutes.

Second, we investigate the channels of these differentiated effects. The fact that PSPP and PEPP have different effects on these two variables specifically, inflation swaps and sovereign spreads, is not anecdotal and sheds light on the potential channels explaining these effects.[3] When the PSPP was announced in January 2015, the ECB was concerned about deflationary risks. Both inflation and inflation expectations were falling and the ECB President Mario Draghi put inflation swaps in the spotlight. The statement released by the ECB explicitly stated that purchases were conditional on "a sustained adjustment in the path of inflation". On 18 March 2020, the PEPP was announced in response to the pandemic financial and economic crisis as the Eurozone faced a sharp increase in financial stress in sovereign debt markets.[4] In a Financial Times column published on 19 March 2020, the ECB President Christine Lagarde linked the PEPP to the fact that sovereign yields had increased and become more dispersed.[5] When justifying the PEPP extension on 4 June 2020, Christine Lagarde reiterated that the PEPP is intended "to address the risk of market segmentation" in the euro area.

Two intertwined explanations emerge for the differentiated effect of PSPP and PEPP. The two policies were implemented in different contexts – deflationary pressures in 2015 and sovereign risk pressures in 2020 – and were motivated by different rationales (i.e. intermediate objectives) – inflation swaps and sovereign spreads.[6] The context hypothesis suggests that the effect of an asset purchase program depends on which variable is under stress and requires intervention at the time of implementation.[7] The effect of a given program would relate to pre-existing trends and would be state-dependent, which would explain why PSPP and PEPP have differentiated effects. The rationale hypothesis suggests that the communication of different rationales for each program indicates different reaction functions that influence investors' beliefs and decisions and in turn trigger different asset price reactions.

To disentangle these two hypotheses, we define episodes of deflationary or sovereign risk pressures based on periods of low inflation swaps or high sovereign spreads and estimate the effect of each program during these episodes using interaction terms. Evidence that both PSPP and PEPP have effects on inflation swaps (sovereign spreads resp.) only during episodes of deflationary (sovereign risk resp.) pressures would support the context hypothesis. Conversely, evidence that PSPP (PEPP resp.) has significant effects on inflation swaps (sovereign spreads resp.) in both states of the economy – normal times and episodes of

[2] We also estimate these effects for each of the 10 individual sovereign spreads separately and confirm this result.
[3] This is in line with Gürkaynak et al. (2021) who show that analyzing the reaction of *several* asset prices helps to identify the transmission mechanism of monetary policy. By looking at a broad set of asset price responses – so bringing in other moments – beyond inflation swaps and sovereign spreads, we are able to narrow down the set of possible mechanisms explaining these effects.
[4] While the PEPP statement was more general overall, we show, based on narrative evidence from newspapers, that the PEPP was clearly interpreted as being about sovereign risk (see Section A of the Appendix)
[5] See the original extract of the Financial Times article in Section A of the Appendix.
[6] Both programs share the same final objective, and the ECB always asserted that these asset purchases contribute to supporting economic activity in order to maintain price stability over the medium term.
[7] A complementary view of the context hypothesis relates to the functioning of financial markets more than to the economic environment. For instance, Gagnon et al. (2018) point to a market functioning channel as *Mortgage-backed securities* (MBS) helped to restore market liquidity and to sustain asset prices in a dysfunctional market.

deflationary pressures (sovereign risk pressures resp.) – while the PEPP (PSPP resp.) has no effect in either of these two states would support the rationale hypothesis.

A key result of this paper is to document that the reason why these two programs affect inflation swaps and sovereign spreads differently lies in their different rationales. We find that PSPP always – i.e. in normal times and during episodes of deflationary pressures – affect inflation swaps but PEPP does not, even during deflationary episodes. The same result holds for the effect of PEPP on sovereign spreads both with and without sovereign risk pressures while PSPP never affects sovereign spreads. We complement this result with an analysis of the sensitivity of inflation swaps and sovereign spreads to inflation and fiscal news before and after the announcement of the two programs. This analysis provides complementary evidence in the spirit of tests assessing the anchoring of inflation expectations.[8] We find that the sensitivity of inflation swaps to inflation news decreased after the PSPP announcement as well as the sensitivity of sovereign spreads to fiscal news after the PEPP announcement, but not the opposite. This result strongly supports the mechanism of a signaling channel through which communicating the rationale of a program influences the dynamics of this objective-variable.[9]

One concern in comparing the two programs is the cross-country allocation of purchases and the so-called "capital key deviations". The PSPP had to comply with ECB capital key shares.[10] In contrast, a key feature of the PEPP is the flexibility option in the country allocation of purchases: PEPP purchases could deviate from capital key shares and differentiated effects on sovereign spreads could be driven by a mechanical effect of over- or under-purchasing some sovereign bonds.[11] Using ECB data, we show that the difference between the two programs in terms of actual purchase deviations is limited, except for French and Italian government securities, which were under- and over-purchased respectively. We use the fact that PEPP-related Italian and French purchases deviate in opposite directions to test whether our main result is driven by a mechanical effect of over- or under-purchasing. We find no evidence of such an effect. However, this difference between the two programs is not neutral. While the PSPP rationale appeared credible because it was directly in line with the ECB mandate, the flexibility option embedded in the PEPP design conveys a strong signal to investors that the ECB aims to improve the transmission of monetary policy and is technically able to reduce sovereign spreads. The flexibility option makes it clear that the rationale of the PEPP is about sovereign risks and makes that rationale credible.

Other potential reasons for the differentiated effects relate to the contrasting economic and financial environments in which the two programs were introduced. We are careful to control

[8] The lack of reaction of market-based measures of inflation expectations to economic data releases indicates that inflation expectations are well anchored. See Gurkaynak et al. (2010).

[9] The dichotomy between PSPP and PEPP programs can be interpreted in two closely related ways. The PSPP can be linked to the reassertion of the ECB mandate and its inflation target. It was introduced when the ECB needed to reaffirm its ability to achieve its inflation target. Conversely, the PEPP can be linked to a cyclical shock (as opposed to changes in investors' beliefs about the inflation target) that hits the euro area asymmetrically and generates sovereign and fragmentation risks. Similarly, the PSPP and PEPP could be interpreted as policies focusing on the monetary policy stance and transmission respectively. Eventually, the different purposes suggested by each interpretation provide information about the respective reaction function of the programs.

[10] For the PSPP, the country breakdown of asset purchases has to reflect the share of each euro area member in the ECB capital. The aim is to avoid creating market distortions among euro area countries.

[11] Christensen and Gillan (2022) suggest another mechanical effect on break-even inflation rates and inflation swaps via liquidity premiums when the Federal Reserve included inflation-indexed bonds in the list of targeted assets for its second QE program. However, in the ECB case, nominal and inflation-indexed bonds were always eligible for both PSPP and PEPP.

for the context and to how liquidity and volatility have evolved over time.[12] In addition, we document that the differences in the operational characteristics - size, length and pace of purchases - of the programs are small in practice and cannot explain the differentiated effects. Finally, the fact that the PSPP announcement was largely anticipated by ECB watchers and financial markets from Fall 2014 differs from the PEPP case and the exogenous and sudden nature of the Covid-19 pandemic. The event-study approach is well suited to control for these anticipation effects – under the assumption that all information and beliefs are incorporated into asset prices. If market participants had anticipated the effect of PSPP on inflation swaps because the program had been widely discussed in the preceding months, we should find a smaller effect of PSPP on inflation swaps relative to PEPP.

Our interpretation of the mechanism drinving the differentiated effects is as follows. Assume that a central bank announces a given policy – for instance, asset purchases – until a certain goal is achieved – say, for instance, lower term premia or an exchange rate depreciation. The effects of purchase announcements on financial markets will differ in the two cases because the central bank has effectively announced two different conditional paths of purchases. In the first case, purchases will not stop until term premia decline, whereas in the second case, purchases will not stop until the exchange rate depreciates. Even though the central bank purchases identical assets, the difference in conditionality creates two different policies. It induces a change in the probability distribution of possible outcomes of the objective-variable. An example of this truncated probability distribution is the "Whatever it takes" announcement of Mario Draghi in July 2012 which suggested that the breakup of the euro area was an unlikely outcome and then led sovereign spreads to ease. This signaling channel influences investors' beliefs and decisions. By communicating about its objective-variables, the central bank provides information about the variables entering the reaction function for a given policy instrument. Communicating the rationale of a policy affects the transmission of that policy. It provides a parallel to the main insight of Haddad et al. (2022) that policymakers will intervene to exclude some extreme events from the range of possible outcomes. There is also a direct analogy with state-contingent forward guidance policies which clarify the reaction function that guides how the central bank sets the policy rate (Lunsford, 2020). Finally, this mechanism is consistent with our first result on the dissipating nature of announcement effects. Initial announcements have stronger effects because they convey information about the link between the objective-variable and the policy instrument, but in subsequent announcements, this information is already priced in.

The mechanism of a signaling channel through which a central bank announcement links the policy instrument to an objective-variable is not specific to ECB asset purchase programs. We provide complementary evidence for a different monetary policy instrument and a different central bank. The Bank of England purchased government bonds under the Asset Purchase Facility for monetary policy purposes starting in 2009 and eventually intervened through temporary and targeted purchases in September 2022 in line with its financial stability objective. Announcements of purchases of the same asset produce significant effects on inflation swaps, stock prices and interest rates in the first case, and on credit spreads and financial risk variables in the second case. Similarly, the ECB forward guidance announcements shifted from time- to state-contingent in March 2016 and we show that their effects evolved accordingly. Prior to the change in the nature of the announcement, interest rate expectations were most affected whereas inflation swaps started to be affected after the announcements were linked to inflation.

[12] We also discuss how the role of fiscal policy effects as a potential confounding factor could lead to an under-estimation of the "true" impact of PEPP on inflation swaps and sovereign spreads.

A key policy implication of our main result is to highlight a potential benefit of central bank asset purchases. Two asset purchase programs, and hence two monetary policy instruments, can be used in parallel with different effects and help achieve different intermediate objectives. Our results suggest that central banks could make use of this additional flexibility to achieve their objectives. More generally, what central banks choose to communicate (the stated purpose or structure of a given policy) can affect how financial market participants react.

This paper contributes to the literature in two ways: it documents that the same action implemented under different titles has different effects and that these effects are driven by the rationale of each policy, i.e. the conditional path of each asset purchase program. The closest papers to ours are the following ones. Krishnamurthy et al. (2018) compare the effects on sovereign bond yields of three different ECB policies – the Securities Markets Programme (SMP), Outright Monetary Transactions (OMT), and Long-Term Refinancing Operations (LTRO) – and document the channels through which these effects operate. Lunsford (2020) shows that the nature of the language used in forward guidance announcements in the United States (US) influences investors' reactions to monetary policy statements. Variations in the expected policy path have differentiated effects on financial and macroeconomic variables depending on the forward guidance language. Our paper sheds light on a similar pattern, but through the clarification of the rationale for an asset purchase policy. Motto and Özen (2022) decompose ECB asset purchase announcements along two dimensions – "conventional QE" and "market-stabilization QE" – which generate expansionary macroeconomic effects and declines in euro area stressed-country sovereign yields respectively. We find a similar pattern using a different identification of the mechanism at work. D'Amico et al. (2020) show that the main factor driving the response to the Fed's Corporate Credit Facility announcements is the elimination of "disaster risk". Haddad et al. (2022) document the conditional policy promises of various policy announcements and their effects on asset prices and tail risks.

This paper relates to the existing literature in two ways. First, it is related to numerous empirical studies on the effects of asset purchase announcements on asset prices. Guidolin and Neely (2010), Hofmann and Zhu (2010), Krishnamurthy and Vissing-Jorgensen (2011), Gagnon et al. (2011), Joyce et al. (2011), Christensen and Rudebusch (2012), D'Amico et al. (2012), Wright (2012), Glick and Leduc (2012), Bauer and Rudebusch (2014), Rogers et al. (2014), Szczerbowicz (2015), Altavilla et al. (2016), Haitsma et al. (2016), Ghysels et al. (2017), Afonso et al. (2018), De Pooter et al. (2018), Dell'Ariccia et al. (2018), Moessner (2018), Altavilla et al. (2019), Eser et al. (2019), Lewis and Roth (2019), De Santis (2020), De Santis and Holm-Hadulla (2020), Pagliari (2020), Altavilla et al. (2021), Bernardini and Conti (2021), Lhuissier and Nguyen (2021), Costain et al. (2021) and Swanson (2021) all investigate the effects of different asset purchase programs in different countries. We differ from these papers by differentiating between asset purchase programs and their effects on different asset prices. An important aspect of the monetary transmission mechanism is the role of institutional policy design and central bank communication in influencing private beliefs about the effects of monetary policy. The features of the two ECB asset purchases provide a relevant setting to properly identify whether the conditional path of a policy instrument matters for its transmission to asset prices.

Second, while there is a rich empirical literature highlighting the effects of central bank communication beyond policy actions, its main focus is on communication about the likely future policy path (see Gürkaynak et al., 2005a, and Hansen and McMahon, 2016), on announcements that could convey information about the macroeconomic outlook (Campbell et al., 2012, and Nakamura and Steinsson, 2018), or on the central bank reaction function (Bauer and Swanson, 2023). In contrast, this paper focuses on the clarification of the objectives of different policy instruments. It thus relates to analyses of the role of communication in

conveying information about policymakers' preferences (Blinder et al., 2008). Communication strategies can provide a benchmark for assessing central bank performance (see Woodford, 2005, Eusepi and Preston, 2010, Gürkaynak et al., 2010, Schmidt and Nautz, 2012, Davig and Foerster, 2023, and Leombroni et al., 2021).

