Master Degree in Economics and Finance

"Save The Euro Policy: European Debt Crisis and Covid-19 Pandemic"

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ABSTRACT IN ENGLISH (100 words):

2008-2009 Global Financial Crisis led to European debt crisis leaving the periphery of euro zone with very high borrowing costs compared to core countries. When Covid-19 Pandemic Crisis hit the economies, unconventional monetary policy tools of European Central Bank prevented a similar debt crisis. We identify the underlying factor of the ECB monetary policy that is active during the 2011-2012 debt crisis and Covid-19 Pandemic periods which operated through sovereign spreads preventing the contagion of fragmentation risk of euro area. We call this new factor, save-the-euro, and using it we shed light on the monetary policies of this unusual periods and formally measure their effects on asset prices.

ABSTRACT IN CATALAN (100 words)

La crisi financera mundial 2008-2009 va conduir a la crisi del deute europeu, deixant la perifèria de la zona euro amb uns costos de préstec molt elevats en comparació amb els països centrals. Quan la crisi pandèmica Covid-19 va colpejar les economies, les eines de política monetària no convencionals del Banc Central Europeu van evitar una crisi de deute similar. Identifiquem el factor subjacent de la política monetària del BCE que està actiu durant la crisi del deute 2011-2012 i els períodes de pandèmia Covid-19 que van operar a través de diferencials sobirans evitant el contagi del risc de fragmentació de la zona de l'euro. A aquest nou factor l'anomenem *save-the-euro* i, utilitzant-lo, aportem llum sobre les polítiques monetàries d'aquests períodes inusuals i mesurem formalment els seus efectes sobre els preus dels actius.

KEYWORDS IN ENGLISH (3):

European debt crisis, Unconventional monetary policies, High frequency identification

KEYWORDS IN CATALAN (3):

Crisi del deute europeu, Polítiques monetàries no convencionals, Identificació d'alta freqüència

MASTER PROJECT

Save The Euro Policy: European Debt Crisis and Covid-19 Pandemic

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Economics and Finance

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Abstract

2008-2009 Global Financial Crisis led to European debt crisis leaving the periphery of euro zone with very high borrowing costs compared to core countries. When Covid-19 Pandemic Crisis hit the economies, unconventional monetary policy tools of European Central Bank prevented a similar debt crisis. We identify the underlying factor of the ECB monetary policy that is active during the 2011-2012 debt crisis and Covid-19 Pandemic periods which operated through sovereign spreads preventing the contagion of fragmentation risk of euro area. We call this new factor, save-the-euro, and using it we shed light on the monetary policies of this unusual periods and formally measure their effects on asset prices. We find that during the sovereign-debt crisis save-the-euro accounts for about 50 percentage points of the variation in sovereign yields and more than 35 percentage points in the stock market, and during the COVID-19 pandemic for 25 and 15 percentage points, respectively.

JEL Classification: E43; E44; E52; E58; G14.

Keywords: European Debt Crisis; Covid-19 Pandemic; unconventional monetary policies; Event-study; sovereign spreads; redenomination risk

1 Introduction

In an expanding literature, the relation between the monetary policy announcements and asset prices is a widely studied question for a long time. Due to its multi-dimensional nature, some aspects of the monetary policy decisions dynamically depend on the conjecture of the economy and in some cases may remarkably divert from the usual track of the policy in various dimensions. In the last decade, there is an increasing consensus that unconventional monetary policies provided a way on the recovery of the 2008-2009 Global Financial Crisis. Given these, measuring the effects of the unconventional policies attracts attention by making use of event-study techniques.

We build on the event-study literature that goes back to the seminal paper of the Cook and Hahn (1989). To quantify the effects of economic policies, reflection on economic variables should be measured by taking into account the causality. In general for economic policies, and in particular for monetary policies as set by central banks, it is not a trivial task to establish causality. Event-study analysis tackles this problem by using the high frequency data around the policy announcement. A reasonable assumption is that during the short bracketed window around the decision, policy does not respond to the economic variables nor does the asset changes (Gürkaynak and Wright (2013)). Not only does the causality of the economic policy announcements (or in general economic news) matter in the measurement of the effects of the news, also shock component of the announcement must be correctly extracted. Forward-looking agents reflect their expectations to their current economic decisions. Therefore, most of the time large portion of the economic announcements are reflected to the asset prices well before the announcement, implying asset changes around the policy announcement has something to do with the surprise part of the news. This problem was formally addressed in the seminal work of Kuttner (2001) for the FOMC announcements of FED[1]. Focusing on the monetary policy announcements of FED, Gürkaynak et al. (2004) formally showed that the asset price responses around the policy dates are multi-dimensional and can be represented by the estimated factors that are orthogonal to each other. Swanson (2017) extends this method to the quantitative

[1]In this vein, Rigobon and Sack (2004), and Campbell et al. (2013) drew the attention of the literature to a puzzling aspect that even in a very short bracketed window over the announcement, estimated shocks explain only a small percentage of the asset price movements stating that noisy measurements of the surprise component of the announcements creating a bias in the estimation part which in turn results in a lower explanatory power. They address this problem introducing the heteroskedasticity-based estimation method. Later, Gürkaynak et al. (2018) revises their approach discussing the measurement methodology of the surprise components and proposes a more plausible structure which takes into account the non-headline parts of the announcements.

easing period of FED after the Global Financial Crisis. In a parallel strand of the literature, some authors opt to measuring the surprises themselves using changes in asset prices, for a recent application and detailed review we refer Gürkaynak et al. (2020).

Particularly for the European Central Bank policy announcements, a recent work which measures the surprises using changes in asset prices in a multi-dimensional setting of Swanson (2017) comes from Altavilla et al. (2019). They consider the ECB policy in two announcement windows separately[2], and find one statistically significant factor in the Press Release Window whereas this increases to two to three significant factors in the Press Conference Window for "pre-QE" period (January 2002 to December 2013) and for "full" sample period (January 2002 to September 2018), respectively. These policy surprises are called Target, Timing, Forward Guidance (FG), and Quantitative Easing (QE) where, together we call them main-stream factors[3].

Unconventional monetary policies can diverge out in various ways depending on the the needs of the conjecture as well as the priorities that put weight on the traction of the long run policy of the central bank. In particular, one such conjecture took the scene for ECB when the euro break-up risk appeared as formally showed by De Santis (2019), and led to European debt crisis (henceforth debt-crisis) during 2011-2012. The debt-crisis is a particular aspect of the euro area as referred by Wright (2019) which stems from being a monetary union of different sovereign countries where fiscal policies may differ over those countries. De Grauwe (2011) sheds light on the structural relation between the euro break-up risk and what it means for the euro area being a monetary union with fiscal independence. During this period, the spreads between the yields of safe German debt and riskier Italian, and Spain debt jumped up which is followed by a fragmentation risk of the euro zone countries. This is by all means an obvious thread to the transmission of monetary policy of ECB across euro area. A considerable portion of the (unconventional) monetary policy during the debt-crisis period inevitably put weight on the reducing the spreads in line with the ultimate goal of saving the euro area.

After nine years from the debt-crisis, a totally exogenous Covid-19 Pandemic shock hit the economies dragging the euro area again in another period which signals serious market

[2]ECB policy announcements take place with two non-overlapping announcement windows. Namely, the Press Release Window, in which only policy rate is announced without any reasoning, and this is followed by Press Conference Window where unconventional monetary policy together with other aspects of the policy is shared. Starting from March, 2016 non-standard monetary policy announcements started to take place in the Press Release Window.

[3]We believe that findings of Altavilla et al. (2019) together with the regularly updated database, called EA-MPD, and accompanied toolbox will be the workhorse of event-study literature for researchers. Here, in this study, we present one example of this.

fragmentation risk similar to the debt-crisis period. Indeed, Covid-19 Pandemic is structurally unique but we find that it effectively shares similar grounds in terms of the effects that it created on the economy of the euro area with the debt-crisis period. In this project, we study and quantify ECB policy during this unusual periods in a complete manner without precluding other dimensions of the policy prevailing during the debt-crisis and Covid-19 Pandemic crisis.

