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Estimating the full effect of a partially anticipated event: a market-based approach applied to the case of TLTROIII

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Abstract

This paper presents an event-study methodology that combines market data and survey-based probabilities to infer the full effect of a policy decision, as seen through the lens of financial markets. The market reaction to an event's outcome reflects its surprise or announcement effect, and generally not its full effect. However, under certain conditions, the unobserved full effect can be derived from the observed surprise effect. Most importantly, the ex-ante probabilities of different outcomes must be known. We apply this methodology to a real-world example: the European Central Bank's announcement of its third series of targeted longer-term refinancing operations (TLTROIII). The introduction of TLTROIII was highly anticipated, and therefore partially priced in, as market participants feared a "cliff effect" with the preceding operations under TLTROII coming due. We estimate the announcement's full effect, focusing on its impact on a set of asset prices, as compared to a baseline wherein TLTROIII would not have been introduced. The full market impact surpasses the surprise effect by a factor of fifteen. We also find that the announcement had a highly heterogeneous impact on euro area sovereign bond yields.

JEL Classification: G12, G13, G14

Keywords: event-study, targeted longer-term refinancing operations

Non-technical Summary

For policy makers, it is imperative to understand the full effect of their decisions. It can be difficult the establish the full effect of a decision, but data from financial markets can be informative. When policies are announced, asset prices react. This reaction reflects market participants' views on the decision's impact. However, markets typically only react to *new* information. Policy decisions are often partially anticipated and therefore partially priced in. The market reaction to a policy decision therefore only reflects its surprise or announcement effect, and not its full effect.

This paper introduces a methodology to derive the full impact of a policy decision from its announcement effect, as seen through the lens of financial markets. We apply this methodology to a real-world example: the announcement of the European Central Bank's (ECB) third series of targeted longer-term refinancing operations (TLTROIII).

Our methodology exploits the fact that pre-event asset prices can be seen as a combination of post-event prices, weighted by the probabilities of the different possible outcomes. We estimate the ex-ante probabilities using survey data. If the policy decision can be modeled as having binary ("yes" or "no") outcomes, then the asset price outcomes for the unobserved counterfactual scenario can be computed. Following this strategy, the decision's full effect, measured vis-a-vis its counterfactual baseline, can be derived.

In order to isolate the impact of a policy decision on asset prices, we use high-frequency intraday data around its announcement.

The announcement of TLTROIII is well-suited for the application of our methodology due to decision's high degree of anticipation, the availability of high frequency market data, and the availability of survey data taken shortly prior to the event.

Our analysis reveals that TLTROIII had a significant impact on sovereign bond yields, particularly for Italy. The full impact of the announcement surpasses its surprise effect by a factor of fifteen, reflecting the extent to which TLTROIII had already been priced in.

Overall, our approach offers a valuable tool and alternative approach for analyzing the effects of monetary policy decisions.

1 Introduction

For policy makers, it is imperative to understand the full effect of their decisions. Financial market data can be useful when assessing the impact of policy decisions. The reaction of asset prices to the announcement of a policy decision provides information about its impact, as seen through the lens of the market. Under the efficient market hypothesis, however, markets only react to new information. Policy decisions are often partially anticipated and therefore partially priced in. The market reaction to an event's outcome only reflects its surprise or announcement effect, and generally not its full effect. Existing studies on the impact of monetary policy decisions on asset prices focus on announcement effects. But when a decision is partially anticipated, the announcement effect does not reflect its full effect, while a policy maker might be more interested in the latter.

This paper presents a methodology, applicable to certain types of events, that infers the unobserved full effect from the observed announcement effect. This methodology is subsequently applied to a real-world example: the announcement of the third series of targeted longer-term refinancing operations by the European Central Bank. The methodology is based on a simple idea: pre-event asset prices can be seen as a probability weighted combination of post-event prices, whereby each possible outcome carries a certain probability as well as a set of expected asset prices. Even though the announcement effect can only be measured for one outcome –the realized outcome–, pre-event asset prices still carry information about the alternative outcomes. This information can be extracted if 1) the decision or event can be modelled as having binary (yes/no) outcomes, and 2) the ex-ante probabilities can be obtained. The set of asset prices under the –unobserved– alternative outcome can then be computed analytically, and a policy decision's full effect can be determined vis-à-vis its counterfactual baseline.