2. The financial market effects of asset purchases

The PSPP was announced on 22 January 2015 and purchases started in March 2015.[13] It consists in purchases of (nominal or inflation-indexed) government bonds. The initial monthly pace of purchases was €60 billion until September 2016. The monthly target for the purchase flows has been adjusted on several occasions thereafter, upward or downward, and the program end has been postponed regularly. From January to October 2019, there was no net purchases, only reinvestments of redemptions. In September 2019, €20 billion of monthly net purchases were announced with no deadline (purchases would be conducted "*as long as necessary*"). In December 2021, the ECB decided to increase the monthly flow of net purchases from €20 to €40 billion, and then reduced this pace back to €20 billion in June 2022. There have not been any net purchases, only reinvestments of redemptions, since July 2022.

The PEPP was announced on 18 March 2020 in response to the Covid-19 pandemic. The list of eligible assets is similar to the APP.[14] Initially, purchases were expected to be conducted until the end of 2020 with a first envelope of €750 billion. The PEPP has then been expanded by €600 billion on 4 June 2020 and by €500 billion on 10 December 2020 (until 2022 for a total amount of €1850 billion). In December 2021, the ECB announced that net purchases under the PEPP would stop in March 2022 while repayments would be reinvested until at least the end of 2024.

2.1. The announcement effect of ECB asset purchase programs

We investigate the effects of both asset purchase program announcements on various financial market variables with an event-study. As these policy decisions have been communicated through press releases at specific dates, this approach is well suited to measure the reaction of asset prices on days of policy announcements. The event-study methodology consists in estimating the effect of policy decisions on changes in asset prices within a short window around the relevant event. Considering that no other event occurred in the same window, the high-frequency change in asset prices can be attributed to the policy announcement. The key assumption is that, since asset prices adjust in real-time, the latest price before the start of the window reflects all information and expectations before the event. Thus, movements during the window only reflect the effect of the policy announcement and are not driven by potential confounding factors (see Lucca and Moench, 2015, de Jong and Naumovska, 2016, and Cieslak et al., 2019). This is crucial for identification since it strips out the endogenous variation in asset prices associated with other shocks.[15]

The effects of PSPP and PEPP announcements are assessed using the following equation:

$$\Delta Y_t = \alpha + \beta_1 PSPP_t + \beta_2 PEPP_t + \gamma_X X_t + \mu_t \quad (1)$$

[13] The PSPP is part of a broader Asset Purchase Programme (APP) that includes the CBPP3 (Covered-Bond Purchase Programme), ABSPP (Asset-Backed Securities Purchase Programme) and CSPP (Corporate Securities Purchase Programme). PSPP purchases represent more than 80% of all APP purchases. CBPP3 and ABSPP purchases started in October and November 2014 respectively. The CSPP was launched later, and purchases started in June 2016.

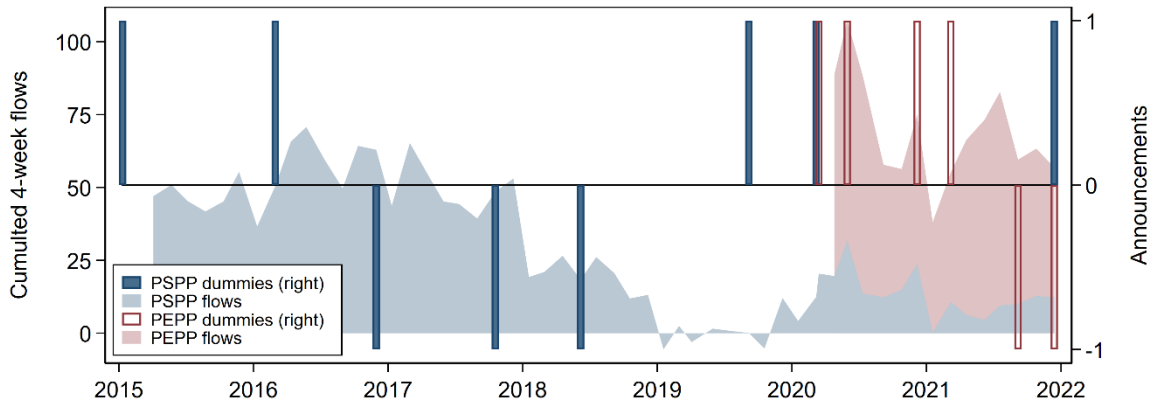
[14] The bulk of PEPP purchases involves public securities. One key difference with the PSPP is the eligibility waiver for Greek sovereign bonds.

[15] Cook and Hahn (1989), Kuttner (2001) and Cochrane and Piazzesi (2002) have initiated this approach.

where ΔY_t is the daily change in various financial market variables. The dummy variables $PSPP_t$ and $PEPP_t$ capture the PSPP and PEPP announcements. X_t is a vector of control variables for other ECB policy announcements. Equation (1) is estimated with OLS using Huber-White heteroskedasticity-robust standard errors, from 1 January 2009 until 16 December 2021 and for announcement days only. By doing so, we assess whether PSPP and PEPP announcements provide relevant information to investors above and beyond the other information conveyed by the ECB throughout these 129 meetings. Our sample starts in 2009 to control for all other asset purchase programs announcements (that started with the CBPP1 on 7 May 2009). Table A in the Appendix describes the variables and their sources.

We consider all announcements at which the flow of purchases has been modified, upward or downward. The dummy variables take the value 1 when asset purchases are initiated or when the size of the program increased and -1 when purchases have been reduced. All announcements but the launch of PEPP on 18 March 2020 happened on Governing Council meeting days. PSPP purchases began in March 2015, but the announcement was made on 22 January 2015, so our dummy takes the value one on this date. The PEPP launch was announced through a press release at 23.53 CET time in the evening of 18 March 2020, so the effects on European financial markets can only be observed on 19 March 2020. The dummy variable $PEPP_t$ takes the value 1 on this date. Figure 1 reports all dates for PSPP and PEPP announcements, together with the flow of net purchases. Finally, the vector of control variables X_t aims to capture the effects of other ECB announcements that could themselves influence these financial market variables. It includes dummies for announcements of other asset purchases, liquidity and long-term refinancing operations.

Figure 1 – PSPP and PEPP announcement dummies and purchase flows



Note: This graph shows the dummy variables for PSPP announcements (blue filled bars) and for PEPP announcements (red empty bars). The dummy variable takes the value 1 when the ECB announces an increase in net purchase flows and the value -1 for a decrease in net purchase flows (right scale). The graph also shows in the background the evolution of actual net purchase flows under the PSPP (blue area) and the PEPP (red area) (left scale in €Bn). Sources: Datastream and ECB's Weekly Financial Statements.

We investigate the effects of these announcements alternatively on long-term nominal sovereign interest rates, sovereign spreads, stock prices, inflation swaps and the exchange rate. We compute the first principal component of 10-year nominal sovereign interest rates across 11 euro area countries (the Euro12 minus Luxemburg).[16] We also compute the first principal component of sovereign spreads across the remaining 10 euro area countries measured as the

[16] Germany, Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland.

difference between their 10-year sovereign yield and Germany's.[17] The key advantage of a principal component analysis – which is essentially a weighted average – is to assign a lower weight to outlier series. It therefore maximizes the common variance of the 11 or 10 series explained by one single metric. Our aim is not to focus on spread differences across countries but on the overall effect on spreads across PSPP and PEPP programs. Stock prices are measured by the Eurostoxx600 stock price index and the exchange rate by the USD/EUR exchange rate. Finally, market-based measures of inflation expectations are proxied with 5-year in 5-year-forward inflation swaps, which are the most commonly used indicator of market-based long-term expectations and is the measure consistently put forward by Mario Draghi and ECB policymakers when discussing inflation expectation dynamics.[18] Table B in the Appendix shows descriptive statistics for all variables.

Table 1 – The financial market effects of PSPP and PEPP announcements

Initial announcement					
	(1)	(2)	(3)	(4)	(5)
	PCA_LTrates	PCA_Spd	STOXX	Swap5y5y	USDEUR
PSPP	-0.187***	-12.489***	4.772***	7.328***	-1.637***
	[-20.91]	[-6.19]	[13.72]	[35.43]	[-18.22]
PEPP	-0.284***	-115.418***	6.842***	-1.961***	-1.257***
	[-31.70]	[-57.21]	[19.68]	[-9.48]	[-13.99]
X_t	Yes	Yes	Yes	Yes	Yes
N	129	129	129	129	129
R2	0.11	0.25	0.26	0.14	0.05
All announcements					
	(1)	(2)	(3)	(4)	(5)
	PCA_LTrates	PCA_Spd	STOXX	Swap5y5y	USDEUR
PSPP	0.026	-2.430	-4.166	2.379*	0.313
	[0.53]	[-0.29]	[-1.51]	[1.80]	[0.73]
PEPP	-0.058	-35.410*	2.227	0.918	0.175
	[-1.03]	[-1.94]	[0.96]	[0.79]	[0.43]
X_t	Yes	Yes	Yes	Yes	Yes
N	129	129	129	129	129
R2	0.05	0.17	0.29	0.11	0.02

Note: t-statistics in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. Parameters are estimated from Equation (1) with OLS using Huber-White heteroskedasticity-robust standard errors. The dependent variable is the daily change in the first principal component of long-term nominal sovereign interest rates over 11 euro area countries – Germany, Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland – (Column 1), the first principal component of long-term sovereign spreads with Germany for 10 euro area countries (Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland) in Column (2), the Eurostoxx600 stock price index (Column 3), 5-year in 5-year forward inflation swaps (Column 4), and the USD/EUR exchange rate (Column 5). The constant being null has been removed from the table. The parameters for the control variables have also been removed for parsimony and are available from the authors upon request.

Table 1 shows the estimates for all five financial market variables of interest. In the upper panel, we focus on the initial announcement for each program. We find that both the PSPP and PEPP announcements have a negative effect on long-term interest rates (Column 1). We also

[17] Table C in the Appendix shows the eigenvalues of the principal component analysis for both 10-year interest rates and sovereign spreads. The first principal component explains 86% and 72% of the variance of all 11 national interest rates and all 10 sovereign spreads respectively.

[18] See for instance Gürkaynak et al. (2010) and Wright (2012). More precisely, inflation swaps are a measure of compensation for expected inflation and risk premia. We do not aim to disentangle both as one of the transmission mechanisms of asset purchases is arguably to affect risk premia. In any case, including a proxy for volatility risk premia, the VSTOXX, in our regression analysis controls for these dynamics such that the estimated effects of both asset purchase programs on inflation swaps are not driven by a risk premia factor.

find a negative effect of both program announcements on sovereign spreads. Interestingly though, the effect of the PEPP announcement is almost 10 times larger than the PSPP one (Column 2). We then find that euro area stock prices react positively to both program announcements in accordance with the idea that these expansionary decisions will have a positive effect on the state of the economy (Column 3). In Column 4, we show an interesting but surprising result: the PSPP and PEPP announcements have different effects on inflation swaps: the PSPP has a positive effect whereas the PEPP has a negative impact. While one would have expected a positive effect of central bank asset purchases on inflation swaps – consistent with the objective of such programs with respect to central bank mandates –, this result suggests that the PSPP does so but not the PEPP. Finally, we show that both program announcements have a negative effect on the exchange rate (Column 5). These estimates, except that on inflation swaps, are consistent with the evidence summarized in the survey of Bhattarai and Neely (2022).

In the bottom panel of Table 1, we provide estimates of the effect of *all* announcements for each program on our five financial market variables. We find no effects of PSPP and PEPP announcements on long-term interest rates (Column 1), stock prices (Column 3) and the exchange rate (Column 5). This is consistent with a large literature showing diminishing effects of asset purchase announcements along time. For instance, comparing QE1 and QE2, Krishnamurthy and Vissing-Jorgensen (2011) find that the effects of QE2 announcements have been smaller than QE1 announcements. This is confirmed by Bauer and Neely (2014) for QE1 compared to QE2 and QE3 and by Hesse et al. (2018) for both the Federal Reserve and the Bank of England. In the euro area, Falagiarda and Reitz (2015) document that the initial SMP announcement had larger effects on the Greek, Portuguese and Irish sovereign yield than the subsequent announcement. We provide evidence of a similar pattern for ECB's PSPP and PEPP announcements. However, we find that the PSPP and PEPP have different effects on sovereign spreads, in line with the large difference in the magnitude of the effects shown in the upper panel. Whereas PSPP announcements have no significant effect, PEPP ones have a negative effect (Column 2). Finally, we also confirm the differentiated effects of PSPP and PEPP announcements on inflation swaps (Column 4). While the initial effects and diminishing returns of asset purchase program announcements are fairly standard in the literature, the result for both inflation swaps and sovereign spreads that PSPP and PEPP have different effects is more puzzling. Hereafter, we focus on these differentiated effects.

2.2. The differentiated effects on inflation swaps and sovereign spreads

We start by normalizing the two dependent variables to a unit standard deviation (SD), so the announcement effects are comparable. Columns 1 and 2 of Table 2 show the estimated effects from Equation (1) of all PSPP and PEPP announcements on inflation swaps and sovereign spreads. While an expansionary PSPP announcement increases inflation swaps by 1.1 SD, the point estimate for an expansionary PEPP one is only 0.4 SD and is not significant. For sovereign spreads, an expansionary PSPP announcement reduces them by 0.1 SD but this effect is not significant, while an expansionary PEPP announcement reduces them significantly by 2 SD.