Our contribution to the event-study literature has several dimensions. First, building on the main stream literature, we present a generalized version of the identification technique of the Altavilla et al. (2019) through latent factors which can quickly be modified for different periods for the euro area. This is itself a remarkable contribution in the sense that especially after widespread utilization of the unconventional monetary policies by the major central banks, policies started to address several different aspects of the economy at the same time that must be sustained for overlapping periods. But this requires a complete and integrated identification which needs to take into account various assets and time intervals all at once[4]. With our generalized estimation methodology we identify a novel factor which is called the "save-the-euro" factor. The novel factor that we identified in this project -which mainly works through to decrease the spreads between safe German Bunds and risky Italian and Spain Bonds- wakes up during the debt-crisis and pandemic. We verify the validity of estimated factors following a thorough fact-check exercise by matching various critical policy dates with market commentaries.

Second, we show that newly introduced factor complements main-stream factors, and together they explain almost all asset movements around policy decisions. This new factor slightly negatively loads on OIS. An expansionary save-the-euro announcement led to a decline in sovereign yields of periphery country and an increase in Bund yields due to the reversal of flight to safety flows. Via arbitrage, this passes through from Bunds to OIS rates. Moreover, an expansionary save-the-euro factor positively effects German sovereign yields and negatively effects Italian, France and Spanish sovereign yields which clearly results in narrowed sovereign spreads. This is the primary aim of the ECB policy during debt-crisis and Covid-19 Pandemic. Furthermore, save-the-euro policy exerts a positive effect on stock prices and exchange rate. Compared to the case where only main-stream factors are taken into account, save-the-euro

[4]We believe such unusual periods are not exhaustible and will be even more frequent in following pace of the economy.26 July 2012 "Whatever it takes" speech of then president Draghi and "Extraordinary times require extraordinary action" tweet of the Lagarde on 19 March 2020, in the wake of Covid-19 Pandemic in euro area just after the ECB announcement of the €750 billion Pandemic Emergency Purchase Programme (PEPP) are examples of unusual sub-periods during the course of the implementation of the monetary policy by ECB.

factor strikingly increases explanatory power of ECB policy on EUR/USD rate as well as stock prices during the turbulent periods.

Remaining part of this study is organized as follows. In Section 2, we explain factor estimation and extended identification strategy. Section 3 presents the estimated factors for the ECB monetary policy. Then in Section 4, we share asset price responses to the monetary policy surprises using an econometric model. Section 5 concludes.

2 Factor Identification: Preliminaries and Methodology

For factor identification we extend Altavilla et al. (2019)'s approach. Namely, we use asset price changes around a short window of ECB Governing Council Meeting announcements for Press Release Window and Press Conference Window. Then, we estimate latent factors from changes in yields with principal components analysis and rotate these factors such that they admit economic interpretations. For further technical details see Appendix A.

Current literature justifiably considers risk-free OIS rates to measure the effects of ECB monetary policy as they reflect the main-stream conventional and unconventional monetary policy announcements to a greater extend. Yet, in some sub-periods like debt-crisis and Covid-19 Pandemic, as considered in this study, the factors derived from OIS rates may fall short to characterize the effects of ECB policy announcements on stock prices and exchange rates. Particularly for the debt-crisis period, policy decisions target different assets implying that a new dimension of policy prevails during this period which is orthogonal to the existing policy. But this in turn can be reflected by a new factor additional to the main-stream factors, and following Wright (2019), we call it "save-the-euro" factor. The euro area monetary policy event-study database, EA-MPD, can be used to estimate and identify the save-the-euro factor, at the same time, preserving the structure of main-stream factors as put by Altavilla et al. (2019). Throughout this study, EA-MPD is used for factor extraction, identification, and econometric analysis[5]

We quantify the ECB policy through estimated factors from a panel of OIS and sovereign yields. Since ECB policies against increasing spreads are in the scope of unconventional monetary policy announcements, we estimate the save-the-euro factor over the Press Conference Window. Particularly, we extract factors from changes in yields spanning 1, 3, and 6-month

[5]EA-MPD contains high frequency tick data history of changes of riskfree OIS rates as well as sovereign yields, stock prices, and exchange rates during the governing council meetings. It is updated regularly.

and 1, 2, 5, and 10-year OIS yield together with 2, 5, and 10-year sovereign yields of Italy, France and Spain. Overall, this adds up to sixteen different assets to estimate the factors [6]. Next step is to determine the number of factors to be identified. Following Altavilla et al. (2019), we consider one factor for Press Release Window, and call it Target. Four factors are estimated in the Press Conference Window We attribute three of them as the main-stream factors, Timing, FG and QE, and consider the same identification scheme of Altavilla et al. (2019) who in turn build on Swanson (2017) and Gürkaynak et al. (2004). After that, extending this identification procedure, we compute the remaining factor, in other words, we identify the save-the-euro factor which mainly captures the ECB monetary policy during the debt-crisis and Covid-19 Pandemic periods. Details of factor identification methodology is given in Appendix A.

3 Estimated Factors

Fig. 1 presents the loadings of the rotated factors over the OIS yields of seven maturities, normalized as explanied in Appendix A. First and second panel present the main-stream factors, whereas last panel shows the save-the-euro factor. Target factor is mostly effective on the very short end of the yield curve whereas Timing and FG from short to middle and lastly QE operates on the long end consistent with policies that target longer yields to stimulate the economy during a zero lower bound period. For a more informative and complete definition of main-stream factors we refer to Gürkaynak (2005), Gürkaynak et al. (2004) and Altavilla et al. (2019)[7].

Loading of the save-the-euro factor over the OIS yields is negative and much smaller compared to main-stream factors. It is negatively correlated with the main-stream factors because an expansionary save-the-euro announcement led to a decline in sovereign yields of periphery country and an increase in Bund yields since there was a reversal of flight to safety flows. Via arbitrage, this passes through from Bunds to OIS rates. The new factor is not significantly effective on OIS yields. Essentially, this finding reassures that ECB policies which target the spreads had no significant effect on term structure of OIS rates. That is why estimating the factors from a panel of only OIS yields may be insufficient to satisfactorily characterize the policies that target market fragmentation. This is also inline with the findings of Rogers et al. (2014). Indeed, ECB monetary policy during the debt-crisis and Covid-19 Pandemic effects OIS

[6] Recall Altavilla et al. (2019) considers only 1, 3, and 6-month and 1, 2, 5, and 10-year OIS yield.
[7] See also Fig. 3 in their main text.

rates not directly but through arbitrage from German sovereign yields as stated before. Recall that, we identify the save-the-euro factor by making use of the negative correlation between OIS and Italian sovereign yields. That is to say, we do not restrict the new factor such that it does not load on OIS yields. Thus, result on the third panel of Fig. 1 is not an assumption but a finding.

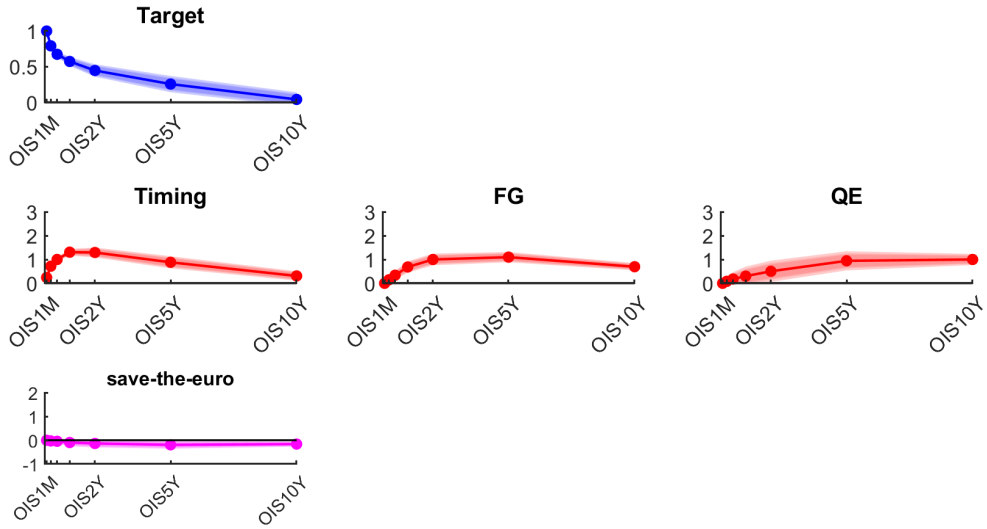

Figure 1: Factor loadings on OIS yields

Note: The figure shows the factor loadings in basis points. For each maturity the loadings are obtained by regressing the surprises onto the factors and also controlling for the standardized surprise associated with the release of the US initial jobless claims. Target, Timing, FG, and QE has unit effect on 1-month 6-month, 2-year, 10-year OIS, respectively. Save-the-euro factor is scaled such that it has unit effect on 5-year Italian sovereign yield. The shaded areas indicate the 90%, 95% and 99% confidence intervals.