A key challenge in this paper is the identification of the impact of a single policy decision on asset prices. To isolate a decision's market-impact, we use high-frequency intraday data around its announcement. This minimizes the effect of other, unrelated factors. Focusing on monetary policy decisions, we use the standard approach for monetary policy event studies as developed by Altavilla et al. (2019) and others, drawing from the Euro Area Monetary Policy Event-Study Database (EA-MPD).

We consider the announcement of the third series of targeted longer-term refinancing operations (TLTROIII) by the European Central Bank (ECB) for the application of our event-study methodology. This case is interesting for economic reasons and well-suited for a number of practical reasons. The study of non-standard monetary policy tools, like the ECB's TLTROs, is generally challenging due to limited historical data, complex transmission mechanisms, measurement difficulties, and heterogeneous responses. Our methodology provides a new approach that can be used to study the effect of such tools.

The questions that arose prior to the introduction of TLTROIII remain relevant today. The introduction of TLTROIII was highly anticipated as market participants feared a "cliff effect" if the preceding TLTROII loans would mature without follow-up operations. Not only would the redemption of TLTROII have absorbed liquidity, its uneven distribution across euro area jurisdictions sparked concern about its impact, especially for those countries where the outstanding amounts under TLTROII surpassed the available excess liquidity. The ECB, as well as other central banks, face similar "cliff edge" concerns today, as central banks around the world are winding up some of the non-standard monetary policy facilities that were introduced during the pandemic. In particular, the (modified) TLTROIII operations themselves are now maturing on a rolling basis.[1]

Finally, the announcement of TLTROIII is also well-suited for our event-study methodology for three technical reasons. First, the decision was highly anticipated, meaning that it is a good example of a decision that was partially priced in. Second, high-frequency market data around the decision's announcement is available through the Euro Area Monetary Policy Event-Study Database (EA-MPD). Third, standardized economist surveys taken shortly before the decision are available from Bloomberg L.P. and Reuters. These surveys facilitate the estimation of the decision's ex-ante probabilities. These surveys included questions about the likelihood of third series of TLTROs, as well as their expected timing, when relevant.

Our focus is on sovereign bond yields and the risk-free curve. The Monetary Policy Event Study database contains euro Overnight Indexed Swap rates and German Government bond yields at various maturities, and French, Italian and Spanish government bond yields for the 2, 5 and 10-year maturities.

Bloomberg L.P. and Reuters take surveys among a fixed panel of market participants and economists prior to the ECB's monetary policy decisions. The Bloomberg and Reuters surveys are both taken in the week prior to the monetary policy decisions. The surveys are taken among

[1] Redemption dates can be found on the ECB website, see the Indicative calendar for the third series of targeted longer-term refinancing operations (TLTROs-III). The last redemption (TLTRO-III.10) is planned for December 2024.

a fixed panel of experts; names of individual respondents are provided in the detailed survey data. The Bloomberg panel included 34 responses, and the Reuters survey 92.

The use of high-frequency intraday data helps to identify the market impact of the monetary policy decisions. However, to identify what the impact of the TLTROIII announcement was, we need to account for the fact that other elements in the published decisions may have had an impact as well. We use the methodology developed by Gürkaynak et al. (2005b) and Swanson (2021), which was applied to the euro area by Altavilla et al. (2019), to "strip off" the impact of other decisions on market pricing, and isolate the (surprise) effect of the TLTROIII announcement. Our factor analysis shows that the moves in the risk-free curve were largely driven by the change in the ECB's forward guidance. By contrast, the significant price action in sovereign spreads can not entirely be explained by the standard monetary policy factors. We attribute the unexplained component to the announcement of TLTROIII. Based on the survey data, we estimate that the ex-ante probability of TLTROIII being introduced 93%, with the probability of the announcement taking place during the ECB's March meeting was 33%. We find that the announcement effect –versus a no-TLTRO baseline– underestimates the full impact of the introduction of TLTROIII by a factor of fifteen. After accounting for the forward guidance component, we estimate that the announcement effect on the Italian-German spreads peaked at the two-year maturity at around 8 basis points. The means that the full effect —versus no-TLTRO baseline– amounted to a tightening of 120 basis points at the two-year maturity. For the 5 and 10-year maturities, the announcement's full effect was smaller. The survey probabilities with regard to the decision's expected timing also allow for an estimate of the announcement's impact versus a different counterfactual baseline, the "no decision in March" baseline – details are provided in section 3 and 4.