The first specification (Equation 1) controls for other ECB policy announcements only. Now, we include, in Equation (2) hereafter, controls of market reactions on the day of the policy meeting. We take into account monetary policy surprises as measured by the daily change in 2-year OIS rates. For the PEPP launch, outside a scheduled Governing Council meeting and during the night from the 18 and 19 March 2020, we consider the change in 2-year OIS rates between these two dates. These monetary surprises aim to control for all policy announcements or signals disclosed in the press release or during the press conference that

could affect our dependent variables. We also control for the daily change in the implied stock market volatility (VSTOXX) that captures uncertainty, financial stress and liquidity. Because PSPP and PEPP announcements have been made in response to exceptional developments, this variable aims to control for how ECB policy announcements affect financial stress which daily changes could in turn affect inflation swaps and sovereign spreads (see Blot et al., 2020). We also include the daily change in long-term interest rates, stock prices and the exchange rate following the same line of argument. We aim to control for how policy announcements may have affected these variables which would have influenced in turn the two dependent variables. We include all these variables in a vector of controls Z_t to estimate the effect of PSPP and PEPP announcements above and beyond their effects. We estimate the following equation:

$$\Delta Y_t = \alpha + \beta_1 PSPP_t + \beta_2 PEPP_t + \gamma_X X_t + \gamma_Z Z_t + \mu_t \quad (2)$$

where ΔY_t is the daily change in either inflation swaps or sovereign spreads. Equation (2) is estimated with OLS using Huber-White heteroskedasticity-robust standard errors, over the 129 meetings from 1 January 2009 until 16 December 2021. Table 2 shows that PSPP announcements have a strong positive effect on inflation swaps (Column 3) while they have no effect on euro area sovereign spreads (Column 4). At the opposite, PEPP announcements have no impact on inflation swaps (Column 3) but a strong negative effect on sovereign spreads (Column 4). Although the inclusion of controls reduces the point estimates of the PEPP effect on sovereign spreads (from -2 to -1.2 SD), the order of magnitude of the PSPP effect on inflation swaps and of the PEPP effect on sovereign spreads are similar. In the following, we consider the specifications reported in Columns (3) and (4) as our baseline case.

Table 2 – The PSPP and PEPP effects on inflation swaps and sovereign spreads

	Normalised to 1 SD				**In basis points**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Swap5y5y	PCA_Spd	Swap5y5y	PCA_Spd	Swap5y5y	Spd_FR	Spd_IT
PSPP	1.113*	-0.138	1.400**	-0.317	2.993**	-0.361	-2.676
	[1.80]	[-0.29]	[2.31]	[-1.02]	[2.31]	[-0.36]	[-1.21]
PEPP	0.429	-2.005*	0.389	-1.222**	0.832	-2.545**	-10.916**
	[0.79]	[-1.94]	[0.72]	[-2.10]	[0.72]	[-2.29]	[-2.01]
X_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Z_t	No	No	Yes	Yes	Yes	Yes	Yes
N	129	129	129	129	129	129	129
R2	0.11	0.17	0.21	0.59	0.21	0.53	0.68

Note: Note: t-statistics in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. Parameters are estimated from Equation (2) with OLS using Huber-White heteroskedasticity-robust standard errors. The dependent variable is the daily change in 5-year in 5-year forward inflation swaps in Columns (1), (3) and (5), in the first principal component of 10-year sovereign spreads with Germany for 10 euro area countries (Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland) in Columns (2) and (4) and in the French and Italian spread with Germany in Columns (6) and (7). The constant being null has been removed from the table. The parameters for the control variables have also been removed for parsimony and are available from the authors upon request.

These findings document that investors have responded differently to the two asset purchase announcements. By focusing on financial market participants' reactions, the event-study approach tells how they have updated their information set and beliefs after policy announcements by the ECB. However, both PSPP and PEPP announcements should imply an improvement of the euro area economic outlook, so an increase in inflation swaps. Similarly, one would expect that PSPP and PEPP announcements work the same way on sovereign spreads. Since both programs consist in purchases of the same identical assets, it confirms that the differentiated effects evidenced here are puzzling.

In complementary specifications (Columns 5 to 7), the dependent variables are expressed in basis points (bps). These estimates enable to apprehend the economic magnitude of the PSPP and PEPP announcement effects. PSPP announcements increase inflation swaps by 2.9 bps, while PEPP ones have no effect. To document the magnitude of the effects on sovereign spreads (and because the unit of principal components is not directly interpretable in economic terms), we use changes in French and Italian spreads.[19] PSPP announcements have no significant effect on French and Italian spreads but PEPP ones decrease them by 2.5 and 11 bps respectively.[20]

2.3. Robustness analysis

We run some complementary tests to ensure the robustness of our main result. We start by estimating Equation (2) on all days, not policy announcement days only, so we compare the effects of PSPP and PEPP announcements to all other potential events. Column 1 of Table D in the Appendix shows the baseline estimates for comparison purposes. Column 2 of Table D shows the effects estimated on all days. Point estimates are close to those in Column 1.[21] We then limit the sample period to start in 2015. The objective is to focus on the period during which asset purchases were in action. The pattern characterized by the differentiated effects of PSPP and PEPP remains the same (Column 3).

In addition, we assess the impact of PSPP and PEPP announcements on 10-year inflation swaps and the mean of euro area sovereign spreads as robustness tests of the two dependent variables. We also consider *intraday* monetary policy surprises as measured by the change in 2-year OIS rates by Altavilla et al. (2019).[22] For the PEPP launch on the evening of the 18 March 2020, we consider the daily change in 2-year OIS rates on the next day. We also include, as an additional control, a dummy variable for ECB announcements about the horizon of PSPP purchases that equals 1 when this horizon is extended and -1 when shortened. Columns 4, 5 and 6 confirm the differentiated effects.

Finally, we estimate the effect of PSPP and PEPP announcements on German and Italian inflation swaps – to check that the evidence provided for the euro area inflation swaps holds at the national level – and on German and Italian nominal yields – to ensure that the evidence provided for sovereign spreads is consistent with both terms of the difference. We find that PSPP announcements have a positive and similar effect on inflation swaps in Germany *and* Italy (see Columns 7 and 8). In addition, we find no significant effect of these PSPP announcements on German and Italian 10-year nominal yields. We also find that PEPP announcements have no effect on German or Italian inflation swaps, but a *positive* effect on German nominal yields, and a *negative* effect on Italian nominal yields, such that the negative effect on the spread is driven by both components of the spread measure.

In addition, we explore whether these results only capture short-term announcement effects or persist beyond the announcement day. To that end, we assess the effect of *actual* asset

[19] These spreads are the best proxies for capturing the changes in the first principal component as they exhibit the highest correlations between our synthetic metric and individual country spreads: (0.90) and (0.88) for the French and Italian spreads respectively.

[20] We have also estimated Equation (2) for each of the 10 individual spreads. See Figure A in the Appendix for the estimates of PSPP and PEPP announcement effects across individual countries. Although the effects are less precisely estimated than for the first principal component or mean of sovereign spreads, the 10 point estimates of the PSPP effect are much smaller on average than point estimates of the PEPP effect.

[21] The main difference is related to the R^2 that is lower when the specification includes all days.

[22] We consider the full monetary event window that goes from the press release to the end of the press conference.

purchases on inflation swaps and sovereign spreads.[23] To do so, we use information released by the ECB on the weekly outstanding amounts of public securities held within the PSPP and PEPP.[24] Because purchases are likely to be driven by the dynamics of inflation swaps and sovereign stress, we use a two-step identification approach to overcome endogeneity issues and circumvent at best this reverse causality bias. We start by isolating the exogenous component of asset purchases in a given week not explained by the dynamics of inflation swaps and sovereign spreads of the preceding weeks. We use these residuals to estimate the causal effect of asset purchases on contemporaneous and future inflation swaps and sovereign spreads.[25] We find evidence that the differentiated effects persist across the following two weeks (see Table E in the Appendix). PSPP purchases have a positive effect on inflation swaps that increases over time, whereas they have no significant effect on sovereign spreads. At the opposite, we find that PEPP purchases do not affect inflation swaps but have a negative and significant effect on sovereign spreads.

3. Two associated explanations: the context and the rationale

In this section, we investigate the two main potential reasons for the differentiated effects of PSPP and PEPP that consist in purchases of the same assets.

3.1. The context and rationale of both asset purchase programs

The PSPP was introduced in January 2015 to counter deflationary risks as both inflation and inflation expectations were falling. Figure 2 shows the evolution of inflation swaps in the years around the PSPP implementation and illustrates the decrease in inflation swaps which accelerated in 2014. The PEPP was announced in March 2020 to counter sovereign and fragmentation risks raised by the asymmetric nature of the Covid-19 shock.[26] Figure 2 also shows the evolution of sovereign spreads around the PEPP enactment. It highlights the sharp increase in sovereign spreads at the outset of lockdown measures. The two programs were introduced when the state of the economy – deflationary pressures and sovereign debt pressures – was different. This suggests that the differentiated effects could relate to the fact that inflation or sovereign spreads were under stress at the time of implementation and required policy intervention. For instance, the effect of PSPP on sovereign spreads would have been "muted" in 2015 because they were not under stress as they had massively declined since 2012. A first hypothesis is that PSPP would affect inflation swaps because it was implemented during deflationary pressures while PEPP would affect sovereign spreads because it was implemented during sovereign debt pressures, such that the differentiated effects reflect the state-dependence of asset purchase policies.

Another (related) explanation for the different effects of PSPP and PEPP comes from their different communicated rationale. As stated in the Introductory Statement released on 22 January 2015, the PSPP was initiated to counter deflationary pressures ("*inflation dynamics have*

[23] One criticism against event-studies is that they capture the immediate impact that could be reversed in the following days. However, such a criticism does not account for the fact that other news on these following days might explain the later asset price dynamics. In addition, Bhattarai and Neely (2022) argue that the short-term effect of an announcement should approximate the longer-term impact of such programs.

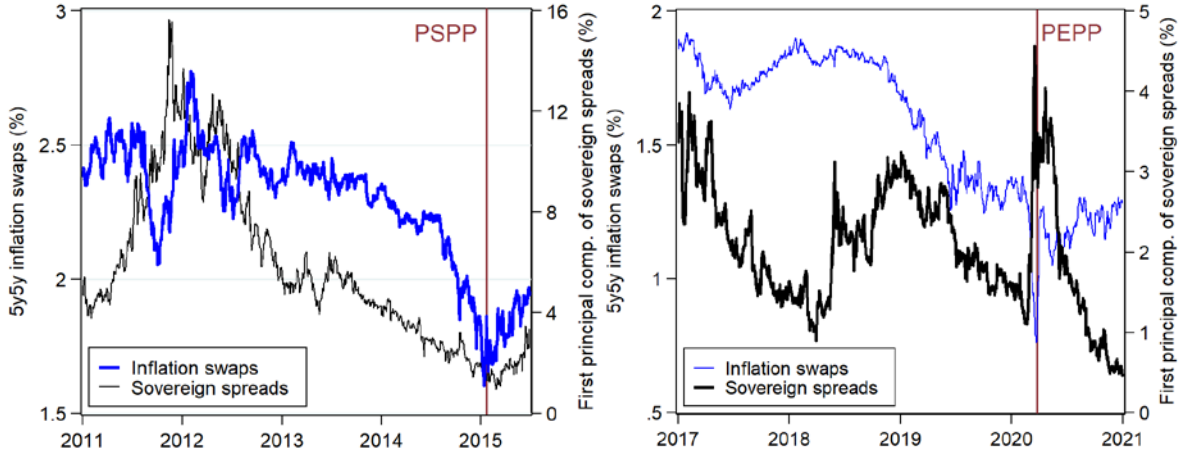
[24] Figure 1 shows PSPP and PEPP net purchase flows.

[25] See Section E in the Appendix for details. As ECB purchases in a given week could still relate to contemporaneous dynamics in inflation swaps and sovereign spreads, so we use end-of-week values (in contrast to week-average values) to measure asset prices. By doing so, we minimize the possibility that weekly asset purchases respond to contemporaneous inflation swaps and sovereign spreads. This timing feature is similar in spirit to timing restrictions that govern the VAR Cholesky-decomposition.

[26] See Ortmans and Tripier (2021) on the link between sovereign stress and the spread of the Covid-19 pandemic.

continued to be weaker than expected", "*further fall in market-based measures of inflation expectations*", "*most indicators of actual or expected inflation stand at, or close to, their historical lows*") and the ECB explicitly stated that purchases were conditional on "*a sustained adjustment in the path of inflation*". The changes in the pace of purchases always referred to deflation risks. For instance, on 10 March 2016, Mario Draghi motivated the expansion of monthly purchases to €80 billion by "*heightened risks to the ECB's price stability objective*" and the 12 September 2019 decision to restart purchases was "*taken in response to the continued shortfall of inflation*". Conversely, all decreases in the pace of purchases intervened when the inflation outlook improved.[27] Thus, these announcements reiterated the aim of the ECB to adjust the monetary policy *stance* in order to comply with the inflation objective.

Figure 2 – Inflation swaps and sovereign spreads around policy implementations



Note: Both panels show the evolution of 5-year in 5-year-forward inflation swaps (blue line) and the first principal component of 10 euro area sovereign spreads relative to Germany (black line) in the years around the PSPP implementation (left panel) and around the PEPP implementation (right panel). The first principal component is rescaled to the interest rate space for sake of simplicity. Source: Datastream.

The PEPP announcement on 18 March 2020 occurred in the context of the financial and economic crisis caused by the pandemic and aimed to restore the *transmission* of monetary policy. The PEPP statement was relatively general and stated that purchases would continue until the "*Covid-19 crisis phase is over*". However, the PEPP can be directly related to the financial effects of the Covid-19 crisis, which triggered an asymmetric increase in sovereign stress, driven by fiscal responses that would undermine public debt sustainability, especially for a couple of fragile countries. Various elements support this view. First, the PEPP announcement followed Christine Lagarde's comment that the ECB was "*not here to close spreads*" on 12 March 2020 – that amplified sovereign stress – and the announcement on 18 March 2020 made clear that this program aimed to respond to sovereign risks ("*fully committed to avoid any fragmentation*", "*high spreads impair the transmission of monetary policy*", "*the ECB will not tolerate any risks (…) in all jurisdictions of the euro area*"). Second, press articles from the Financial Times, Wall Street Journal or Reuters, in the morning of 19 March 2020, show that the PEPP was clearly interpreted by ECB watchers as being about sovereign risks (see Section A of the Appendix). Third, Christine Lagarde's column in the Financial Times on 19 March 2020 explicitly confirmed that the PEPP was linked to sovereign risks (see also Section A of the Appendix). Fourth, while justifying the PEPP extension on 4 June 2020, Christine Lagarde

[27] The reduction of the monthly pace of purchases announced on 26 October 2017 reflected "*growing confidence in the gradual convergence of inflation towards our inflation aim*".

reiterated that the PEPP is expected "*to address the risk of market segmentation*" in the euro area.[28] As an anecdotal evidence, comments from ECB watchers seem to confirm this interpretation (see for example the tweet from Frederik Ducrozet of Pictet Wealth Management on 17 May 2021 : "*Like it or not, markets will continue to focus on weekly PEPP purchases as peripheral bond yields move higher*").