Loadings over the Italian sovereign yields are shown in Fig. 2. Compared to Fig. 1, main-stream factors effect Italian sovereign rates and OIS rates in a similar way. In contrast, save-the-euro factor, which is very silent on OIS rates, is quite effective on Italian sovereign yields. Its shape is also different than the main-stream factors in the sense that it is almost equally effective on 2, 5 and 10-year Italian sovereign yields. Therefore, save-the-euro factor differs from main-stream factors both in terms of the mechanism that it works through on the term structure of interest rates and magnitudes of effects that it created on sovereign and OIS rates[8].

[8]We also compute loadings over the Spanish yields. Results are very similar and available from authors upon request.

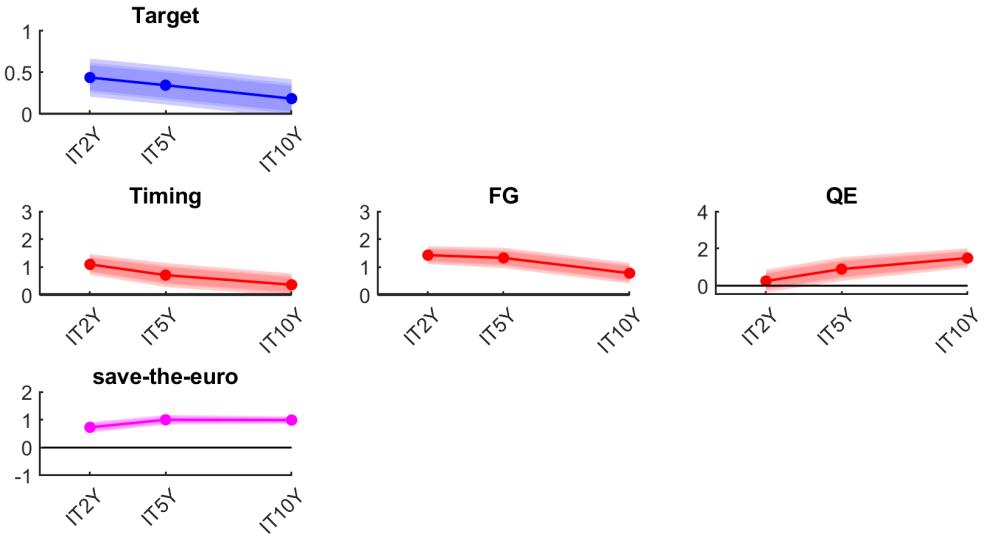

Figure 2: Factor loadings on Italian sovereign yields

Note: The figure shows the factor loadings in basis points. For each maturity the loadings are obtained by regressing the surprises onto the factors and also controlling for the standardized surprise associated with the release of the US initial jobless claims. Save-the-euro factor is scaled such that it has unit effect on 5-year Italian sovereign yield. The shaded areas indicate the 90%, 95% and 99% confidence intervals.

3.1 Correspondence of Save-the-Euro Factors to Critical ECB Announcements

Matching the important monetary policy announcements with estimated factors is a commonly accepted approach to check how well the estimated factors capture the major policy dates (Gürkaynak et al. (2004); Swanson (2017)). We collect noteworthy ECB policy announcements during the debt-crisis, and Covid-19 Pandemic as well as an important QE announcement which intersect with EA-MPD dates in Table 1[9]. Fig. 3 matches corresponding ECB policy dates, given in the table, with the estimated QE and save-the-euro factors. Negative values correspond to monetary policy easing and positive values stand for policy tightening [10]. Note that, a positive reading on save-the-euro factor means a surprise for the market implying an

[9]Recall that EA-MPD only contains ECB Governing Council Policy Meeting Dates.

[10]Recall that, we rescale the estimated factors in a way that a negative value in main-stream factors (save-the-euro factor) are reflected as a decrease in OIS rates (Italian sovereign yields). Thus a negative reading on main-stream factors (save-the-euro factor) correspond to an expansionary monetary policy in terms of OIS (Italian sovereign) yields. Note that ECB monetary policy effects all sovereign yields in the same direction as it does for OIS rates. During the debt-crisis period, however, effects of ECB policy on OIS rates and on some sovereign yields can be negatively correlated. Therefore, definition of expansionary and contractionary monetary policy should be taken carefully.

increase in the Italian sovereign yields, which in turn results in increased spreads. It is regarded as a contractionary save-the-euro policy.

Table 1: Dates and descriptions of critical ECB announcements during the debt-crisis and Covid-19 Pandemic

Date	Acronym	Description
	European Debt Crisis	
4 August 2011	SMP-IT/ES	Italy and Spain are included to Securities Market Programme (SMP)
6 October 2011	CBPP2	Second Covered Bond Purchase Programme (CBPP) is launched to buy covered bonds across the Euro Area in both primary and secondary markets
8 December 2011	3YLTRO	ECB president Mario Draghi offered no indication that he is willing to intervene aggressively in the bond market
5 July 2012	LTROcom	No pre-commitment on continuation of unconventional monetary policies, in particular for LTRO
2 August 2012	OMT	Outright Monetary Transaction (OMT) Programme is announced to purchase Euro Area sovereign debt but tied to the goverment budget cuts
6 September 2012	OMTdet	OMT is detailed, collateral rules are eased and reiteration of the pledge to do "whatever it takes" to preserve the euro
	Major Quantitative-Easing Policies	
22 January 2015	APP	Announcement of €60bn-a-month bond-buying programme
	Covid-19 Pandemic	
12 March 2020	NotHereToCloseTheSpreads	ECB President tweeted stating that there are other tools and actors that should address the market fragmentation
30 April 2020	PEPP Hold Off	Market expectations of ECB expanding its plan to buy more assets were proven to be wrong
4 June 2020	600Billion Stimulus	Bigger-than-anticipated increase in ECB's emergency bond-buying program

Note: The table reports the summary of the ECB announcements during the debt-crisis, 2011-2012 and Covid-19 Pandemic,2020. Each announcement is depicted with the corresponding acronym as given in the table.

We collect six most critical ECB policy announcements for the debt-crisis period where, for four of them we compute a positive save-the-euro surprise even though during that meetings ECB announces various supportive packages to decrease the IT and ES yields, like LTROs, OMT, etc. This can be explained in two different ways. First, it can be regarded as a pure policy shock, in other words, those packages fall short compared to market expectations on the necessary actions needed to eliminate the break-up risk of euro zone. Second, increase in the spreads after powerful packages may be perceived by the investors as a signal coming from ECB where it has information about the significant break-up risk which market lacks. Either interpretation is possible but first one seems more plausible. Indeed, after a comprehensive revision on the market commentaries for the specific dates we find that during the most acute

phase of the debt-crisis period, expectations of market participants from ECB to act on the bond markets were highly demanding and in most of the cases, ECB policies appears to fall short compared to the market expectations. In terms of exercises we carry out, this reflects to our results as large positive surprises confirming the estimated save-the-euro factor.

Below, we match some of the largest save-the-euro surprises that we estimated with the commentaries and alongside carry out a fact-check exercise for the novel save-the-euro factor. This approach is necessarily ad-hoc but provides an informative fact-check in the absence of even ex-post realized surprise values for the policy announcements.