In economic terms, we see that TLTROIII had a highly heterogeneous impact on euro area sovereign curves, whereby the impact on the German curve was negligible, while the impact on the Italian curve was significant. The Spanish sovereign curve also reacted to the announcement, albeit much less than its Italian counterpart. This may be explained by the relatively smaller liquidity shortfall in the "cliff-edge" scenario (see section 3).

At a higher level, our research indicates a promising avenue for policymakers to leverage surveys, building upon the established utilization of survey data by central banks. The ECB's Survey of Monetary Analysts (SMA) stands out for its incorporation of probabilistic survey questions, which are particularly useful for estimating probabilities related to events with binary outcomes, aligning with our event-study methodology. However, the utilization of surveys by policymakers may inadvertently leak information or lead to unintended interpretations by market participants. While monetary policy cannot be conducted in a laboratory setting where external conditions can be controlled, our methodology could be used as a one-shot "monetary policy experiment."

Literature Review

This paper connects to three bodies of literature. First, conceptually it is related to work in the area of the event study methodology. Within this domain, it is most closely related to more recent papers that attempt to account for the fact that event outcomes are typically partially priced in. Second, this paper connects to the literature on the market impact of monetary policy decisions. Third, it connects –albeit only tangentially– to the broader literature that assesses the impact of the ECB's longer-term refinancing operations on macro-economic variables and lending conditions.

The *event study methodology* (see Binder (1998) and Corrado (2011) for an overview) refers to a set of techniques that seeks to extract information from financial markets with regard to how various outcomes are priced, and was originally developed in the context of corporate events such as earnings announcements, stock splits or mergers and acquisitions. This paper is related to later developments that attempt to account for the fact that event-outcomes are typically partially anticipated, such as Malatesta and Thompson (1985), Warren-Boulton and Dalkir (2001) and Cai et al. (2011). More similar to our application, later work also expands to other types (non-corporate) of events such as election results (see Langer and Lemoine (2020); Wagner et al. (2018); Roberts (1990); Snowberg et al. (2011)), the outcomes of OPEC meetings (see Langer and Lemoine (2020)), wars (see Snowberg et al. (2009)), or the passing of (or failure to pass) legislation (see Borochin and Golec (2016)). Snowberg et al. (2011); Langer and Lemoine (2020) and Borochin and Golec (2016) are conceptually close to this paper, as they exploit the idea that pre-event prices may be seen as probability-weighted linear combinations of post-event prices. Instead of deriving market pricing for unobserved outcomes, Langer and Lemoine (2020) use option prices to "back out" the market-implied probabilities for the outcomes of the 2016 US elections as well as OPEC meetings – effectively using our methodology "in reverse". Borochin and Golec (2016) uses (daily) stock-option prices to determine the full stock value effect of the passage of Obamacare, more akin to our approach. Using option prices comes with the advantage that the option-implied probabilities are risk-neutral, and that state-contingent market prices can be deduced on an ex-ante basis. On the other hand, results may be model/parameter-dependent, and the approach relies on the availability of relevant (liquid) option contracts and pricing data. As an alternative to option-implied probabilities, Snowberg et al. (2011); Roberts (1990); Borochin and Golec (2016) consider/compare option-implied probabilities with betting odds and prediction markets.

Methodologically, the study of monetary policy decisions has the advantage that the time-window over which the market-reaction is measured is very short, compared to the above-mentioned cases. Intraday data for liquid assets is readily available for our application, and this allows for a relatively "clean" identification of the event's impact. Another advantage is that survey data is readily available, whereby the surveys were taken relatively shortly before the actual event.