The explanation for the differentiated effects is that the different rationales (or different intermediate objectives for each program) signal that the PSPP and PEPP policies follow different reaction functions. The information conveyed by the announcement – the rationale for a policy – signals to investors which variable enters policymakers' asset purchase reaction function. The two programs, by shaping investors' beliefs about policymakers' preferences, trigger different asset price reactions. The effects of these programs on financial markets differ across the two policies because the central bank has effectively announced two different conditional paths of purchases. In the PSPP case, purchases are conditioned on inflation, whereas in the PEPP case, they are conditioned on sovereign stress. Even though the ECB purchases identical assets, the difference in conditionality creates different market reactions.

3.2. Confronting the two hypotheses

In this section, we aim to disentangle the role of these two hypotheses in explaining the differentiated effects of PSPP and PEPP on inflation swaps and sovereign spreads. If the context is the key driver of the differentiated effects of the programs, one would expect similar effects during periods when the context is the same. The first test consists in restricting the empirical analysis to a common sample period when both programs were in place, either reenacted (PSPP net purchases stopped in December 2018 and relaunched in September 2019) or enacted (in March 2020 for the PEPP). We therefore estimate Equation (2) over a subsample starting in 2019. Although the sample size is obviously very small (and so the standard errors are likely to be large), the point estimates provide some information on whether the PSPP and PEPP effects are different when controlling for the environment. Column (2) of Table 3 reports these estimates: they provide evidence against the context-dependent explanation.

We then examine more specifically the role of the recent dynamics of each dependent variable when each program was implemented. The hypothesis that the differentiated effects is context-dependent implies that one variable, but not the other, was under stress at the time of implementation. Thus, conditional on the recent dynamics of inflation swaps and sovereign spreads, the PSPP and the PEPP should have similar effects. It would therefore suggest that the baseline result would be driven by the fact that the volatility of the two dependent variables varied over time. To explore this issue, we normalize the daily change in each dependent variable by their recent volatility (their standard deviation over the preceding 50 days) such that the PSPP and PEPP estimated effects are conditional on whether these asset prices were under stress and required intervention. We estimate Equation (2) with these alternative dependent variables. Column (3) of Table 3 shows that the baseline result is robust to this alternative specification.

Another way to explore this issue is to control for the level and recent dynamics of the dependent variables. According to the context hypothesis, PSPP could affect inflation swaps because they were at low levels at the time of its implementation. The same reasoning would

[28] On 10 December 2020, the ECB updated its language towards a more general phrasing and the idea of preserving favorable "*financing conditions*". This change aimed to refer to household and corporate interest rates in jurisdictions where they may be tightening and not focus exclusively on the divergence in sovereign interest rates.

apply to the PEPP implementation: while sovereign stress was increasing rapidly, inflation swaps were decreasing rapidly too and hit a lower level than in 2015 (see Figure 2). According to this context hypothesis, PEPP should have had a positive effect on inflation swaps then. Our baseline estimates downplay this explanation. However, we test more formally this hypothesis by augmenting Equation (2) with another vector of control variables C_t that includes the level and the change over 50 days in the dependent variable. While Z_t and X_t control for changes that happen on the announcement days, C_t aims to control for low-frequency changes. Column (4) of Table 3 shows the estimates of this specification that confirm the baseline results. The differentiated effect does not appear to be driven by the level and the recent dynamics of the two intermediate objectives.[29]

Finally, we investigate the relevance of the rationale hypothesis more directly. To do so, we aim to isolate episodes of deflationary pressures and define a dummy variable I_D that equals one when inflation swaps are below their 25th percentile and zero otherwise. We also isolate episodes of sovereign risk pressures and define a dummy variable I_S that equals one when our composite measure of sovereign spreads is above its 75th percentile and zero otherwise. We then augment Equation (2) with an interaction term between each PSPP and PEPP announcement variable and the dummy variable for inflationary pressures (as shown in Equation 3) or with the dummy for sovereign risk pressures (as shown in Equation 4). The key idea of these specifications is to test whether announcing a different rationale for each program (inflation for PSPP and sovereign spreads for PEPP) matters more or less than implementing each program in a certain context (deflationary pressures and sovereign risk pressures) for explaining the PSPP and PEPP effects. We estimate the following equations:

$$\Delta Y_t = \alpha + \beta_1 PSPP_t + \beta_2 PEPP_t + \gamma_1 PSPP_t \cdot I_{D,t} + \gamma_2 PEPP_t \cdot I_{D,t} + \gamma_3 I_{D,t} + \gamma_X X_t + \gamma_Z Z_t + \gamma_C C_t + \mu_t \quad (3)$$

$$\Delta Y_t = \alpha + \beta_1 PSPP_t + \beta_2 PEPP_t + \gamma_1 PSPP_t \cdot I_{S,t} + \gamma_2 PEPP_t \cdot I_{S,t} + \gamma_3 I_{S,t} + \gamma_X X_t + \gamma_Z Z_t + \gamma_C C_t + \mu_t \quad (4)$$

Equations (3) and (4) are estimated with OLS using Huber-White heteroskedasticity-robust standard errors, from 1 January 2009 until 16 December 2021 and for announcement days only. Column (5) of Table 3 shows the estimates of Equation (3) which comprises the vector of controls variables C_t that includes the level and the change over 50 days in the dependent variable (as in Column 4). If the context hypothesis explains our results, then we should find that the PSPP effect is magnified when inflation swaps are low and PEPP effect is magnified when sovereign spreads are high. We find that PSPP announcements have a positive and significant effect on inflation swaps *both* during normal episodes and episodes of deflationary pressures, although the effect of PSPP is twice larger in the latter case. At the opposite, PEPP announcements have no effect on inflation swaps, including during deflationary episodes. This result suggests that it is not enough to announce any asset purchase program during a deflationary episode to trigger a positive effect on inflation swaps, but that the rationale of the PSPP drives it. We find a similar result for sovereign spreads and sovereign risk episodes. PSPP announcements have no effect on sovereign spreads, including during episodes of sovereign risk pressures. At the opposite, PEPP announcements always have a negative and significant effect on sovereign spreads irrespective of whether they happen during normal times or during episodes of high sovereign stress.

[29] The fact that PSPP and PEPP effects on sovereign spreads are relatively homogeneous across individual countries (see Figure A in the Appendix) although individual spreads exhibit large cross-sectional dispersion in their levels suggests that the effect of both programs is not driven by the pre-existing conditions on these variables.

Table 3 – Announcement effects beyond the financial context

Inflation swaps					
	(1)	(2)	(3)	(4)	(5)
	Baseline	Post-2019	DepVar. Nor.	Controls	Interacted
	Swap5y5y	Swap5y5y	$Swap5y5y_N$	$Swap5y5y_N$	$Swap5y5y_N$
PSPP	1.400**	3.015*	1.217**	1.419***	0.982*
	[2.31]	[1.79]	[2.42]	[2.84]	[1.73]
PEPP	0.389	0.834	0.158	0.271	-0.046
	[0.72]	[0.95]	[0.35]	[0.60]	[-0.12]
$PSPP*I_D$					2.265***
					[2.92]
$PEPP*I_D$					0.854
					[0.78]
X_t	Yes	Yes	Yes	Yes	Yes
Z_t	Yes	Yes	Yes	Yes	Yes
C_t	No	No	No	Yes	Yes
N	129	25	129	127	127
R2	0.21	0.45	0.18	0.20	0.24
Sovereign spreads					
	(1)	(2)	(3)	(4)	(5)
	Baseline	Post-2019	DepVar. Nor.	Controls	Interacted
	PCA_Spd	PCA_Spd	PCA_Spd_N	PCA_Spd_N	PCA_Spd_N
PSPP	-0.317	0.343	-0.481	-0.454	-0.291
	[-1.02]	[1.34]	[-1.25]	[-1.16]	[-0.56]
PEPP	-1.222**	-0.833***	-1.165***	-1.153***	-0.882***
	[-2.10]	[-5.03]	[-3.82]	[-3.93]	[-3.54]
$PSPP*I_S$					-0.570
					[-0.78]
$PEPP*I_S$					-1.730**
					[-2.55]
X_t	Yes	Yes	Yes	Yes	Yes
Z_t	Yes	Yes	Yes	Yes	Yes
C_t	No	No	No	Yes	Yes
N	129	25	129	127	127
R2	0.59	0.96	0.45	0.45	0.46

Note: t-statistics in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Parameters are estimated from Equation (2) with OLS using Huber-White heteroskedasticity-robust standard errors for Columns (1) to (4) and from Equation (3) in the upper panel and Equation (4) in the bottom panel for Column (5). The dependent variable is the daily change in 5-year in 5-year forward inflation swaps in the upper panel and the first principal component of 10-year sovereign spreads with Germany for 10 euro area countries (Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland) in the bottom panel. In Columns (3) to (5), the dependent variables are normalized by their recent volatility (namely their standard deviation over the last 50 days). The constant being null has been removed from the table. The parameters for the control variables have also been removed for parsimony and are available from the authors upon request. Column (1) shows the baseline estimates. In Column (2), the sample period starts in January 2019. In Column (3), the dependent variables are normalized by their recent volatility. In Column (4), we augment Equation (2) with additional controls: the level and 50-day change in the dependent variable. In Column (5), the PSPP and PEPP variables are interacted with dummy variables that isolate periods of deflationary pressures (upper panel) and of sovereign risk pressures (bottom panel).

These results support the view that while some of the effects may be partly driven by the context (PSPP and PEPP effects are larger during episodes of deflationary and sovereign risk pressures resp.), the key driver of our result is not the context but the communicated rationale of each program. Announcing a generic (in the sense nonspecific) asset purchase program during deflationary episodes does not affect inflation swaps, as evidenced by PEPP non-

effects. Symmetrically, announcing a generic asset purchase program during sovereign risk episodes does not affect sovereign spreads, as evidenced by PSPP non-effects.

3.3. Sensitivity to inflation and fiscal news

A complementary way to assess the rationale hypothesis is to assess the link between the two objective-variables and inflation and fiscal news before and after the announcement of the implementation of the two asset purchase programs. The rationale hypothesis suggests that clarifying the objective-variable that enters the reaction function of a given asset purchase program conveys information on the set of possible outcomes for that objective-variable. The truncation of the distribution of outcomes implies that this objective-variable becomes less sensitive to related news, or said differently, more determined by the central bank program announcement. There is a direct analogy with the inflation expectation anchoring test based on the sensitivity of market-based measures of inflation expectations to macroeconomic data releases (see Beechey et al., 2011, Gürkaynak et al., 2005b, 2010, Ehrmann et al., 2011).

More specifically, we estimate the sensitivity of relevant asset prices – inflation swaps and sovereign spreads – to surprises to inflation and fiscal data releases before and after PSPP and PEPP first announcements. If the rationale hypothesis is at work, inflation swaps should react less to inflation news after the PSPP announcement than before and sovereign spreads should react less to fiscal news after the PEPP announcement than before. In contrast, the sensitivity of sovereign spreads to fiscal news around the PSPP announcement and of inflation swaps to inflation news around the PEPP announcement should not be affected.

We collect Bloomberg surprises for inflation and fiscal (budget balance and debt) data releases for the Eurozone and the four largest economies of the euro area (Germany, France, Italy and Spain). These surprises are computed as the difference between the actual data release and the Bloomberg consensus. We focus our analysis to the period right before and after each program announcement in order to compare the sensitivity of asset prices in similar environments and estimate the following equation on 6-month samples around each announcement:

$$|\Delta Y_t| = \alpha + \gamma_\pi S_{\pi,t} + \mu_t \quad (5)$$

$$|\Delta Y_t| = \alpha + \gamma_F S_{F,t} + \mu_t \quad (6)$$

where $|\Delta Y_t|$ is alternatively the absolute value of daily changes in inflation swaps or sovereign spreads for each of the two equations, $S_{\pi,t}$ is the absolute value of the surprise in inflation data releases and $S_{F,t}$ is the absolute value of the surprise in fiscal data releases. Equations (5) and (6) are estimated with OLS using Huber-White heteroskedasticity-robust standard errors, for all business days from 22 July 2014 to 21 January 2015 and from 22 January 2015 to 21 July 2015 for the PSPP announcement, and from 19 September 2019 to 18 March 2020 and from 19 March 2020 to 18 September 2020 for the PEPP announcement.