For the first announcement at Table 1, 4 August 2011, we read a positive observation in Fig. 3, which implies an increase in spreads. According to Financial Times commentaries, increase in the spread was due to the investors realized the ECB was not buying those countries' bonds where market participants were expecting a transaction on that day[11]. The second consecutive announcement in Table 1, 6 October 2011, corresponds to a moderate negative realization on Fig. 3, meaning that market perceives this as an expansionary shock (which supports to decrease the spreads). In a speech at the Tenth Economic Policy Conference, Málaga, 21 October 2011 José Manuel González-Páramo, Member of the Executive Board of the ECB relates the CBPP2 to the debt-crisis stating that, "*... with the recent intensification of the sovereign debt crisis, covered bond markets have again come under significant pressure. At its meeting of 6th October, the Governing Council therefore decided to announce a second covered-bond purchase programme, CBPP2*".

The second largest realization of the save-the-euro factor occurs when again ECB policy did not meet the market expectations on 5 July 2012. This is stated by Holger Schmieding, chief economist at Berenberg Bank, as the CNN reports: "*These moves were highly necessary and widely expected, but are insufficient to turn the euro zone economy around. The ECB would have to do more to intervene to calm market anxiety.*". This meeting was also read by the market participants as ECB was signaling that there is no pre-commitment on continuation of unconventional monetary policies (Rogers et al. (2014)).

Matching estimated surprises with market perceptions proves that the save-the-euro factor correctly captures the surprise part of the policy which targets market fragmentation or break-up risk. This procedure, however, can be qualified only if the save-the-euro factor works consistently together with main-stream factors which represent other dimensions of the pol-

[11] Although it is not in our dataset, on 7 August 2011 SMP on Italy and Spain was acknowledged by ECB and borrowing costs of both countries decreased.

icy. Perhaps the most important factor among main-stream factors that may propagate into the save-the-euro and complicate the identification of two different dimensions of the policy is the QE. Reasoning behind this can be discussed both in the technical grounds which relates the proposed identification procedure as well as ECB policy design where most of the bond purchasing programmes that address market fragmentation in a broad sense can be classified under the QE as well. In an attempt to show that employed identification procedure indeed successfully separates QE and save-the-euro dimensions of the policy correctly, we consider 22 January 2015 APP stimulus package. This is known as one of the largest unexpected pure QE surprise that ECB announced. First of all, this stimulus was widely unexpected by the market. CNN reports that "*The ECB took the unprecedented step because previous stimulus measures – including record low interest rates and buying other assets – had failed to boost inflation expectations.*". This verify largest negative QE surprise in the first panel of Fig. 3. But more importantly, we read a negligible save-the-euro surprise in the second panel documenting that our estimated factors could separate market perception on QE and save-the-euro.

For the Covid-19 Pandemic we consider three important governing council meetings as given in the third panel of the Table 1. On 12 March 2020 Announcement ECB president addressed different actors and tools to target market fragmentation. We estimate the largest positive surprise for the save-the-euro factor as well as a large contractionary QE surprise. Confirming our tightening surprise Financial Times reported that "*...Markets had hoped that today would be Christine Lagarde's "Whatever it takes" moment. Those hopes have proven misplaced...*". Similarly, 30 April 2020 announcement also comes with a direct contrast to the market expectations where againg it was reported by Financial Times that "*Some economists had predicted that the ECB would expand its plans to buy more than €1tn of assets this year to counter the threat that the countries hit hardest by coronavirus, such as Italy and Spain, could suffer a surge in borrowing costs — but it held off on any such announcement.*

On 4 June 2020, we estimate policy easing surprise for the save-the-euro factor. ECB announced a stimulus package worth €600 billion. In a Bloomberg Survey before the announcement, the vast majority of economists had predicted a boost of 500 billion euros.

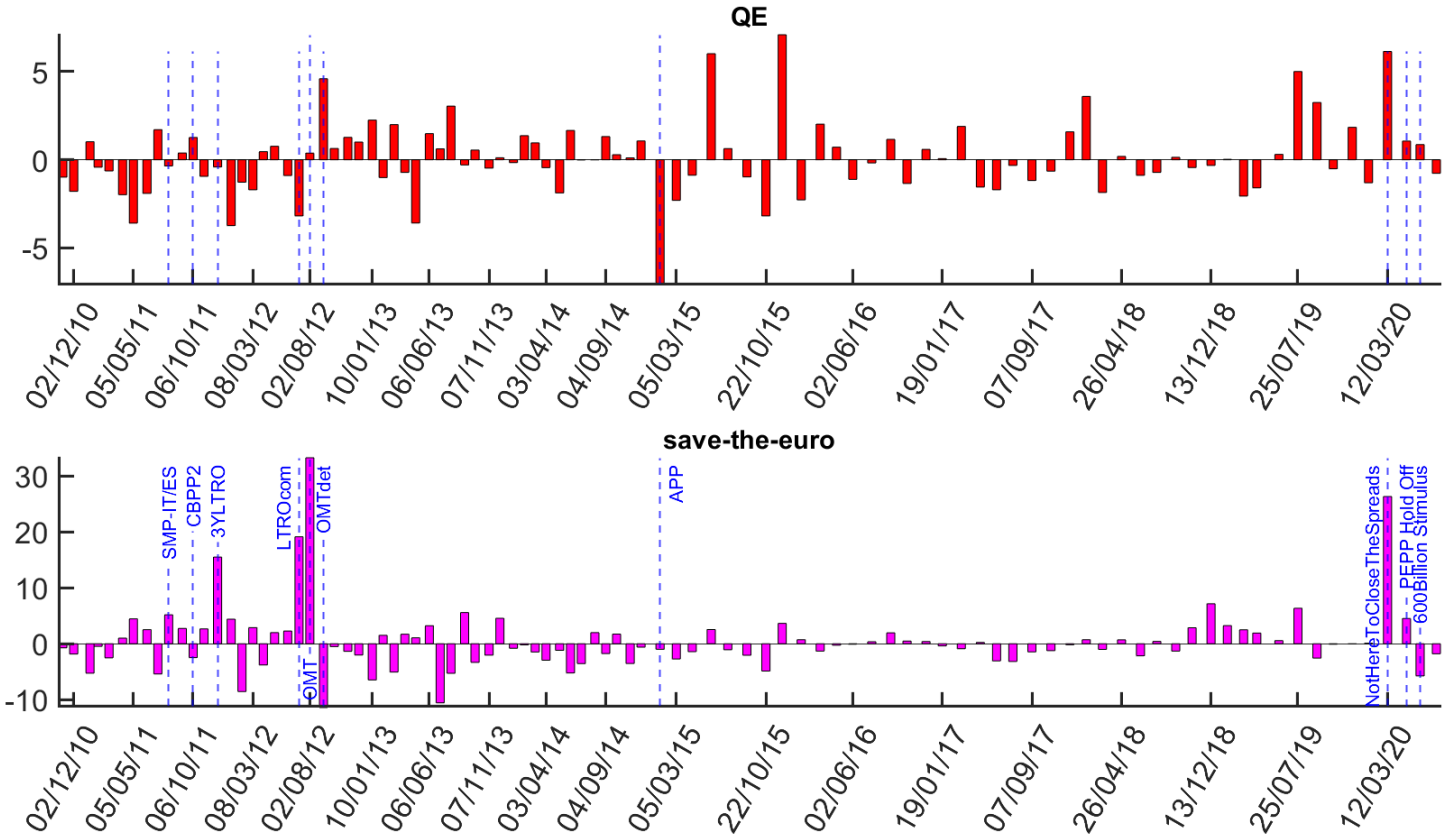

Figure 3: Estimated save-the-euro factor with critical ECB announcement during debt-crisis, 2011-2012

Note: The figure shows the estimated save-the-euro factor in basis points, together with critical ECB announcements during the debt-crisis period. Each dashed line shows ECB announcements with the corresponding acronym as given in the Table 1. Negative values correspond to monetary policy easings and positive values stand for policy tightenings.

4 Asset Price Responses to Policy Surprises

Throughout this section, to better characterize economic effects of the estimated factors during the sub-periods covered by our sample, we subdivide the full sample (3 January 2002 to 16 July 2020) into three periods spanning, "pre-crisis period (3 January 2002 - 4 September 2008)", "crisis period before QE (4 September 2008 - 9 January 2014)" which includes debt-crisis as well, and "QE period (9 January 2014 - 16 July 2020)" which covers Covid-19 Pandemic. We also control for the standardized surprise associated with the release of the US initial jobless claims (IJC).