The second body of literature to which this paper connects, in its application to the event study of the announcement of TLTROIII, is the literature that focuses on high-frequency financial-market surprises after monetary policy announcements. This literature attempts to evaluate the causal (observed, surprise) effect of policy decisions. Seminal work originates from before the Great Financial Crisis Gürkaynak et al. (2005a) and focuses on the identification of two different types of surprises: a current policy rate factor, and a future policy rate factor. In this paper, we refer to these two factors as the *target* and *forward guidance* (FG) factors. Later work attempts to identify separately a third factor that appeared with the introduction of the large post-2008 asset purchase programs Swanson (2011); Krishnamurthy and Vissing-Jorgensen (2011); Swanson (2016); Altavilla et al. (2019); Swanson (2021). We refer to this third type of monetary policy surprise as the *quantitative easing* (QE) factor. The above-mentioned papers use high-frequency data taken over a short window around monetary policy events, such that the impact of other news-flows on financial market variables is minimized. The monetary policy surprise affects financial markets, but given the short time-window, not the other way around. Rogers et al. (2014) uses a different approach to measuring euro area monetary policy surprises: rather than using risk-free rates, it uses intraday changes in the spread between Italian and German government bond yields. While we don't use the approach of Rogers et al. (2014), their approach underpins the relevance of Italian sovereign spreads in assessing the impact of euro area monetary policy surprises. Instead, we use the approach of Altavilla et al. (2019) to decompose the market reaction to the press release of the ECB's March 2019 monetary policy decision into the above-mentioned factors. We identify the impact of the TLTROIII announcements as the residual after "stripping off" the target, FG and QE-factors.

The third body of literature to which this paper connects concerns studies of the impact of various ECB longer-term refinancing operations, albeit only tangentially. Relevant studies investigate the impact of the TLTROs (I,II and III) as well as the preceding three-year Longer-Term Refinancing Operations ("VLTROs").[2] These papers are only tangentially related to our paper, as they focus on the impact of the TLTROs on macroeconomic variables (e.g. GDP) and credit supply, whereas our study focuses on the surprise effect of the announcement as measured through intraday market-data. The studies on the impact of the VLTROs on bank-lending and the real economy point to a net positive effect Darracq-Paries and Santis (2015); Casiraghi et al. (2016); Andrade et al. (2018); García-Posada and Marchetti (2016); Jasova et al. (2018), although some evidence suggests that part of the funds were used to purchase securities Acharya and Steffen (2015); Crosignani et al. (2019). For the TLTROs, positive effects on output and/or lending to non-financial corporations were also found Afonso and Sousa-Leite (2019); Laine (2019), as well as evidence for a decline in loan rates van Dijk and Dubovik (2018); Benetton and Fantino (2018) and interbank spreads Quint and Tristani (2017). The last paper —albeit very different in its methodology— is most closely connected to ours, as it takes a macrofinancial perspective whereby the TLTROs are seen as liquidity shocks. Their model results suggest that "in the absence of ECB liquidity injections interbank spreads would have been at least 200 basis points higher." Quint and Tristani (2017) does not distinguish the different euro area countries; our market-based analysis suggests that the impact is highly heteregenous accross countries.

2 Methodology

2.1 Conceptual Framework

In this subsection, we provide a derivation our conceptual framework. This conceptual framework is simple –it can be summarized in one formula (equation 6)– and rooted in basic asset pricing literature (e.g. see Cochrane (2009)). We will consider more practical implementation issues in section 3.

First, consider the price of an asset for which the payouts are contingent on a discrete set

[2] European Central Bank, "ECB announces measures to support bank lending and money market activity," Press Release, 8 December 2011.

of outcomes. In line with Cochrane (2009) we use $E(\cdot)$ to denote the expectation value of a variable with respect to the underlying real-world probability distribution, while $E^*(\cdot)$ is the expectation value with respect to the risk-neutral measure. For an asset with a state-contingent pay-out X_{t+1} at time $t+1$, and no intermediate cash flows, its price p_t at time t is given by