Table 4 – The sensitivity to news of inflation swaps and sovereign spreads

	Around PSPP announcement				Around PEPP announcement			
	Before	After	Before	After	Before	After	Before	After
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Swap5y5y	Swap5y5y	PCA_Spd	PCA_Spd	Swap5y5y	Swap5y5y	PCA_Spd	PCA_Spd
Inflation news surprises	0.243*	-0.071	.	.	0.093	-0.016	.	.
	[1.71]	[-0.53]			[0.73]	[-0.40]		
Fiscal news surprises	.	.	0.290	-0.277	.	.	0.104	-9.329***
			[1.20]	[-1.05]			[0.29]	[-4.43]
N	106	103	106	103	104	106	104	106
R2	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00

Note: t-statistics in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. Parameters are estimated from Equation (5) for Columns (1), (2), (5) and (6) in which the dependent variable is the daily change in 5-year in 5-year forward inflation swaps. Parameters are estimated from Equation (6) for Column (3), (4), (7) and (8) in which the dependent variable is the first principal component of 10-year sovereign spreads with Germany for 10 euro area countries (Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland). The explanatory variables are Bloomberg surprises for inflation and fiscal (budget balance and debt) data releases for the Eurozone and the four largest economies of the euro area (Germany, France, Italy and Spain). These surprises are computed as the difference between the actual data release and the Bloomberg consensus. Equations (5) and (6) are estimated with OLS using Huber-White heteroskedasticity-robust standard errors, for all business days from 22 July 2014 to 21 January 2015 (Columns 1 and 3) and from 22 January 2015 to 21 July 2015 (Columns 2 and 4) for the PSPP announcement, and from 19 September 2019 to 18 March 2020 (Columns 5 and 7) and from 19 March 2020 to 18 September 2020 (Columns 6 and 8) for the PEPP announcement.

Table 4 shows that while the link between inflation news and inflation swaps was positive before the PSPP announcement, it becomes much smaller and insignificant once the PSPP has been announced. In contrast, the link between fiscal news and sovereign spreads is not significant in both 6-month samples around the PSPP announcement. When focusing on the PEPP announcement, we observe the opposite pattern. The link between inflation news and inflation swaps is not affected by the new program announcement, whereas the link between fiscal news and sovereign spreads shows a clear difference before and after the announcement. Fiscal news have much less impact on sovereign spreads after PEPP is announced. These results provide evidence that the different rationales of these two programs lead to different dynamics of their objective-variables.

3.4 The role of the PEPP flexibility option

One fundamental difference between the two programs that held attention is the flexibility of the cross-country allocation of PEPP asset purchases whereas the PSPP purchase shares had to comply with the ECB capital key, so it had to be proportional to the respective size of Eurosystem countries. Although the ECB announced that PEPP purchases had to comply with the ECB capital key *eventually*, PEPP purchases could be implemented in "*a flexible manner*" that meant that purchases could deviate from the capital key across time. The fact that the capital key constraint is different for both programs could explain their differentiated effects: purchases of given countries' sovereign bonds at the expense of other countries would mechanically affect sovereign spreads.[30] In the next section, we show that in practice, the capital key constraint difference between PSPP and PEPP programs is very limited.

However, we believe that the flexibility option was key in setting clear the PEPP rationale. While the PSPP rationale appeared naturally credible because directly in line with the ECB mandate, the PEPP *flexibility option* is a crucial element of the more-novel PEPP rationale. First, the possibility for capital key deviations reinforced that the rationale of the PEPP was about sovereign risks, and second, it signaled that the ECB would be technically able to reduce sovereign spreads. The possibility for capital key deviations therefore makes the overall policy

[30] The case for why the PEPP flexibility would affect inflation swaps differently than the PSPP is unclear though.

announcement credible. This feature is important since, contrary to the PSPP for which there is no need to convince financial markets that this program is fully consistent with the ECB mandate of maintaining price stability, the rationale of the PEPP is related to the ECB mandate only through the argument of the smooth transmission of monetary policy in all jurisdictions of the euro area. In order to affirm this novelty, the ECB needed a distinct program with a flexibility option regarding the country breakdown of purchases to make this new rationale credible. The flexibility option embedded in the policy design aims to convince financial market participants that the PEPP can achieve its purpose. From an anecdotal perspective, in response to the case with the German constitutional court, the ECB highlighted that the PSPP was consistent with the ECB mandate and that capital key shares were respected. For the PEPP to be credible, the ECB had to alter beliefs on that latter issue.

On this matter, one can draw a parallel with the sequence combining the "*Whatever it takes*" and OMT (Outright Monetary Transaction) program announcements in July and September 2012. The ex-ante perspective of announcing a program that could deviate from the established principles of market neutrality and capital key allocation can exert an impact even if ex-post the program does not make use of the "built-in flexibility". The credibility of the announcement could in fact be enough to affect market participants' beliefs. A prominent example of this sort of credibility is the July 2012 "*Whatever it takes*" speech. The announcement was credible enough to influence financial markets even though the ECB never conducted any asset purchase under the OMT program.[31] The differentiated design and the different rationales between PSPP and PEPP could then affect market participants' beliefs differently and generate these different impacts on asset prices.

4. Additional potential explanations for the differentiated effects

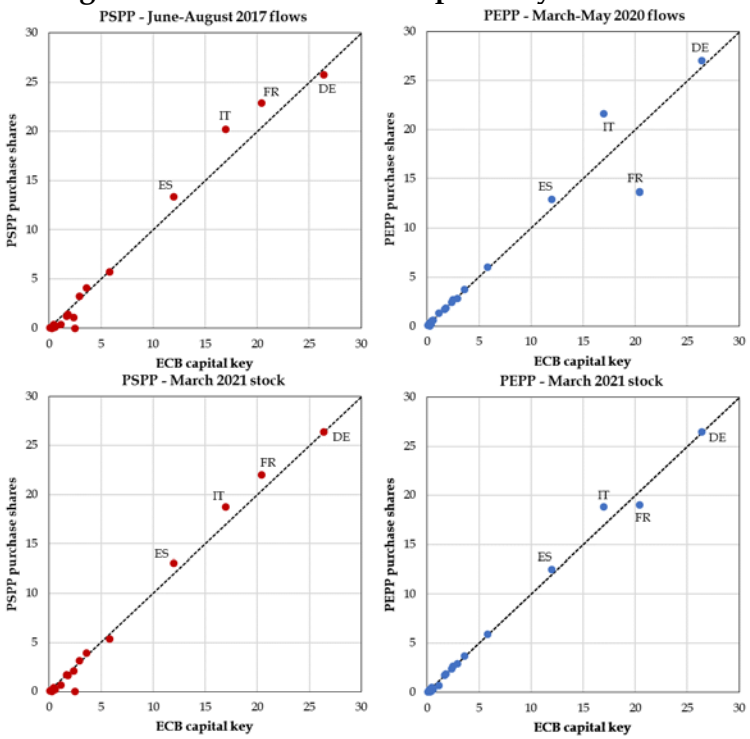
4.1. Capital key deviations

As mentioned earlier, in practice, the difference between PSPP and PEPP programs in capital key deviations is very limited. Deviations were also a concern with the PSPP, despite the apparent constraint embedded in its operational design. For instance, in September 2017, the issue of capital key deviations was raised, as the ECB had purchased a higher share of Italian and French bonds. Mario Draghi recognized that "*there have always been temporary deviations from the capital key*" (Press conference, 07/09/2017) because of market liquidity conditions. At the opposite, despite the flexibility announcement, PEPP purchases have been well aligned with the capital key for most countries, except for French and Italian bonds during the first months of the program. Figure 3 shows deviations from the capital key for both programs.[32] PSPP deviations are small but not negligible while PEPP deviations only apply to French and Italian bonds. Overall, the difference in capital key deviations appears relatively sparse. Another common feature of both programs is that the capital key has to be respected at the end date of each program. Consequently, even in the event of actual capital key deviations, market participants might anticipate subsequent opposite flows to offset initial deviations.

[31] See Altavilla et al. (2016) and Bhattarai and Neely (2022) for more details.

[32] Country breakdowns of bonds' holdings for PSPP and PEPP are available on the ECB website, but not at the weekly frequency. PEPP purchase breakdown is only available for irregular spans of 2 or 3 months, while PSPP purchase breakdown is available at the monthly frequency.

Figure 3 – PSPP and PEPP capital key deviations



Note: Left-hand side panels show how actual PSPP purchase shares compare to the ECB capital key, while right-hand side panels show how actual PEPP purchase shares compare to the ECB capital key. On the upper row, 3-month flows are considered while the bottom row plots purchase stocks as of March 2021. Sources: https://www.ecb.europa.eu/mopo/implement/pepp for the history of 3-month PEPP purchase breakdowns and https://www.ecb.europa.eu/mopo/implement/app for the history of monthly PSPP purchase breakdowns.

Yet, we explore whether our differentiated results would be – at least partly – driven by this operational difference between programs, consistent with the results of Krishnamurthy and Vissing-Jorgensen (2011) and D'Amico et al. (2012) that the effect of asset purchases are more pronounced on targeted assets. We make use of the fact that PEPP asset purchases did not deviate from the capital key for most countries but did so for purchases of French and Italian sovereign bonds in the first months and in opposite directions. We estimate, based on Equation (2), the effects of PSPP and PEPP announcements on a measure of the first principal component of sovereign spreads that excludes these two countries. We also estimate the PSPP and PEPP announcement effects on the spread, relative to German bonds, of Italian bonds (that are over-purchased) and French bonds (that are under-purchased). If the difference between PSPP and PEPP announcement effects is driven by the "mechanical" effect of PEPP capital key deviations, spreads of countries in line with the capital key should not react to the PEPP while French (resp. Italian) spreads should increase (resp. decrease). Table 5 shows estimates of these tests. We find that the differentiated effects of PSPP and PEPP on spreads is still at work even after excluding French and Italian bonds (so when the capital key is enforced). The differentiated effects of PSPP and PEPP also hold for the two individual countries, so they are not a mechanical consequence of buying relatively more Italian bonds or less French bonds. These estimates suggest that the main result is not driven by capital key deviations.

Table 5 – Exploring the role of capital key deviations

	(1)	(2)	(3)
	PCA ex. FR/IT	Spd_IT	Spd_FR
PSPP	-0.329	-0.362	-0.134
	[-1.00]	[-1.21]	[-0.36]
PEPP	-1.127**	-1.476**	-0.943**
	[-2.04]	[-2.01]	[-2.29]
X_t	Yes	Yes	Yes
Z_t	Yes	Yes	Yes
N	129	129	129
R2	0.50	0.68	0.53

Note: t-statistics in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. Parameters are estimated from Equation (2). The dependent variable is the first principal component of 10-year sovereign spreads with Germany excluding France and Italy, so for 8 euro area countries (Spain, Portugal, Greece, Ireland, Netherlands, Belgium, Austria and Finland) in Column (1), the Italian 10-year sovereign spread in Column (2) and the French 10-year sovereign spread in Column (3). The constant and parameters for the control variables have been removed for parsimony and are available from the authors upon request.

It may be argued that the Securities Market Programme (SMP), launched in May 2010, is close to the PEPP since it consists in purchases of the same assets (i.e. sovereign bonds) and its objective was explicitly to deal with fragmentation risks in euro area sovereign debt markets. However, it would not be relevant to consider this program in our empirical exercise. A key operational feature of the SMP is to purchase sovereign bonds only from countries under stress. [33] In that case, the effect on sovereign yields and therefore on spreads is – at least partly – mechanical. In the case of the comparison between the PSPP and PEPP, when the Eurosystem purchases sovereign bonds from countries under stress, it also purchases German bonds – and even more than from countries under stress through the capital key constraint. So the effect on spreads does not boil down to a standard market effect of ECB excess demand for sovereign bonds from one specific country.

4.2. Controlling for the financial and economic conditions

Our baseline result might also be driven by the fact that financial and economic conditions were different when both programs were implemented. We therefore include as controls the level of and 50-day change in various financial or economic indicators. We start with long-term nominal interest rates and short-term (2-year) inflation swaps as they relate directly with our dependent variables. We also consider the VSTOXX to check for potentially different market conditions across time – in terms of financial stress and liquidity (see Bernardini and De Nicola, 2020). We also test the level of and 50-day change in the VIX to control for the global financial environment. We then include the level of and 50-day change in Eurostoxx600 stock prices to capture a potential central bank put – the response of central banks to stock market dynamics (see Cieslak and Vissing-Jorgensen, 2021). We also control for Scotti (2016)'s macroeconomic news surprises. Table 6 shows estimates of the PSPP and PEPP effects when controlling for these factors. All tests confirm the differentiated effects of the two programs.

[33] Szczerbowicz (2015) finds significant effects of SMP announcements on Greek, Italian, Spanish, Portuguese and Irish sovereign yields but not on the French sovereign yield. De Pooter et al. (2018) find significant and long-lasting effects of SMP purchases on sovereign bond liquidity premia of Ireland, Italy, Portugal and Spain.

Table 6 – Announcement effects beyond financial and economic conditions

Inflation swaps						
	(1)	(2)	(3)	(4)	(5)	(6)
	LT rates	InfSwap2y	VSTOXX	VIX	STOXX	MacroSurp.
	Swap5y5y	Swap5y5y	Swap5y5y	Swap5y5y	Swap5y5y	Swap5y5y
PSPP	1.426**	1.493**	1.488**	1.473**	1.567**	1.522**
	[2.25]	[2.58]	[2.09]	[2.14]	[2.36]	[2.19]
PEPP	0.399	0.220	0.313	0.253	0.349	0.476
	[0.70]	[0.51]	[0.61]	[0.52]	[0.62]	[0.62]
X_t	Yes	Yes	Yes	Yes	Yes	Yes
Z_t	Yes	Yes	Yes	Yes	Yes	Yes
N	127	127	127	127	127	122
R2	0.22	0.25	0.27	0.26	0.25	0.26
Sovereign spreads						
	(1)	(2)	(3)	(4)	(5)	(6)
	LT rates	InfSwap2y	VSTOXX	VIX	STOXX	MacroSurp.
	PCA_Spd	PCA_Spd	PCA_Spd	PCA_Spd	PCA_Spd	PCA_Spd
PSPP	-0.324	-0.183	-0.016	-0.020	-0.126	-0.341
	[-0.96]	[-0.57]	[-0.06]	[-0.07]	[-0.46]	[-1.06]
PEPP	-1.195**	-1.149**	-0.941**	-0.940**	-1.085**	-1.713*
	[-2.20]	[-2.05]	[-2.40]	[-2.41]	[-2.42]	[-1.93]
X_t	Yes	Yes	Yes	Yes	Yes	Yes
Z_t	Yes	Yes	Yes	Yes	Yes	Yes
N	127	127	127	127	127	122
R2	0.59	0.59	0.62	0.62	0.61	0.60

Note: t-statistics in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. Parameters are estimated from Equation (2) with OLS using Huber-White heteroskedasticity-robust standard errors. The dependent variable is the daily change in 5-year in 5-year forward inflation swaps in the upper panel and the first principal component of 10-year sovereign spreads with Germany for 10 euro area countries (Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland) in the bottom panel. The constant being null has been removed from the table. The parameters for the control variables have also been removed for parsimony and are available from the authors upon request. In Columns (1) to (5), we control for the level and change over 50 days in the first principal component for long-term nominal interest rates, 2-year inflation swaps, VSTOXX, VIX and Eurostoxx600 respectively. In Column (6), we include Scotti (2016)'s macroeconomic surprises as an additional control.