Table 2 reports the estimated effects of factors on German sovereign yields. The foremost difference between the save-the-euro factor and the main-stream factors is that former effects the OIS rates in opposite direction compared to the latter and its effect is limited. That is to say, an expansionary save-the-euro factor increases the OIS yields and its magnitude is tiny. Not surprisingly, this is a consequence of sign normalization over the estimated factors which is explained in detail in Section 2. Furthermore, it should be underlined that, inclusion of the save-the-euro factor in last panel discernibly increases the total explanatory power of factors on on German yields during the crisis period before QE.

What makes the picture, however, more intriguing is the reaction of save-the-euro factor which jumps from a limited and negative effect on OIS rates up to the level of main-stream factors when regressed on Italian yields as showed in Table 3. Table 3 presents the reaction of Italian sovereign yields at different maturities to surprises in monetary policy for given sub-samples. Reaction of yields to main-stream factors are well established in the sense that effect of Target on 2, 5 and 10-year is limited and its explanatory power is limited, as well. Effect of Timing, FG and QE (when present) during the sub-samples pretty much similar and in line with the findings of Altavilla et al. (2019). This also proves that our extended identification scheme preserves the structure of main-stream factors while allowing the presence of the save-the-euro policy. The save-the-euro factor, in the pre-QE period, elicits a very sizable effect on Italian sovereign yields and its effect -different from Timing and FG in the same period- is almost the same across the 5 and 10-year and slightly lower for 2-year yield.

These findings imply that during the debt-crisis period, an expansionary save-the-euro factor narrows the yield spreads. Even more interestingly, during the same period, when we regress Italian yields only on Timing, FG, and QE as shown in Panel B, adjusted R-squared value of factors sharply fall for 2, 5 and 10-year yields, respectively. This finding further corroborates

Table 2: Estimated effects of monetary policy surprises on Germany sovereign yields

Panel (A): Press release window

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		01/2002-09/2008			09/2008-01/2014			01/2014-07/2020	
VARIABLES	DE 2Y	DE 5Y	DE 10Y	DE 2Y	DE 5Y	DE 10Y	DE 2Y	DE 5Y	DE 10Y
Target	0.02	-0.01	-0.06	0.40***	0.22*	0.04	0.64***	0.33***	-0.03
	(0.12)	(0.13)	(0.11)	(0.08)	(0.12)	(0.10)	(0.08)	(0.12)	(0.13)
Observations	75	75	75	62	62	62	57	57	57
R-squared	-0.01	-0.01	0.01	0.33	0.09	0	0.61	0.17	0.02

Panel (B): Conference window

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		01/2002-09/2008			09/2008-01/2014			01/2014-07/2020	
VARIABLES	DE 2Y	DE 5Y	DE 10Y	DE 2Y	DE 5Y	DE 10Y	DE 2Y	DE 5Y	DE 10Y
Timing	1.10***	0.55***	0.19**	1.22***	0.90***	0.40***	1.02***	0.90***	-0.14
	(0.09)	(0.08)	(0.09)	(0.10)	(0.10)	(0.08)	(0.20)	(0.29)	(0.25)
FG	1.34***	1.35***	0.71***	0.89***	0.84***	0.52***	1.46***	1.55***	0.91***
	(0.05)	(0.14)	(0.16)	(0.12)	(0.13)	(0.12)	(0.19)	(0.19)	(0.20)
IJC	-0.27	0.44	0.50	-2.76	-3.63	-2.12	0.46**	0.01	0.03
	(0.54)	(0.70)	(0.86)	(2.14)	(2.17)	(1.80)	(0.17)	(0.15)	(0.16)
QE							0.30***	0.64***	1.18***
							(0.09)	(0.13)	(0.10)
Observations	70	70	70	62	62	62	57	57	57
R-squared	0.99	0.88	0.76	0.82	0.64	0.33	0.83	0.86	0.92

Panel (C): Conference window: with the save-the-euro factor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		01/2002-09/2008			09/2008-01/2014			01/2014-07/2020	
VARIABLES	DE 2Y	DE 5Y	DE 10Y	DE 2Y	DE 5Y	DE 10Y	DE 2Y	DE 5Y	DE 10Y
Timing	1.10***	0.55***	0.19**	1.20***	0.87***	0.36***	1.25***	1.08***	0.13
	(0.09)	(0.08)	(0.09)	(0.08)	(0.08)	(0.07)	(0.12)	(0.21)	(0.17)
FG	1.34***	1.35***	0.71***	1.04***	1.06***	0.74***	1.21***	1.35***	0.64***
	(0.05)	(0.14)	(0.16)	(0.10)	(0.10)	(0.08)	(0.12)	(0.19)	(0.12)
IJC	-0.27	0.44	0.50	-2.62	-3.43**	-1.92	0.25*	-0.16	-0.20*
	(0.54)	(0.70)	(0.86)	(1.62)	(1.56)	(1.33)	(0.14)	(0.14)	(0.11)
save-the-euro				-0.22***	-0.31***	-0.30***	-0.22***	-0.17***	-0.25***
				(0.04)	(0.04)	(0.02)	(0.04)	(0.05)	(0.04)
QE							0.53***	0.82***	1.44***
							(0.07)	(0.17)	(0.09)
Observations	70	70	70	62	62	62	57	57	57
R-squared	0.99	0.88	0.76	0.9	0.82	0.7	0.89	0.88	0.95

*Note: The table reports the reaction of Germany sovereign yields at different maturities to surprises in monetary policy using intraday data. Coefficients are expressed in percentage per annum per standard deviation change in the factors. Robust standard errors in parentheses; ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.*

the existence and the importance of our newly introduced factor for the turmoil periods of the euro area[12].

Table 4 reports results for the euro-US dollar exchange rate. Save-the-euro factor, together with main-stream factors all exert highly statistically significant effects on exchange value of the euro along all sub-samples. Reaction of exchange rate on main-stream factors are again in line with the findings of Altavilla et al. (2019). What is noteworthy, however, is the effect of

[12] A similar pattern is also valid for reaction of Spanish sovereign yields, but for the sake of brevity we exclude it from this report. Result are available upon request.

Table 3: Estimated effects of monetary policy surprises on Italian sovereign yields

Panel (A): Press release window

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		01/2002-09/2008			09/2008-01/2014			01/2014-07/2020	
VARIABLES	IT 2Y	IT 5Y	IT 10Y	IT 2Y	IT 5Y	IT 10Y	IT 2Y	IT 5Y	IT 10Y
Target	0.18	0.01	-0.06	0.43**	0.36**	0.14	0.75**	0.68*	0.57
	(0.11)	(0.13)	(0.10)	(0.17)	(0.14)	(0.11)	(0.29)	(0.36)	(0.50)
Observations	75	75	75	62	62	62	57	57	57
R-squared	0.07	-0.01	0.01	0.19	0.11	0.02	0.17	0.16	0.11

Panel (B): Conference window

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		01/2002-09/2008			09/2008-01/2014			01/2014-07/2020	
VARIABLES	IT 2Y	IT 5Y	IT 10Y	IT 2Y	IT 5Y	IT 10Y	IT 2Y	IT 5Y	IT 10Y
Timing	1.15***	0.67***	0.17*	0.98***	0.49**	0.29	2.23***	2.00***	1.26*
	(0.06)	(0.09)	(0.09)	(0.21)	(0.19)	(0.20)	(0.49)	(0.71)	(0.66)
FG	1.22***	1.21***	0.65***	1.99***	1.90***	1.25***	0.55	-0.04	-0.37
	(0.04)	(0.09)	(0.16)	(0.28)	(0.35)	(0.28)	(0.40)	(0.61)	(0.53)
IJC	-0.45	-0.15	0.40	1.77	-2.51	-2.58	-1.70***	-0.93*	-0.52
	(0.46)	(0.65)	(0.85)	(2.38)	(2.94)	(2.46)	(0.37)	(0.52)	(0.40)
QE							1.17***	1.82***	2.61***
							(0.18)	(0.28)	(0.21)
Observations	70	70	70	62	62	62	57	57	57
R-squared	0.99	0.96	0.72	0.62	0.44	0.25	0.74	0.7	0.84