$$p_t = \frac{1}{R^f} E_t^* \left(X_{t+1} \right) \tag{1}$$

where R^f is the risk-free rate. Given a short enough time interval between time t and $t+1$, $R^f = 1$ is a good approximation.[3] Furthermore, we consider an asset for which the state-contingent "pay-out" only consists of the price-return on the asset itself, $X_{t+1} = p_{t+1}$ (i.e. no coupons or dividends). Now consider a discrete set of outcomes denoted by $\{s\}$, where π_s^* denotes the risk-neutral probabilities and p_t^s an asset's price under outcome s. For an event with bindary outcomes $s = 1, 2$ equation (1) now becomes

$$p_t = \pi_1^* p_{t+1}^1 + \pi_2^* p_{t+1}^2 \tag{2}$$

Subtracting p_t on both sides of the equation, and using the fact that $\pi_2^* = 1 - \pi_1^*$, we find

$$0 = \pi_1^* (p_{t+1}^1 - p_t) + (1 - \pi_1^*)(p_{t+1}^2 - p_t), \tag{3}$$

from where it can easily be seen that

$$(p_{t+1}^2 - p_t) = -\frac{\pi_1^*}{1 - \pi_1^*}(p_{t+1}^1 - p_t) \quad \text{or} \quad \Delta p_{t+1}^2 = -\frac{\pi_1^*}{1 - \pi_1^*} \Delta p_{t+1}^1. \tag{4}$$

When outcome $s = 1$ materializes, the price p_{t+1}^1 can be observed, and (when no other concurrent events occurred) the term $\Delta p_{t+1}^1 \equiv (p_{t+1}^1 - p_t)$ can be interpreted as the *announcement* or *surprise effect*. Equation (4) can also be used to obtain an expression for the *full effect* $\Delta p_{t+1}^{12} \equiv p_{t+1}^1 - p_{t+1}^2$ in terms of the observed *surprise effect* Δp_{t+1}^1:

$$\overbrace{\Delta p_{t+1}^{12}}^{\text{full effect}} = \frac{1}{1 - \pi_1^*} \overbrace{\Delta p_{t+1}^1}^{\text{surprise effect}} \tag{5}$$

Our analysis will focus on bond yields and swap rates. Expanding bond prices and working

[3] The surveys were taken a week prior to the policy announcement. The one-week overnight index swap (EONIA OIS) rate was -0.3635 percent as of 28 February, meaning that $R_f = 1 + O(10^{-4})$.

at linear order (neglecting $O(\Delta y^2)$ terms) equation (4) can be written as:[4]

$$\boxed{\overbrace{\Delta y^{12}_{t+1}}^{\text{full effect}} = \frac{1}{1-\pi^*_1}\overbrace{\Delta y^{1}_{t+1}}^{\text{surprise effect}}} \tag{6}$$

Equation (6) forms the basis for the methodology and its application in this paper. Once the surprise effect Δy^1_{t+1} is known, and if the risk-neutral probability π^*_1 can be estimated reliably, one can derive the full effect Δy^{12}_{t+1}.

Finally, in the specific application that we consider in this paper, we will work with the simplifying assumption that the risk-neutral probabilities are equal to the real-world probabilities: $\pi_s = \pi^*_s$. Risk-neutral probabilities are, in the general case, not necessarily equal to real-world probabilities. For equality to hold, the investor's utility function must be linear. In the general case (assuming a concave utility function), the risk-neutral probabilities for "bad outcomes" are larger than their real-world counterparts, and vice versa for "good outcomes".

In the case of TLTROIII however, we will argue that the risk-neutral probabilities do not deviate significantly from the real-world probabilities. For deviations in wealth or consumption w from some baseline level w_0, the Taylor expansion of the utility function u is given by

$$u(w) = u(w_0) + u'(w_0)(w-w_0) + \frac{1}{2}u''(w_0)(w-w_0)^2 + O\left((w-w_0)^3\right), \tag{7}$$

where u' and u'' denote the first and second derivatives of the utility function, respectively. The non-linear (higher order) contributions are relatively small if $u''(w_0))$ is small (indicating low curvature or concavity), and the range of w around w_0 is small. Under these conditions, the utility function exhibits approximate linearity. We will argue that this is the case in our application: the impact of the TLTROIII announcement on investor's total wealth is negligible, i.e. the total value of the market-weight portfolio only changes marginally, even in a "TLTRO excluded" scenario. We test the validity of the assumption of $\pi_s = \pi^*_s$ in section 5. Other methodological aspects related to the specific case of the announcement of TLTROIII are outlined in section 3.