Another potential issue relates to the fact that the analysis abstracts from fiscal policy and from the fiscal context in which both programs were designed. The fiscal policy stance was much more expansionary in 2020 than in 2015. We may expect that the 2020 massive fiscal stimulus has had a positive effect on inflation and inflation expectations (demand effect) and on sovereign spreads (related to differentiated country debt sustainability issues). Fiscal policy might therefore be a confounding factor driving our results. In the event-study, we check that no fiscal policy announcements happened on days of PSPP or PEPP announcements. More conceptually, considering the estimated effects of PEPP on inflation swaps and on sovereign spreads, the role of fiscal policy effects – if fiscal policy is a confounding factor – would lead to an under-estimation of the "true" impact of PEPP on inflation swaps and sovereign spreads. It suggests that this potential confounding factor does not drive our differentiated results.

4.3. Factors related to program announcements

Both programs entail the purchase of identical assets but their operational characteristics were not exactly identical. However, as we report in the following, they were very close.

First, whether the horizon of purchases is open-ended or finite could affect liquidity premia via the mechanism described in Christensen and Gillan (2022) and generate differentiated

effects on targeted assets. However, both the PSPP and PEPP were first announced with a finite horizon, i.e. for some months. The PSPP has then been extended multiple times and was still ongoing after 6 years and the PEPP termination date had been postponed twice before being stopped. Second, the size of the two programs can be perceived as different: the ECB announced a monthly pace (€60 billion) of purchases for the PSPP, but a total envelope (€750 billion) for the PEPP.[34] Eventually, there is a strong equivalence between committing to purchase flows over a given period (€60 billion per month over 18 months for the PSPP, so €1080 billion) and a total envelope until a given date. In addition, considering that the size of the PSPP was larger than the PEPP, estimates from Tables 1 or 2 suggest that the effect on sovereign spreads of the PEPP relative to the PSPP was even more powerful. Third and related to the previous point, the ECB communicated on a monthly pace of purchases for the PSPP that appeared strictly pre-determined, but on a total envelope coupled with a "flexible" pace for the PEPP leaving room for maneuver to adjust purchases. This feature introduces a difference in how PSPP and PEPP purchase flows could affect asset prices. However, the actual variability of PSPP and PEPP purchase flows is extremely close. The standard deviation of weekly PSPP and PEPP net flows is €6.41 billion and €6.62 billion, respectively. Overall, it seems that the differences in the operational characteristics of the two programs are negligible in practice.

Another potential source of differences relates to the fact that the PSPP announcement was discussed by many ECB watchers in 2013 and 2014 and anticipated by financial markets since the launch of the CBPP3 on 20 October 2014 and the ABSPP on 21 November 2014, whereas the PEPP announcement was not (or at least, less) anticipated (see De Santis, 2020). The event-study methodology is well-suited to tackle the potential issue that one of the two programs might have been more anticipated than the other. This empirical approach identifies financial market participants' response on the day of the announcement and the identification of the causal effect of asset purchases relies on the fact that asset prices at the start of the daily window incorporate these anticipation effects. Thus, if market participants had anticipated the effect of PSPP on inflation swaps because the program was largely discussed in the months before, we should see a muted effect of PSPP on inflation swaps. Since the change in asset prices on the announcement day captures the revision in private agents' information set, the fact that the PSPP effect on inflation swaps is large compared to the PEPP null effect on inflation swaps would suggest the exact opposite pattern: PSPP was not much anticipated whereas the PEPP was fully anticipated.

5. Complementary evidence

The mechanism by which a central bank announcement clarifies the reaction function of a given instrument, by linking it to an objective-variable and thus truncating the distribution of realizations of that variable, is not limited to asset purchase programs and to the ECB. The changing nature of the forward guidance announcements of the ECB provides an experiment to test this mechanism. The shift in the rationale of asset purchases by the Bank of England in September 2022 sets another example.

5.1. BoE asset purchase interventions

There is a direct related case study for the mechanism emphasized in this paper. In the UK, the BoE implemented an asset purchase program in March 2009, named Asset Purchase Facility (APF), based on monetary policy considerations in line with its inflation targeting

[34] See D'Amico and King (2013) for a quantification of flow and stock effects.

mandate. However, in September 2022, the BoE intervened on government bond markets via a standard asset purchase program – temporary and targeted purchases (TTP). The aim was to mitigate the financial panic raised by Liz Truss government's economic program that put British pension funds into difficulty. The BoE purchased similar government bonds as in the APF program but "*in line with its financial stability objective*". The same assets were purchased in the two types of interventions, but with different justifications or objectives such that the mechanism described in this paper could be at work too.

We estimate a modified version of Equation (1) in which we include two dummy variables for APF and TTP announcements. The list of those dates and the key statements is presented in Section C in the Appendix. The two sets of dependent variables are the daily change in inflation swaps, the FTSE index and 1- and 10-year Gilt rates as indicators of the monetary policy objectives and 1-year (BBB - AA) and 10-year (BBB - AAA) credit spreads, 5-year UK banks credit default swaps (CDS) and the FTSE volatility index. We also include as an additional covariate the level of the dependent variable on the day before the policy meeting to control for the environment as in Section 4.2.

Table 7 – The differentiated effects of BoE asset purchase programs

	Monetary policy objectives				Financial stability objectives			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Swap1y	FTSE	Gilt1y	Gilt10y	CrdSpd1y	CrdSpd10y	BankCDS5y	FTSEVol
APF	0.383*	0.604**	-0.584**	-0.672*	0.158	0.145	0.013	-0.194
	[1.72]	[2.22]	[-1.98]	[-1.74]	[0.89]	[0.31]	[0.06]	[-0.74]
TTP	-1.997	-0.448	-0.566	-0.835	-1.278***	-2.455***	-0.093***	-0.767***
	[-0.52]	[-0.89]	[-0.22]	[-0.25]	[-4.89]	[-4.38]	[-7.35]	[-15.54]
N	160	160	160	160	148	160	160	160
R2	0.21	0.03	0.12	0.08	0.03	0.08	0.02	0.06

Note: t-statistics in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. Parameters are estimated from a modified Equation (1) with OLS using Huber-White heteroskedasticity-robust standard errors in which the dependent variable is the daily change in 1-year inflation swaps (Column 1), the FTSE index (Column 2) and 1- and 10-year Gilt rates (Columns 3 and 4) as indicators of the monetary policy objectives and 1-year (BBB - AA) and 10-year (BBB - AAA) credit spreads (Columns 5 and 6), 5-year UK banks' credit default swaps (CDS) (Column 7) and the FTSE volatility index (Column 8). The explanatory variables are two dummy variables for APF and TTP announcements. The list of those dates and the key statements is presented in Section C in the Appendix. We also include as an additional covariate the level of the dependent variable on the day before the policy meeting to control for the environment as in Section 4.2.

Table 7 shows the estimates of the effects of APF and TTP announcements on the dependent variables normalized to a unit standard deviation. The main outcome of Table 7 is that APF announcements positively affect inflation swaps and FTSE returns and negatively affect government bond yields but have no effects on risk variables. In contrast, TTP announcements have a negative effect on all risk measures: credit spreads, CDS and the FTSE volatility index, but no effect on inflation swaps, FTSE returns and sovereign bond yields. Although the same assets were purchased, the effects of these announcements are critically different. These results suggest that communicating on the conditionality of policy instruments affects the dynamics of the objective-variable and is not specific to the euro area.

5.2. Time- vs. state-contingent forward guidance

There is another related case study for this mechanism. The ECB recent history offers another case study of a shift in the conditionality of a monetary policy instrument, via forward guidance announcements. From its first announcement in July 2013 to February 2016, the forward guidance was time-contingent and aimed to influence the path of expected future short-term interest rates. It then became state-contingent after March 2016 when a strong conditional link to inflation deviations from the central bank target and inflation expectations

has been asserted. We can therefore apply the same exercise as in Section 2 for PSPP/PEPP to the two types of forward guidance announcements and the two objective-variables: expected future short-term interest rates and inflation swaps.

We estimate a modified version of Equation (1) in which we include two dummy variables for time- and state-contingent forward guidance announcements. Because the forward guidance statement was repeated at each meeting after its introduction (word for word in most cases), we only consider the key announcements when the forward guidance statement evolves significantly. The list of those dates and statements is presented in Section B in the Appendix. The two dependent variables are the daily change in 2-year OIS rates and 5-year in 5-year forward inflation swaps. We also include as an additional covariate the level of the dependent variable on the day before the policy meeting to control for the environment as in Section 4.2.

Table 8 – The differentiated effects of time- and state-contingent forward guidance

	Expected future policy path			**Inflation compensation**		
	(1)	(2)	(3)	(4)	(5)	(6)
	OIS2y	OIS2y	OIS2y	Swap5y5y	Swap5y5y	Swap5y5y
Time FG	-0.026**	-1.012**	-1.001**	0.935	0.437	0.410
	[-2.04]	[-2.04]	[-1.99]	[1.13]	[1.13]	[1.04]
State FG	0.026	1.011	0.781	3.097*	1.448*	1.400***
	[1.06]	[1.06]	[1.54]	[1.92]	[1.92]	[3.10]
ECB ann.	No	No	Yes	No	No	Yes
N	129	129	129	129	129	129
R2	0.01	0.01	0.04	0.05	0.05	0.12

Note: t-statistics in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. Parameters are estimated from a modified Equation (1) with OLS using Huber-White heteroskedasticity-robust standard errors in which the dependent variable is the daily change in 2-year OIS rates (Columns 1 to 3) and in 5-year in 5-year forward inflation swaps (Columns 4 to 6). We include as an additional covariate the level of the dependent variable on the day before the policy meeting to control for the environment as in Section 4.2. In Columns (2), (3), (5) and (6), the dependent variables are normalized to a unit standard deviation. The explanatory variables are two dummy variables for time- and state-contingent forward guidance announcements. The list of those dates and statements is presented in Section B in the Appendix. In Columns (3) and (6), we augment the specification with controls for other ECB policy announcements such as liquidity provisions, long-term refinancing operations and asset purchase programs.

Table 8 shows the estimates of the effects of time- and state-contingent forward guidance announcements on the raw dependent variables (Columns 1 and 4) and normalized to a unit standard deviation (Columns 2, 3, 5 and 6). In Columns (3) and (6), we augment the specification with controls for other ECB policy announcements such as liquidity provisions, long-term refinancing operations and asset purchase programs. The main outcome of Table 8 is that time-contingent forward guidance announcements negatively affect OIS rates but have no effects on inflation swaps. In contrast, state-contingent forward guidance announcements have a positive effect on inflation swaps but no effects on OIS rates. These results suggest that the mechanism by which communicating the rationale of an instrument and clarifying its reaction function affects the dynamics of this given objective-variable appears at work beyond asset purchase programs.

6. Discussion and Conclusion

This paper documents an original pattern in the transmission of ECB asset purchases. We investigate whether similar-asset purchases from two different programs produce different financial market effects. To answer this question, we exploit the unique setting of ECB asset purchases: the PSPP was introduced in 2015 to counter deflationary risks, while the PEPP was introduced in 2020 to counter sovereign risks. The main result of this paper is that the PSPP and PEPP are not substitutes. The PSPP positively affects inflation swaps but has only a slight

negative impact on sovereign spreads, whereas the PEPP has a strong negative effect on sovereign spreads but no effect on inflation swaps.

Our analysis suggests that the key difference between the two ECB programs relies mainly on their rationale and the design that makes these announcements credible. Our favored explanation of the mechanism at work is the following. By communicating the rationale of a policy – and the operational features that make it credible –, the announcement clarifies the link between the instrument and an objective-variable. Different rationales create different reaction functions. By shaping investors' beliefs about the range of possible outcomes for these objective-variables, the announcements affect these objective-variables. Consequently, the effects of the initial announcements – when the first signals about which variables enter the asset purchase reaction function are disclosed – should be larger since investors update their beliefs about the reaction function. This is consistent with our finding that the first announcement for each program (22 January 2015 for the PSPP and 18 March 2020 for the PEPP) has larger impact than later ones. The main policy implication of this paper is that communicating explicitly a credible rationale for a given policy is crucial in determining the effects of that policy on its intermediate objectives.

This mechanism may be related to the frameworks of Eusepi and Preston (2010) and Davig and Foerster (2023). Both papers discuss the extent to which central bank communication may be central in driving private expectations. Eusepi and Preston (2010) show that communicating the precise details of the monetary strategy or the variables on which central bank decisions are conditioned help anchor private expectations. Davig and Foerster (2023) show that central banks that communicate a tolerance band around their inflation target and communicate their inflation forecasts provide the same information as a rule-based policy without having to express explicitly their policy rule. These theoretical models show that agents extract information about policymakers' reaction function from central bank communication. In this paper, thanks to the unique setting of ECB asset purchases, we provide evidence that similar mechanisms can be empirically observed. Conditional forward guidance by the ECB and conditional BoE asset purchases offer additional evidence.