Panel (C): Conference window: with the save-the-euro factor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		01/2002-09/2008			09/2008-01/2014			01/2014-07/2020	
VARIABLES	IT 2Y	IT 5Y	IT 10Y	IT 2Y	IT 5Y	IT 10Y	IT 2Y	IT 5Y	IT 10Y
Timing	1.15***	0.67***	0.17*	1.05***	0.59***	0.39***	1.55**	0.79***	0.20
	(0.06)	(0.09)	(0.09)	(0.12)	(0.09)	(0.08)	(0.59)	(0.16)	(0.13)
FG	1.22***	1.21***	0.65***	1.53***	1.29***	0.64***	1.26***	1.22***	0.74***
	(0.04)	(0.09)	(0.16)	(0.11)	(0.14)	(0.15)	(0.29)	(0.10)	(0.09)
IJC	-0.45	-0.15	0.40	1.35	-3.08	-3.15*	-1.09***	0.15*	0.42***
	(0.46)	(0.65)	(0.85)	(1.31)	(1.87)	(1.77)	(0.25)	(0.08)	(0.09)
save-the-euro				0.65***	0.87***	0.86***	0.65***	1.15***	1.01***
				(0.03)	(0.05)	(0.09)	(0.13)	(0.04)	(0.03)
QE							0.49***	0.62***	1.56***
							(0.16)	(0.10)	(0.07)
Observations	70	70	70	62	62	62	57	57	57
R-squared	0.99	0.96	0.72	0.94	0.91	0.87	0.9	0.99	0.99

*Note: The table reports the reaction of Italian sovereign yields at different maturities to surprises in monetary policy using intraday data. Coefficients are expressed in percentage per annum per standard deviation change in the factors. Robust standard errors in parentheses; ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.*

save-the-euro factor during the pre-QE sub-sample, i.e., the sample that contains debt-crisis. Indeed, we find that "preserving the euro effect" of Rogers et al. (2014) works through save-the-euro factor and where an easing surprise through save-the-euro appreciates euro. We do not observe the same reaction during the last sub-sample which includes Covid-19 Pandemic. In this sub-sample save-the-euro is not statistically significantly different than zero. Explanatory power of the save-the-euro factor during the debt-crisis is are also remarkable.

Having observed the effects of monetary policy surprises, on OIS/sovereign yields and exchange rates, we now turn to the reaction of the euro area stock markets to the factors. Table

5 shows the effect of estimated surprises on stock market indices, considering the same sub-periods. Reaction of general euro area stock market index and and the euro area bank stock market sub-index to the save-the-euro factor are highly significant and negative during both debt-crisis and Covid-19 Pandemic. It should be underlined that, in the same sub-sample reaction of indices on some main-stream factors are insignificant. This is argued by Altavilla et al. (2019) on the grounds of monetary policy shock and information shock and it turns out that effects of these two shocks on stock prices may cancel each other due to their opposite effects on stocks forcing the effects of policy surprises on indices insignificant.

Highly significant reaction of stocks on save-the-euro factor imply that information effects (Delphic) do not interfere and implying the save-the-euro surprises are perceived mostly as a monetary shock. Recall that, in Section 3.1, we prove this to some extend by matching large surprises during the most acute phase of the debt-crisis and Covid-19 Pandemic with the market commentaries published after the ECB announcements. Commentaries suggest that (at least for the specific dates that we considered in this study) for all positive surprises that is estimated for the save-the-euro factor market expectations were highly demanding whereas ECB policy was biased towards not intervening to the sovereign debt market. We state this period as Odyssean reaction of market participants to the "preserving the euro" policy of ECB, while its reaction to other policies (as measured by main-stream factors) are still Delphic in the same period [13].

[13] Please see Fig. 4 in the Altavilla et al. (2019) for Delphic and Odyssean periods.

Table 4: Estimated effects of monetary policy surprises on the exchange rate

Panel (A): Press release window

	(1)	(2)	(3)	(4)
	01/2002-07/2020	01/2002-09/2008	09/2008-01/2014	01/2014-07/2020
VARIABLES	EUR/USD	EUR/USD	EUR/USD	EUR/USD
Target	0.02	-0.01	0.02*	0.02
	(0.01)	(0.02)	(0.01)	(0.04)
Observations	194	75	62	57
R-squared	0.03	0	0.09	0.04

Panel (B): Conference window

	(1)	(2)	(3)	(4)
	01/2002-07/2020	01/2002-09/2008	09/2008-01/2014	01/2014-07/2020
VARIABLES	EUR/USD	EUR/USD	EUR/USD	EUR/USD
Timing	0.06***	0.08***	0.07***	0.15**
	(0.01)	(0.01)	(0.02)	(0.06)
FG	0.06***	0.02	0.05***	0.24***
	(0.01)	(0.02)	(0.01)	(0.05)
QE	0.08***			0.09***
	(0.02)			(0.02)
IJC	0.05	0.56***	-0.02	0.06
	(0.08)	(0.21)	(0.30)	(0.04)
Observations	189	70	62	57
R-squared	0.31	0.38	0.29	0.58

Panel (C): Conference window: with the save-the-euro factor

	(1)	(2)	(3)	(4)
	01/2002-07/2020	01/2002-09/2008	09/2008-01/2014	01/2014-07/2020
VARIABLES	EUR/USD	EUR/USD	EUR/USD	EUR/USD
Timing	0.06***	0.08***	0.07***	0.18**
	(0.01)	(0.01)	(0.02)	(0.07)
FG	0.06***	0.02	0.07***	0.22***
	(0.01)	(0.02)	(0.02)	(0.05)
QE	0.08***			0.11***
	(0.03)			(0.03)
save-the-euro	-0.02***		-0.03***	-0.02
	(0.01)		(0.00)	(0.02)
IJC	0.06	0.56***	-0.00	0.04
	(0.08)	(0.21)	(0.29)	(0.05)
Observations	189	70	62	57
R-squared	0.35	0.38	0.49	0.58

*Note: The table reports the reaction of euro-dollar exchange rate over different samples to surprises in monetary policy using intraday data. Coefficients are expressed in percentage points per standard deviation change in the factors. Robust standard errors in parentheses; ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.*

Table 5: Estimated effects of monetary policy surprises on stock prices

Panel (A): Press release window

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	01/2002-07/2020	01/2002-07/2020	01/2002-09/2008	01/2002-09/2008	09/2008-01/2014	09/2008-01/2014	01/2014-07/2020	01/2014-07/2020
VARIABLES	STOXX50E	SX7E	STOXX50E	SX7E	STOXX50E	SX7E	STOXX50E	SX7E
Target	-0.05**	-0.05	-0.09***	-0.08***	-0.03	-0.03	-0.09	-0.07
	(0.02)	(0.03)	(0.01)	(0.01)	(0.02)	(0.02)	(0.06)	(0.10)
Observations	194	194	75	75	62	62	57	57
R-squared	0.11	0.02	0.33	0.37	0.07	0.02	0.13	0.02

Panel (B): Conference window

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	01/2002-07/2020	01/2002-07/2020	01/2002-09/2008	01/2002-09/2008	09/2008-01/2014	09/2008-01/2014	01/2014-07/2020	01/2014-07/2020
VARIABLES	STOXX50E	SX7E	STOXX50E	SX7E	STOXX50E	SX7E	STOXX50E	SX7E
Timing	-0.02	-0.05	-0.05***	-0.04*	0.01	-0.02	-0.30***	-0.45**
	(0.02)	(0.04)	(0.02)	(0.02)	(0.03)	(0.05)	(0.10)	(0.18)
FG	-0.05**	-0.06	-0.02	-0.04	-0.06*	-0.16**	-0.17**	0.04
	(0.02)	(0.05)	(0.03)	(0.03)	(0.04)	(0.08)	(0.08)	(0.14)
QE	-0.07*	-0.03					-0.15***	-0.20***
	(0.04)	(0.08)					(0.03)	(0.06)
IJC	-0.28***	-0.46***	-0.83***	-0.78**	-0.27	-0.56	-0.12*	-0.12
	(0.08)	(0.17)	(0.25)	(0.31)	(0.38)	(0.62)	(0.06)	(0.15)
Observations	189	189	70	70	62	62	57	57
R-squared	0.1	0.07	0.15	0.13	0.1	0.15	0.42	0.32