[4]Bond prices can be expanded as $P(y_0 + \Delta y) = P(y_0) - D(y_0)P(y_0)\Delta y + O(\Delta y^2)$ where $D(y_0)$ is the bond's duration. Expanding equation (4) accordingly, one can check that terms involving $D(y_0)$, $P(y_0)$ cancel out at linear order in Δy.

3 Application: Event Study of the TLTROIII Announcement

3.1 The Third Series of Targeted Longer-Term Refinancing Operations

This section introduces the event to which the methodology of Section (2) is applied: the European Central Bank (ECB) Governing Council's decision to introduce a third series of targeted longer-term refinancing operations (TLTROIII).

During the global financial crisis and the subsequent European sovereign debt crisis, the ECB introduced a number of non-standard monetary policy measures. In addition to its asset purchase programmes, the ECB introduced a series of longer term loans to eligible banks. In 2014, a series of eight Targeted Longer-Term Refinancing Operations (TLTROs) was announced.[5] A unique feature of the TLTROs was their conditionality: banks needed to reach their bank-specific benchmark for (increased) lending to the real economy, which was enforced by means of a mandatory repayment mechanism. In 2016, a second series of Targeted Longer-Term Refinancing Operations (TLTRO-II) was announced,[6] with as unique feature that the operations' rates were conditional on banks' lending to the real economy.[7]

While the TLTROs were targeted, they were not sterilized and therefore also constituted a significant expansion of the monetary base. The repayment of these loans at maturity would therefore have resulted in a sharp decline in excess liquidity. The refinancing needs stemming from TLTROII redemptions, assessed here shortly before the announcement of TLTROIII, varied significantly between the euro area countries (see Figure 1). Figure (1) shows, by country, the outstanding amounts of TLTROII funding as of 1 March 2019, as well as their excess liquidity levels. On aggregate, sizable liquidity shortfalls can be seen for Italian banks, and to some extent, Spanish banks.[8] These statistics point to a substantial refinancing need in the absence of any follow-up operations (i.e. without TLTROIII).

On 07 March 2019, a third series of quarterly two-year Targeted Longer-Term Refinancing Operations (TLTROIII) was announced, with its first allotment starting in September 2019, and last allotment in March 2021, each with a maturity of two years (European Central Bank, 7 March 2019). This paper focuses on the market reaction to this announcement.[9]

[5]European Central Bank, "ECB announces monetary policy measures to enhance the functioning of the monetary policy transmission mechanism," Press Release, 5 June 2014.

[6]European Central Bank, "ECB announces new series of targeted longer-term refinancing operations (TLTRO II)," Press Release, 10 March 2016.

[7]European Central Bank, "Decision (EU) 2016/810 Of The European Central Bank," 2016.

[8]Outstanding amounts under TLTROII also surpassed Portugal's and Greece's excess liquidity levels.

[9]It should be noted that the modalities of TLTROIII were later adjusted in response to the continued shortfall of

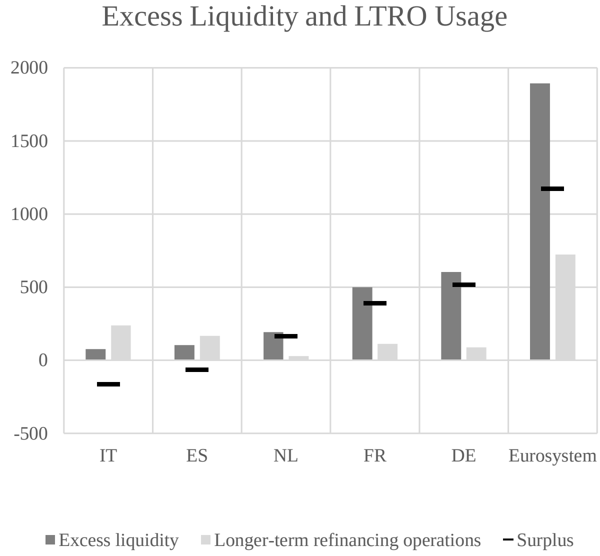

Figure 1: Excess liquidity and outstanding amounts of TLTROII, based on the *Disaggregated financial statement of the Eurosystem* of 01-03-2019

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3.2 To TLTROIII or not to TLTROIII: the decision tree

With the prospect of the potential "cliff effect" at the end of TLTROII, market participants speculated on the possibility of the introduction of a third series of Targeted Longer-Term Refinancing Operations, TLTROIII, as the maturity dates of TLTROII tranches approached. Early in 2019, TLTROIII was broadly anticipated, but uncertainty remained.