Another implication refers to the benefit of using asset purchases as an instrument of monetary policy. Two different programs of asset purchases can be implemented in parallel with different objectives whereas this is not directly the case for the interest rate instrument. Policymakers could adjust the reaction function for the policy interest rate but could not have two different interest rates and reaction functions at the same time. The same holds for forward guidance. Our results suggest that central banks could make use of additional flexibility from asset purchases to achieve different objectives (say, for instance, increasing inflation swaps, reducing sovereign spreads, lowering term premia, or depreciating the exchange rate). More generally, what central banks choose to communicate (the stated purpose or structure of a given policy) can affect how financial market participants react.

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APPENDIX
FOR ONLINE PUBLICATION

A. Press articles about ECB decisions

The ECB will do everything necessary to counter the virus
Christine Lagarde, ECB President
Financial Times - 19 March 2020
https://www.ft.com/content/281d600c-69f8-11ea-a6ac-9122541af204

"Risk-free rates have moved up and government bond yields — benchmarks that are key to the pricing of all assets — have increased everywhere and become more dispersed. These developments impair the smooth transmission of our monetary policy across the euro area and put price stability at risk."
"As a result, the European Central Bank's governing council has created a new Pandemic Emergency Purchase Programme of up to €750bn until the end of the year on top of the €120b in extra purchases announced on March 12."

ECB to launch €750bn bond-buying programme
Financial Times - 19 March 2020
https://www.ft.com/content/711c5df2-695e-11ea-800d-da70cff6e4d3

"The move brought an instant rebound in European debt markets, boosting the price of sovereign bonds from Italy to Germany, which had been under pressure from investors selling assets in response to fears about the pandemic."
"The yield on Italian 10-year bonds dropped 106 basis points to 1.37 per cent — almost halving the Italian government's financing costs, and soothing fears that investors could test the ECB's ability to backstop the debts of peripheral nations."
"Economists have been calling for the ECB to increase its bond-buying programme, which has already collected €2.6tn of assets, particularly since the borrowing costs of southern eurozone countries — including Italy and Greece — began rising sharply to levels not seen for more than a year."
"Ms Lagarde was also forced to beat a hasty retreat and to issue an apology to the rest of the council last week after she said it was not the ECB's role to "close the spread" in sovereign debt markets — referring to the gap between Italian and German bond yields that is a key risk indicator for Italy. That triggered a bond market sell-off, pushing up Italian government bond yields."

ECB to Buy Bonds to Combat Economic Slowdown From Coronavirus
Wall Street Journal - 19 March 2020
https://www.wsj.com/articles/ecb-seeks-to-mend-rifts-as-economic-clouds-gather-11584523534

"The European Central Bank unveiled a new €750 billion ($818.7 billion) bond-buying program aimed at shielding the eurozone economy from the spreading coronavirus, casting aside longstanding taboos to send a determined signal to investors that the bank will stand behind the region's embattled governments."
"The decision came during an unscheduled late-night conference call among top ECB officials, on a day when borrowing costs for governments like Italy and Spain jumped as the virus roiled and shuttered the region."

"Last Thursday, ECB President Christine Lagarde stressed at a news conference that the bank was "not here to close spreads," suggesting it wouldn't intervene to narrow the difference in borrowing costs between Germany and Italy."

ECB to print 1 trillion euro this year to stem coronavirus rout
Reuters – 19 March 2020
https://www.reuters.com/article/us-health-coronavirus-ecb-idUSKBN21543D

"The European Central Bank launched 750 billion euro emergency bond purchase scheme in a bid to stop a pandemic-induced financial rout from shredding the euro zone's economy and raising fresh concerns about the currency bloc's viability."
"Although global stocks continued to fall after the ECB's move, the euro held broadly steady and bond yields in the bloc's periphery tumbled, with Italy leading the way with a 90 basis point drop on its 10-year benchmark."
"Although it will still buy government bonds according to each country's shareholding in the bank, the so-called capital key, the ECB said it would be flexible and may deviate from this rule."
"This was seen as a clear indication that it will not tolerate the surge in yield spreads between euro zone members seen in Italy and Greece in recent days."

B. ECB statements about forward guidance

4 July 2013
"The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time."

9 January 2014
"We firmly reiterate our forward guidance that we continue to expect the key ECB interest rates to remain at present or lower levels for an extended period of time."

10 March 2016
"The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time, and well past the horizon of our net asset purchases."

14 June 2018
"We expect them to remain at their present levels at least through the summer of 2019 and in any case for as long as necessary to ensure that the evolution of inflation remains aligned with our current expectations of a sustained adjustment path."

25 July 2019
"We expect them to remain at their present or lower levels at least through the first half of 2020, and in any case for as long as necessary to ensure the continued sustained convergence of inflation to our aim over the medium term."

12 September 2019
"We now expect the key ECB interest rates to remain at their present or lower levels until we have seen the inflation outlook robustly converge to a level sufficiently close to, but below, 2% within our projection horizon, and such convergence has been consistently reflected in underlying inflation dynamics."

C. BoE statements about asset purchases

5 March 2009

The Committee decided to reduce Bank Rate by 0.5 percentage points, to 0.5%. The Committee judged that this reduction in Bank Rate would by itself still leave a substantial risk of undershooting the 2% CPI inflation target in the medium term. Accordingly, the Committee also resolved to undertake further monetary actions, with the aim of boosting the supply of money and credit and thus raising the rate of growth of nominal spending to a level consistent with meeting the inflation target in the medium term.

To that end, and noting the recent exchange of letters between the Governor and the Chancellor of the Exchequer concerning the use of the Asset Purchase Facility for monetary policy purposes, the Committee agreed that the Bank should, in the first instance, finance £75 billion of asset purchases by the issuance of central bank reserves. The Committee recognised that it might take up to three months to carry out this programme of purchases. Part of that sum would finance the Bank of England's programme of private sector asset purchases through the Asset Purchase Facility, intended to improve the functioning of corporate credit markets. But in order to meet the Committee's objective of total purchases of £75 billion, the Bank would also buy medium- and long-maturity conventional gilts in the secondary market. It is likely that the majority of the overall purchases by value over the next three months will be of gilts.

+ **7 May 2009**, **6 August 2009**, **5 November 2009**, **6 October 2011**, **9 February 2012**, **5 July 2012**, **4 August 2016**, **19 March 2020**, **18 June 2020**, and **5 November 2020** for new purchases of government bonds.

+ **3 February 2022** and **22 September 2022** for a reduction the stock of purchased government bonds.

28 September 2022

In line with its financial stability objective, the Bank of England stands ready to restore market functioning and reduce any risks from contagion to credit conditions for UK households and businesses.

On 28 September, the Bank of England's Financial Policy Committee noted the risks to UK financial stability from dysfunction in the gilt market. It recommended that action be taken, and welcomed the Bank's plans for temporary and targeted purchases in the gilt market on financial stability grounds at an urgent pace.

These purchases will be strictly time limited. They are intended to tackle a specific problem in the long-dated government bond market. Auctions will take place from today until 14 October. The purchases will be unwound in a smooth and orderly fashion once risks to market functioning are judged to have subsided.

17 October 2022

In line with its financial stability objective, the Bank of England has carried out temporary and targeted purchases of long-dated UK government bonds since 28 September.

At the outset of the intervention, the Bank said that it would carry out temporary purchases on whatever scale was necessary to restore orderly market conditions. The purpose of the operations was to provide time for LDI funds to address risks to their resilience from volatility in the gilt market, not to provide a permanent backstop.

As previously announced, the Bank terminated these operations and ceased all bond purchases on Friday 14 October.

D. Additional information and evidence

Table A – Data description and sources

Event-study analysis		
PSPP	Dummy variable that equals +1 when the ECB announces an increase in PSPP purchase flows and -1 for a decrease in purchase flows, and 0 otherwise.	ECB
PEPP	Dummy variable that equals +1 when the ECB announces an increase in PEPP purchase flows and 0 otherwise.	ECB
LTRO	Dummy variable that equals 1 when LTRO or TLTRO programs or extensions are announced, and 0 otherwise.	ECB
PELTRO	Dummy variable that equals 1 when PELTRO programs or extensions are announced, and 0 otherwise.	ECB
OTHER_PURCH	Dummy variable that equals 1 when other asset purchases are announced (CBPP1, SMP, CBPP2, OMT, ABSPP, CBPP3 and CSPP), and 0 otherwise.	ECB
OIS2Y	2-year OIS rates	Datastream Thomson Reuters
PSPP_Ext	Dummy variable that equals 1 when the length of PSPP purchases are announced, and 0 otherwise.	ECB
Swap5y5y	5-year in 5-year-forward euro area inflation swaps	Datastream Thomson Reuters
Swap10y	10-year forward euro area inflation swaps	Datastream Thomson Reuters
NomIR_*	10-year sovereign interest rate for country *	Datastream Thomson Reuters
PCA_LTrates	First principal component of 11 euro area 10-year sovereign interest rates	Datastream Thomson Reuters
Spd_*	Difference between the 10-year sovereign interest rate for country * and the 10-year sovereign interest rate for Germany (* Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria or Finland)	Datastream Thomson Reuters
PCA_Spd	First principal component of the 10 Spd_*	Authors' computation
Mean_Spd	Mean of the 10 Spd_*	Authors' computation
Intraday OIS2y	Intraday changes in 2-year OIS rates	Altavilla et al. (2019)
VSTOXX	Eurostoxx50 implied volatility index	Datastream Thomson Reuters
VIX	CBOE's SP500 implied volatility index	Datastream Thomson Reuters
Eurostoxx600	Stock price index of Eurozone stocks	Datastream Thomson Reuters
USDEUR	USD / EUR exchange rate	Datastream Thomson Reuters
InfSwap2y	2-year forward euro area inflation swaps	Datastream Thomson Reuters
Swap10yDE	10-year forward Garmany inflation swaps	Datastream Thomson Reuters
Swap10yIT	10-year forward Italy inflation swaps	Datastream Thomson Reuters
Scotti_macro	Real-time surprise index summarizing economic data surprises.	Scotti (2016)
Flow analysis		
PSPP	Weekly net PSPP purchase flows	ECB
PEPP	Weekly net PEPP purchase flows	ECB
Swap5y5y	End-of-week 5-year in 5-year-forward inflation swaps	Datastream Thomson Reuters
Spd_*	End-of-week 10-year sovereign spread for country * computed as above	Datastream Thomson Reuters
HICP	Growth rate of the Harmonised Index of Consumer Prices (month-over-month growth rate). Last available	Datastream Thomson Reuters
Dsvenf02	Treasury nominal interest rates at the 2-year maturity	Federal Reserve Board

Note: If not specified in the bottom panel, the daily series presented in the upper panel that are used for the flow analysis are the week-average of the daily observations.

Table B – Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Swap5y5y	129	2.07	0.48	0.79	2.93
Swap10y	129	1.75	0.45	0.47	2.46
PCA_Spd	129	0.31	2.79	-2.98	9.57
mean_Spd	129	1.88	1.48	0.43	7.44
OIS2Y	129	0.22	0.69	-0.62	1.95
PCA_LTrates	129	0.54	3.12	-4.34	5.83
Eurostoxx600	129	312.69	65.69	173.05	471.79
USDEUR	129	125.18	11.79	105.81	150.88
VSTOXX	129	24.21	8.44	13.30	61.80
Spd_IT	129	1.92	0.99	0.64	4.98
Spd_ES	129	1.72	1.19	0.49	5.71
Spd_PT	129	3.23	2.87	0.49	11.89
Spd_GR	129	8.03	7.78	1.16	46.80
Spd_IE	129	1.93	2.12	-0.11	9.45
Spd_FR	129	0.45	0.25	0.12	1.39
Spd_NL	129	0.23	0.15	-0.03	0.71
Spd_BE	129	0.67	0.50	0.18	2.63
Spd_AU	129	0.37	0.25	0.04	1.24
Spd_FI	129	0.25	0.13	0.00	0.77
Intraday OIS2y	129	-0.10	3.96	-17.17	15.18
VIX	129	19.26	10.06	9.22	74.24
Scotti_macro	124	0.00	0.03	-0.13	0.19
InfSwap2y	129	1.2	0.5	-0.2	2.4
Swap10yDE	123	1.9	0.4	0.8	2.6
Swap10yIT	129	1.5	0.4	0.2	2.3
NomIR DE	129	1.2	1.3	-0.7	3.6
NomIR IT	129	3.16	1.59	0.53	6.63

Table C – Principal Component Analysis

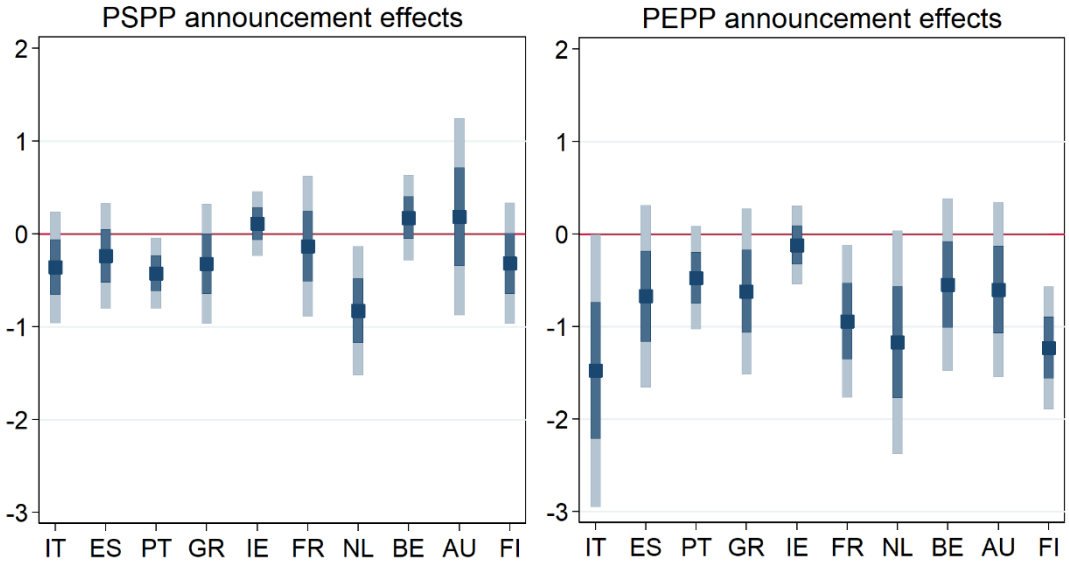
10-year nominal sovereign interest rates			
N	3 392	Variables	11
	Eigenvalue	Proportion	Cumulative
Comp1	9.47	0.86	0.86
Comp2	1.21	0.11	0.97
Comp3	0.13	0.01	0.98
Sovereign spreads			
N	3 392	Variables	10
	Eigenvalue	Proportion	Cumulative
Comp1	7.26	0.73	0.73
Comp2	1.31	0.13	0.86
Comp3	0.50	0.05	0.91
Correlation			
	Mean_Spd	Spd_FR	Spd_IT
PCA_Spd	0.95	0.90	0.88