Panel (C): Conference window: with the save-the-euro factor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	01/2002-07/2020	01/2002-07/2020	01/2002-09/2008	01/2002-09/2008	09/2008-01/2014	09/2008-01/2014	01/2014-07/2020	01/2014-07/2020
VARIABLES	STOXX50E	SX7E	STOXX50E	SX7E	STOXX50E	SX7E	STOXX50E	SX7E
Timing	-0.02	-0.05**	-0.05***	-0.04*	-0.00	-0.04	-0.17**	-0.20
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.07)	(0.14)
FG	-0.05***	-0.06**	-0.02	-0.04	-0.02	-0.05	-0.30***	-0.21*
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.07)	(0.11)
QE	-0.07**	-0.03					-0.03	0.04
	(0.03)	(0.03)					(0.03)	(0.07)
save-the-euro	-0.08***	-0.17***			-0.07***	-0.16***	-0.12***	-0.23***
	(0.01)	(0.01)			(0.01)	(0.03)	(0.03)	(0.05)
IJC	-0.25***	-0.38***	-0.83***	-0.78**	-0.23	-0.45	-0.24***	-0.33**
	(0.09)	(0.11)	(0.25)	(0.31)	(0.39)	(0.58)	(0.06)	(0.14)
Observations	189	189	70	70	62	62	57	57
R-squared	0.39	0.54	0.15	0.13	0.46	0.66	0.58	0.52

*Note: The table reports the reaction of the general euro area stock market index over different samples, and the reaction of the euro area bank stock market sub-index over the same samples to surprises in monetary policy using intraday data. Coefficients are expressed in percentage points per standard deviation change in the factors. Robust standard errors in parentheses; ***, **, and * denote statistical significance at the, 1%, 5% and 10% levels, respectively.*

5 Conclusion

ECB monetary policy during the Sovereign debt crisis period was a test ground to euro area's intention staying as a monetary union. The same risk occurred again during the Covid-19 Pandemic. These unusual periods are multidimensional and characterized by unconventional monetary policy tools. In terms of the exercises we carry out, our value added is to shed light on the monetary policies of these periods and formally measure their effects.

Main-stream factors of Altavilla et al. (2019) represents the major portion of euro area monetary policy. In this study, using their publicized database, EA-MPD and accompanied toolbox, we show that their findings can be extended to the debt-crisis period, as well as Covid-19 crisis and some missing parts of ECB monetary policy can be explained with the save-the-euro factor introduced in this study, while main-stream factors show similar responses in parallel with the findings of the previous literature.

Apart from the main stream factors, we find strong evidence in favor of existence of a new factor in explaining the sovereign yields, exchange rates and stock market variations during the debt-crisis and Covid-19 Pandemic. By matching important policy dates with the press commentaries, we validate the new factor. As a consequence of the employed identification methodology, new factor works through the sovereign spreads such that an expansionary save-the-euro policy decreases Italian and Spain sovereign yields. Moreover, we show that an expansionary save-the-euro factor appreciates euro and increases the stock prices further supporting characterization of the new factor.

In an attempt to document effectiveness of our novel factor, as a future research, setting up an macro VAR and computing the impulse responses would be a good exercise to see effects for different euro area countries. Further to that relation between the new factor and self-fulfilling market reactions hypothesis can be discussed for future research.

Appendices

Appendix A. Factor Identification Methodology

In order to capture and quantify the ECB policy during the debt-crisis, we extend the identification methodology of Altavilla et al. (2019) in two ways. First, the latent factors are estimated not only with changes in OIS yields spanning 1, 3, and 6-month and 1, 2, 5, and 10-year but also with 2, 5, and 10-year sovereign yields of Italy, France and Spain. Second, we consider four factors in the Press Conference Window instead of three.

Consider the $\boldsymbol{Y}$ matrix, and let it has aforementioned assets in its sixteen columns and each row contains price change for each governing council meeting. In other words, The $\boldsymbol{Y}$ is the price matrix for an estimation window of length R with a typical column of $\boldsymbol{Y}_m = \begin{bmatrix} Y_{1,m} & \dots & Y_{R,m} \end{bmatrix}'$, $\boldsymbol{Y} = \begin{bmatrix} \boldsymbol{Y}_1 & \dots & \boldsymbol{Y}_{16} \end{bmatrix}_{R\times 16}$. The factor structure is:

$$\boldsymbol{Y} = \boldsymbol{F}\boldsymbol{\Lambda} + \boldsymbol{\epsilon} \tag{A.1}$$

where $\boldsymbol{F}$ is the common latent factors, with the n-th column is equal to $\boldsymbol{F}_n = \begin{bmatrix} F_{1,n} & \dots & F_{R,n} \end{bmatrix}'$, $\boldsymbol{\Lambda}$ is the 4×16 factor loadings matrix, and $\boldsymbol{\epsilon}$ is the idiosyncratic variation of yield changes at different maturities, $n = 1, \dots, 4$. Factors are estimated with principal components.

Latent factors in their raw forms have no apparent economic meaning and must be identified with some constraints in the sense that each factor represents one dimension of monetary policy. This procedure is called factor rotation. We extend the factor rotation metodology of Altavilla et al. (2019). Consider a 4×4 rotation matrix, $\boldsymbol{U}$, satisfying $\boldsymbol{U}\boldsymbol{U}' = I$, where I is an identity matrix. Also let $\{u_{ij}\}$ be the corresponding entry at column-j row-i of the rotation matrix. One can reformulate Eq. A.1 as given below:

$$\boldsymbol{Y} = \tilde{\boldsymbol{F}}\tilde{\boldsymbol{\Lambda}} + \boldsymbol{\epsilon}, \text{where } \tilde{\boldsymbol{F}} = \boldsymbol{F}\boldsymbol{U}, \text{and } \tilde{\boldsymbol{\Lambda}} = \boldsymbol{U}'\boldsymbol{\Lambda}. \tag{A.2}$$

Essentially, factor rotation is equivalent to determination of entries of $\boldsymbol{U}$ matrix such that rotated, i.e., identified factors, $\boldsymbol{F}^*$, is given by:

$$\boldsymbol{F}^* = \boldsymbol{F}\boldsymbol{U}^*, \tag{A.3}$$

where $\boldsymbol{U}^*$ is the uniquely identified matrix. To identify $\boldsymbol{U}$, one needs sixteen restrictions in

total. Let for a given matrix $\boldsymbol{X}$, $\boldsymbol{X}_{.,j}$ denote the j-th column and $\boldsymbol{X}_{i,.}$ denote the i-th row of $\boldsymbol{X}$. four restrictions comes from columns of $\boldsymbol{U}$ being equal to one:

$$\boldsymbol{U}'_{.,1}\boldsymbol{U}_{.,1} = 1,\ \boldsymbol{U}'_{.,2}\boldsymbol{U}_{.,2} = 1,\ \boldsymbol{U}'_{.,3}\boldsymbol{U}_{.,3} = 1,\ \boldsymbol{U}'_{.,4}\boldsymbol{U}_{.,4} = 1, \tag{A.4}$$

and six of them comes from columns of $\boldsymbol{U}$ being orthogonal:

$$\begin{aligned} &\boldsymbol{U}'_{.,1}\boldsymbol{U}_{.,2} = 0,\ \boldsymbol{U}'_{.,1}\boldsymbol{U}_{.,3} = 0,\ \boldsymbol{U}'_{.,1}\boldsymbol{U}_{.,4} = 0, \\ &\boldsymbol{U}'_{.,2}\boldsymbol{U}_{.,3} = 0,\ \boldsymbol{U}'_{.,2}\boldsymbol{U}_{.,4} = 0, \\ &\boldsymbol{U}'_{.,3}\boldsymbol{U}_{.,4} = 0. \end{aligned} \tag{A.5}$$