In this paper, we model the ECB's course of action as having two discrete outcomes: the introduction (y/n) of TLTROIII. In addition, there is a timing component: market participants expected a decision in the March, April or June meeting. Viewing the outcome space as effectively binary is a simplification, based on the idea that the provision of (medium-term) liquidity was more important, in the eyes of market participants, than the programme's exact details.[10]

Pre-event surveys provide us with two real-world probability estimates, that can be used to extract the full effect of the TLTROIII announcement vis-a-vis two different baselines. The

inflation with respect to the ECB's aim. First, the maturity of the operations was extended to three years; second, the 10 basis point spread of the operations' rates with respectively the MRO and DF rates was removed; and third, a voluntary repayment option after two years was (re-)introduced. See European Central Bank (2019), "Monetary policy decisions," Press Release, 12 September 2019, and European Central Bank (2019), "ECB announces changes to new targeted longer-term refinancing operations (TLTRO III)," Press Release, 12 September 2019.

[10]The implementation of a TLTROIII programme could have had various different parameters (i.e. interest rate, amount, length, conditionality, et cetera).

these probability estimates are based on the survey questions:[11]

- *"Will the ECB launch a new targeted long-term refinancing operation (TLTRO) in 2019?"*
- *"If you expect new long-term loans, when do you expect the ECB to announce and allot the first ones?"*

Based on the answers to these two questions, we can derive estimates for the following real-world probabilities:

(A) *the probability of TLTROIII being introduced at the March meeting* ($\pi^{\text{TLTROIII}}_{\text{March}}$).

(B) *the probability of TLTROIII being introduced at some point* (π^{TLTROIII}).

We use these two probability estimates to establish the full effect of the announcement of TLTROIII vis-a-vis two different, unobserved, baselines. The unobserved baseline associated with (A) is the combination of either *the explicit exclusion of TLTROIII at the March meeting* or *the postponement of the decision*. Together, we will refer to this baseline as "no TLTROIII in March." The unobserved baseline associated with (B) *exclusion* of a TLTROIII programme *at some point of time*, i.e. at the March meeting or at one of the later meetings. We will refer to this baseline as "TLTROIII excluded."

The first probability (A) is used to obtain an estimate of the full impact of the TLTROIII announcement versus the "no TLTROIII in March" baseline. The second probability (B) can be used to obtain an estimate of the full impact of the TLTROIII announcement versus the "TLTROIII excluded" baseline. This paper thus derives estimates of the full impact of the announcement of TLTROIII vis-a-vis two different baselines. Our focus is on baseline B.

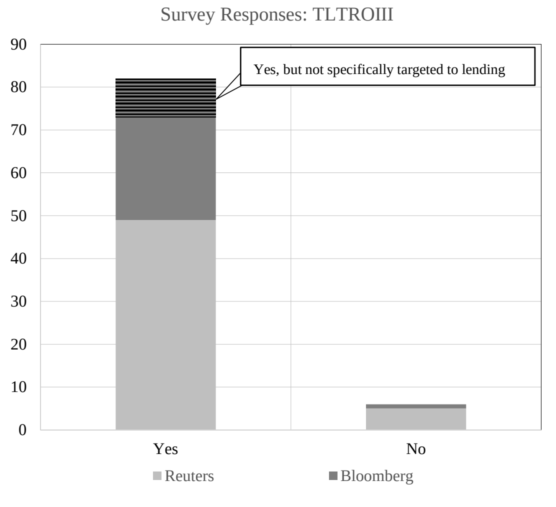
Table 1 outlines the two configurations that are considered in this paper in its application of Equation 6.