Table D – Exploring further the announcement effects

Inflation swaps								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Baseline	All days	Post 2015	Swap10y	Intraday	PSPP_Ext	DE	IT
	Swap5y5y	Swap5y5y	Swap5y5y	Swap10y	Swap5y5y	Swap5y5y	Swap10y	Swap10y
PSPP	1.400**	1.239**	1.478**	1.398**	1.394**	2.045***	0.946**	1.212**
	[2.31]	[2.06]	[2.61]	[2.31]	[2.26]	[3.10]	[2.56]	[2.51]
PEPP	0.389	0.319	0.503	0.134	0.393	0.553	0.058	0.185
	[0.72]	[0.56]	[0.70]	[0.24]	[0.73]	[0.97]	[0.15]	[0.35]
X_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Z_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	129	2713	57	129	129	129	123	129
R2	0.21	0.09	0.31	0.29	0.21	0.23	0.30	0.29
Sovereign spreads								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Baseline	All days	Post 2015	Mean	Intraday	PSPP_Ext	DE	IT
	PCA_Spd	PCA_Spd	PCA_Spd	Mean_Spd	PCA_Spd	PCA_Spd	Nom IR	Nom IR
PSPP	-0.317	-0.330	-0.188	-0.369	-0.420	-0.724	0.222	-0.258
	[-1.02]	[-1.08]	[-0.55]	[-1.50]	[-1.29]	[-1.57]	[1.19]	[-1.03]
PEPP	-1.222**	-1.360*	-1.231***	-0.971*	-1.281**	-1.326**	0.826*	-1.095**
	[-2.10]	[-1.91]	[-2.91]	[-1.77]	[-1.99]	[-2.13]	[1.91]	[-2.01]
X_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Z_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	129	2713	57	129	129	129	129	129
R2	0.59	0.29	0.73	0.52	0.57	0.59	0.73	0.81

Note: t-statistics in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Parameters are estimated from Equation (2) with OLS using Huber-White heteroskedasticity-robust standard errors. The dependent variable is the daily change in 5-year in 5-year forward inflation swaps in the upper panel and the first principal component of 10-year sovereign spreads with Germany for 10 euro area countries (Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland) in the bottom panel. The constant being null has been removed from the table. The parameters for the control variables have also been removed for parsimony and are available from the authors upon request. Column (1) shows the baseline estimates. In Column (2), Equation (2) is estimated on all days, not announcement days only. In Column (3), the sample period starts in January 2015. In Column (4), the dependent variable is replaced with 10-year inflation swaps (upper panel) and the mean of the 10 sovereign spreads (bottom panel). In Column (5), we replace the daily change in 2-year OIS rates as a proxy for monetary surprises by the intraday change in 2-year OIS rates from Altavilla et al. (2021). In Column (6), we control for announcements of the extension of the period during which asset purchases will be conducted. In the upper panel, Columns (7) and (8) show estimates for German and Italian 10-year inflation swaps, while in the bottom panel, Columns (7) and (8) show estimates for the German and Italian 10-year nominal interest rates.

Figure A – Announcement effects on individual sovereign spreads



Note: The left panel shows the estimated effect -using equation (2)- of PSPP announcements on each country's sovereign spread with Germany, while the right panel shows the estimated effect -using equation (2)- of PEPP announcements on each country's sovereign spread with Germany. Bars represent 1 and 2 standard errors confidence intervals.

E. The implementation effect of asset purchases

We explore whether the former results only capture the role of communication – announcement effects – or persist beyond the announcement day. To that end, we assess the effect of *actual* asset purchases on inflation swaps and sovereign spreads. To do so, we use information released by the ECB on the weekly outstanding amounts of public securities held within the PSPP and PEPP. Figure 1 shows PSPP and PEPP net purchase flows.

Because the ECB may adjust weekly purchases to the dynamics of inflation swaps and sovereign spreads, there is a potential endogeneity issue such that we cannot directly test the effect of weekly purchases on these two variables. To circumvent this reverse causality, we follow a two-step approach. We first estimate the relationship between weekly purchases and *lagged* inflation swaps and sovereign stress, up to the last day of the previous week.[35] We then use the residuals from this first-stage equation in a second-stage equation to assess the impact of exogenous variations in purchases on contemporaneous and future inflation swaps and sovereign spreads. Because ECB purchases could still relate to *contemporaneous* dynamics in inflation swaps and sovereign spreads, we use some timing features of the data to circumvent this issue. ECB purchases are the sum of all purchases during a given week, whereas asset prices are end-of-week values (in contrast to week-average values).[36] Therefore, within a given period (i.e. week), we minimize by construction the possibility that weekly asset purchases respond to contemporaneous inflation swaps and sovereign spreads.

[35] See Blot et al. (2020) for a similar procedure.
[36] This timing feature is similar in spirit to timing restrictions that govern the VAR Cholesky-decomposition.

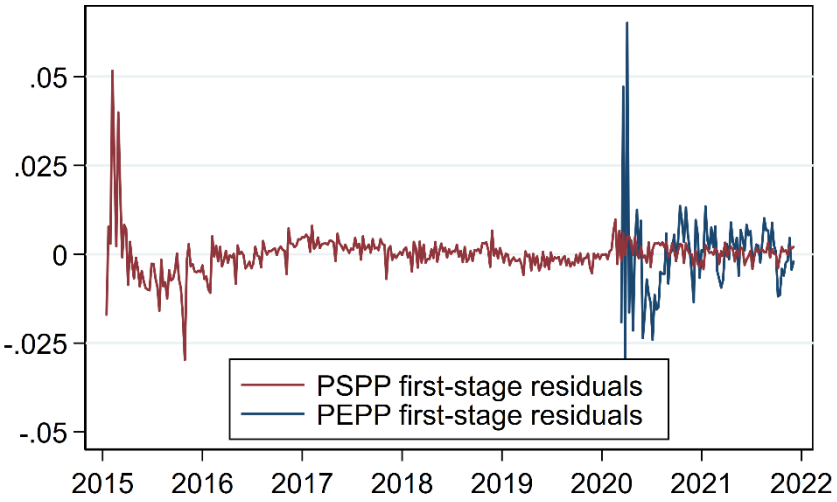
The first-stage equation consists in purging the endogenous response of PEPP and PSPP purchases for their main potential determinants. We estimate the following two equations:

$$pspp_t = \alpha + \sum_i \rho_i pspp_{t-i} + \sum_i \delta_{1i} pca1_{t-i} + \sum_i \delta_{2i} pca2_{t-i} + \sum_j \phi_i \pi^e_{t-i} + \theta Z_{1,t} + \epsilon^{pspp}_t \quad \text{(A1)}$$

$$pepp_t = \alpha' + \sum_i \rho'_i pepp_{t-i} + \sum_i \delta'_{1i} pca1_{t-i} + \sum_i \delta'_{2i} pca2_{t-i} + \sum_j \phi'_i \pi^e_{t-i} + \theta' Z_{1,t} + \epsilon^{pepp}_t \quad \text{(A2)}$$

where $pspp_t$ and $pepp_t$ are weekly outstanding amounts for both programs, regressed on their own lagged values. We compute the first (*pca*1) and second (*pca*2) principal components of 10 euro area sovereign spreads.[37] We also include lagged 5-year in 5-year-forward inflation swaps (π^e_t). We consider purchases during a week t against inflation expectations and sovereign spreads in the previous two weeks (so i = 2). Inflation swaps and sovereign spreads are considered at their end-of-week values. The vector $Z_{1,t}$ include financial market volatility (VSTOXX) to control for changing market conditions, Scotti (2016)'s macroeconomic news surprise index and the (month-over-month) inflation rate to control for the endogenous policy response of a standard central bank reaction function.[38] Equation (A1) for PSPP purchases is estimated from March 2015 (week 14) to December 2021 (week 52), while Equation (A2) for PEPP purchases is estimated from April 2020 (week 15) to December 2021 (week 52). Residuals of both equations, shown in Figure B, represent our exogenous variations in PSPP and PEPP weekly purchases.

Figure B – First-stage residuals



Note: The figure plots the residuals of equation (A1) in red for PSPP purchases and the residuals of equation (A2) in blue for PEPP purchases.

In the second-stage equation, we estimate the effects of the first-stage residuals on inflation swaps and sovereign spreads. Equation (A3) for PSPP purchases is estimated from March 2015 to March 2021, while Equation (A4) for PEPP is estimated from April 2020 to December 2021:

$$Y_{t+h} = \alpha + \rho Y_{t-1} + \beta_{pspp} \epsilon^{pspp}_t + \theta Z_{2,t} + \mu_t \quad \text{(A3)}$$

$$Y_{t+h} = \alpha' + \rho' Y_{t-1} + \gamma_{pepp} \epsilon^{pepp}_t + \theta' Z_{2,t} + \mu'_t \quad \text{(A4)}$$

[37] The first two principal components have eigenvalues above one. They explain 75% of the variance (51% and 24%).
[38] Alternative specifications (including the ECB's sovereign CISS, excluding the set of macroeconomic controls or considering these controls with a lag) provide similar results in the 2nd-stage equation.

where Y_{t+h} is either 5-year in 5-year-forward inflation swaps or the first principal component of euro area sovereign spreads with Germany. To capture the dynamic effects of PEPP and PSPP, both equations are estimated for $h = \{0,...,2\}$. The vector $Z_{2,t}$ includes raw net purchase flows of the considered program, a dummy for ECB policy announcements – to control for the effects evidenced in the event-study –, the change in financial market volatility (VSTOXX), and monetary surprises as measured by Altavilla et al. (2019). In the PEPP equation (A4), because PSPP and PEPP purchases happen side-by-side, we also include PSPP residuals as an additional control in the vector $Z_{2,t}$. We estimate both equations with OLS and compute heteroskedasticity and autocorrelation robust Newey-West standard errors. Both dependent variables and PSPP and PEPP residuals have been normalized to a unit standard deviation so the effects can be compared.

We find evidence that the differentiated effects are persistent. Table E provides evidence of the same pattern as in the event-study. PSPP purchases have a positive effect on inflation swaps, whereas they have no significant effect on sovereign spreads. The PSPP effect on inflation swaps increases with time: a 1-standard-deviation (SD) increase in PSPP purchases generates an increase of 0.023 SD in inflation swaps during the contemporaneous week up to 0.045 SD after 2 weeks. At the opposite, we find that PEPP purchases do not affect inflation swaps (the point estimate of the contemporaneous effect is 0.007) but have a negative and significant effect on sovereign spreads. A 1-SD increase in PEPP purchases reduces the first principal component of euro area spreads by 0.041 SD in the contemporaneous week and by 0.069 SD two weeks after.

Table E – Implementation effects

	Swap5y5y			PCA_Spd		
	t	**t+1**	**t+2**	**t**	**t+1**	**t+2**
PSPP flows over 2015 - 2021						
	(1)	(2)	(3)	(4)	(5)	(6)
ϵ_{PSPP}	0.023***	0.032***	0.045***	-0.007	-0.030*	-0.017
	[3.49]	[3.60]	[3.21]	[-0.61]	[-1.92]	[-0.77]
$Z_{2,t}$	Yes	Yes	Yes	Yes	Yes	Yes
N	352	351	350	352	351	350
R2	0.97	0.95	0.92	0.93	0.87	0.81
PEPP flows over 2020 - 2021						
	(1)	(2)	(3)	(4)	(5)	(6)
ϵ_{PEPP}	0.007	0.008	0.033	-0.041***	-0.036*	-0.069***
	[0.42]	[0.25]	[1.04]	[-2.80]	[-1.70]	[-2.95]
$Z_{2,t}$	Yes	Yes	Yes	Yes	Yes	Yes
N	89	88	87	89	88	87
R2	0.98	0.96	0.95	0.96	0.94	0.91

Note: t-statistics in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. Parameters are estimated from Equation (A3) for the effect of PSPP flows (upper panel) and Equation (A4) for the effect of PEPP flows (bottom panel) with OLS using Newey-West autocorrelation-heteroskedasticity-robust standard errors. The dependent variable is 5-year 5-year forward inflation swaps in Columns (1) to (3) and the first principal component of 10-year sovereign spreads with Germany for 10 euro area countries (Italy, Spain, Portugal, Greece, Ireland, France, Netherlands, Belgium, Austria and Finland) in Columns (4) to (6). PSPP residuals are estimated from Equation (A1) while PEPP residuals are estimated from Equation (A2). The constant and parameters for the control variables have also been removed for parsimony and are available from the authors upon request. The effect of PSPP (or PEPP) is estimated contemporaneously and over the following 2 weeks. The sample for the upper panel starts in March 2015 (week 14) and the one for the bottom panel starts in April 2020 (week 15). They both end in December 2021 (week 52).

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The Paris-based Observatoire français des conjonctures économiques (OFCE), or French Economic Observatory is an independent and publicly-funded centre whose activities focus on economic research, forecasting and the evaluation of public policy.

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