We need six more restrictions. These come from economic considerations. Three of them are due to the fact that rotated factors in the Press Conference Window do not load on 1M OIS except first factor:

$$\boldsymbol{U}'_{.,2}\boldsymbol{\Lambda}_{.,1} = 0,\ \boldsymbol{U}'_{.,3}\boldsymbol{\Lambda}_{.,1} = 0,\ \boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,1} = 0. \tag{A.6}$$

Up to this point, restrictions are in parallel with Altavilla et al. (2019). Next three novel economic restrictions are specifically introduced to identify the save-the-euro factor. During the debt-crisis ECB policies targeted the sovereign spreads (Rogers et al. (2014); Wright (2019)). This can be reflected by considering OIS yield and Italian Sovereign yield such that product of effect of fourth-factor on 5-year OIS yield and effect of fourth-factor on on 5-year Italian Sovereign yield is negative. This restriction reflects the fact that during the debt-crisis period ECB policies either narrowed or expanded the spreads [14]:

$$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,9}) < 0. \tag{A.7}$$

Last two restrictions are build upon Swanson (2017) identification. We require that sum of main-stream QE factor variance during the pre-crisis period (2 January 2002 - 7 Aug 2008), and save-the-euro factor total variance before debt-crisis period (2 January 2002 - 9 Jun 2011) and after that (10 Jan 2013 - 24 Oct 2019) is minimum [15]. In other words, we extend the

[14] As a robustness check, we replace this restriction with Spain yields and GDP-weighted average of Italian and Spain yields, instead of Italian yields. Details of robustness check scenarios are given in Appendix B.

[15] We consider the most acute phase of the debt-crisis from 7 July 2011 to 6 January 2012 to identify the

optimization procedure of Altavilla et al. (2019) such that, it is required that not only the variance of QE in the pre-crisis period is minimum but sum of variances of both QE and save-the-euro factors in corresponding periods is minimum. Let $\boldsymbol{F}^{preFC}$, $\boldsymbol{F}^{preDC}$, $\boldsymbol{F}^{postDC}$ denote factor matrix before the financial crisis, before the debt-crisis and after the debt-crisis until the start of Covid-19 Pandemic period, respectively[16]. Then solution to below optimization problem gives the rotation matrix, $\{u_{ij}\}$:

$$\begin{aligned}\boldsymbol{U}^* = \arg\min_{\{u_{ij}\}} \quad & \underbrace{\sum_{t=1}^{T_{preFC}} (\boldsymbol{F}^{preFC}_{t,\cdot}\boldsymbol{U}_{\cdot,3})^2/T_{preFC}}_{\text{variance of rotated\_F3 before the financial crisis}} \\ & + \underbrace{\sum_{t=1}^{T_{preDC}} (\boldsymbol{F}^{preDC}_{t,\cdot}\boldsymbol{U}_{\cdot,4})^2/T_{preDC}}_{\text{variance of rotated\_F4 before the debt-crisis}} \\ & + \underbrace{\sum_{t=1}^{T_{postDC}} (\boldsymbol{F}^{postDC}_{t,\cdot}\boldsymbol{U}_{\cdot,4})^2/T_{postDC}}_{\substack{\text{variance of rotated\_F4 after the debt-crisis} \\ \text{until the start of Covid-19 Pandemic}}} \\ & \text{subject to} \\ & \text{Eq. A.4, A.5, A.6, and A.7.}\end{aligned} \tag{A.8}$$

Where T_{preFC}, T_{preDC}, and T_{postDC} represents total data points in the corresponding periods. Thus, last two restrictions can be obtained from first order conditions of the optimization problem. Recall that $\boldsymbol{U}^*$ is unique up to a rotation. Therefore, we can scale the rotated factors, $\boldsymbol{F}^*$, such that resulting main-stream factors, namely Target, Timing, FG, and QE are positively correlated with the 1-month 6-month, 2-year, 10-year OIS, respectively. Moreover, we scale save-the-euro factor such that it is positively correlated with the 5-year Italian sovereign yield.

Appendix B. Robustness of Factors: Different Identification Scenarios

In Appendix A, we present the baseline identification methodology for the mainstream factors and save-the-euro factor. Various other identification techniques are also possible in order to

save-the-euro factors. This period starts when the sovereign spreads of Italy increased above 300 basis points and ends when the break-up risk of euro zone muted at the end of the 2012, as explained by De Santis (2019).

[16]Formally, on 30 Jan 2020, World Health Organization declared the outbreak a Public Health Emergency of International Concern. In order to cover the whole pandemic period, we consider 12 Dec 2019, i.e., the last Governing Council meeting of 2019 as the start date of the pandemic.

estimate our newly introduced save-the-euro factor. In this section, we discuss a series of possible scenarios and show that indeed our estimated factors, and particularly save-the-euro factor is robust to other methodologies.

Table 7 presents possible identification schemes to estimate the save-the-euro factor. As explained in previous section, there are two main identifying assumption for the new factor as governed by Eq. A.7 and Eq. A.8, respectively. Therefore, for the robustness scenarios, we revise these equations in different dimensions while keeping other equations as given before. "rob1A" corresponds to baseline estimation methodology as given in Appendix A. For "rob1X", in order to identify the save-the-euro factor, we use Italian sovereign yields, whereas in "rob2X", we consider Spanish sovereign yields, where X $\in$\{A, B, C, D, E, F\}. These modifications in identification of the save-the-euro factor is represented by different versions of Eq. A.7 as given for respective scenarios in the table.

Second identifying assumption for the save-the-euro factor is given by the variance minimization in different periods. Save-the-euro factor, by definition, captures the part of the ECB monetary policy that targets market fragmentation risk within euro area. This risk first occurred during the debt-crisis period (2011-2012) and woke up again after a long period of silence during the Covid-19 Pandemic period (2020). We consider different dates covered by the debt-crisis and Covid-19 Pandemic as given in Table 6.

Table 6: Periods for variance minimization in Eq. A.8

Period	Covered Dates
debt-crisis	07 Jun 2011 - 06 Dec 2012
covid-19	12 Dec 2019 - 16 Jul 2020
debt-crisis*	07 Jun 2010 - 06 Dec 2012
covid-19*	12 Mar 2019 - 16 Jul 2020

Note: The table reports different identification scenarios to estimate the save-the-euro factor. For the detailed explanation of the table see the text.

In the identification procedure, we use different combinations of minimization periods for Eq. A.8. These scenarios are presented in the third column of Table 7. In each scenario we exclude corresponding time period from the objective function. For example, for scenario-A, we adapt Eq. A.8 such that in the objective function we minimize the variance of fourth factor excluding both debt-crisis and Covid-19 Pandemic period whereas in scenario-B we minimize the variance of fourth factor excluding only the debt-crisis period. Following this, we revise

Eq. A.8 in a way that, $\boldsymbol{F}^{postDC}$ contains the period after the debt-crisis until the beginning of Covid-19 Pandemic for the scenario-A (i.e., 10 Jan 2013 - 24 Oct 2019) and until the end of the whole sample for scenario-B (i.e., 10 Jan 2013 - 16 Jul 2020).

Table 7: Identification scenarios for robustness of save-the-euro factor

Robustness Scenarios	Eq. A.7	Eq. A.8
rob1A(baseline)	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,9}) < 0$	debt-crisis + covid-19
rob1B	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,9}) < 0$	debt-crisis
rob1C	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,9}) < 0$	debt-crisis* + covid-19
rob1D	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,9}) < 0$	debt-crisis*
rob1E	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,9}) < 0$	debt-crisis* + covid-19*
rob1F	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,9}) < 0$	debt-crisis + covid-19*
rob2A	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,15}) < 0$	debt-crisis + covid-19
rob2B	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,15}) < 0$	debt-crisis
rob2C	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,15}) < 0$	debt-crisis* + covid-19
rob2D	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,15}) < 0$	debt-crisis*
rob2E	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,15}) < 0$	debt-crisis* + covid-19*
rob2F	$(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,6})(\boldsymbol{U}'_{.,4}\boldsymbol{\Lambda}_{.,15}) < 0$	debt-crisis + covid-19*

Note: The table reports different identification scenarios to estimate the save-the-euro factor. For the detailed explanation of the table see the text.

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