[11] See Appendix A for more details. The surveys from Bloomberg L.P. and Thomson Reuters Eikon use slightly different formulations.

Table 1: Description of analyses: definition of observed and unobserved outcomes

	(A) No TLTROIII in March	**(B) TLTROIII Excluded**
Unobserved outcome *(baseline)*	The TLTROIII decision is postponed at the March meeting, or explicitly excluded.*	TLTROIII is explicitly excluded (at any of the monetary policy meetings).**
Observed outcome	TLTROIII is announced at the March meeting	TLTROIII is announced
Implied Probabilities*** *(survey based)*	$\pi^{\text{TLTROIII}}_{\text{March}} = 0.3306$ $\pi^{\text{No TLTROIII}}_{\text{March}} = 0.6694$	$\pi^{\text{TLTROIII}} = 0.9318$ $\pi^{\text{TLTROIII Excluded}} = 0.0682$
Full effect (Eq. 5)*** *(versus baseline)*	$\Delta y^{\text{baseline A}}_{\text{full effect}} = 1.49 \cdot \Delta y_{\text{surprise effect}}$	$\Delta y^{\text{baseline B}}_{\text{full effect}} = 14.66 \cdot \Delta y_{\text{surprise effect}}$
Assumptions *(on decision tree)*	The outcome space can be seen as having two distinct types of outcomes (TLTROIII/no-TLTROIII), i.e. the specifics such as the loan conditions do not meaningfully affect the market reaction.	Same as **(A)**, plus: full effect of TLTROIII does not depend on the decision's timing.

*Although TLTROIII could theoretically have been excluded at the March meeting, this was considered unlikely by market participants, as the ECB was expected to at least keep the optionality to introduce TLTROIII at a later point on the basis of additional information. In other words, analysis (A) effectively captures the impact of announcing TLTROIII versus postponing the decision.
**TLTROIII excluded, or simply not introduced before the TLTROII "cliff".
***For illustration, the Table shows the point estimates of the probabilities based on survey results; in Section 5 we derive confidence intervals for these estimates.



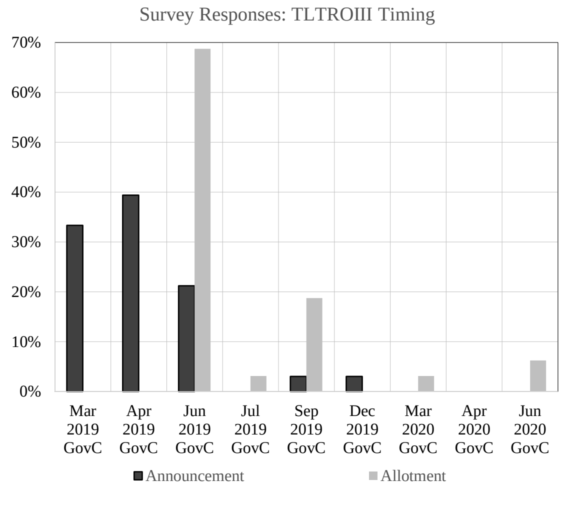
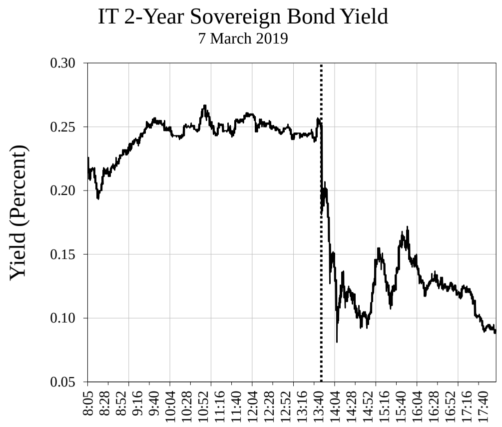


Figure 2: Reuters: "Will the ECB launch a new targeted long-term refinancing operation (TLTRO) in 2019?" Bloomberg: "TLTROs will expire between June 2020 and March 2021. How do you expect the ECB will deal with that?" Possible answers: 1) The ECB will offer new targeted long-term loans , 2) The ECB will offer new long-term loans not specifically targeted to lending, or 3) The ECB won't offer new long-term loans. Bloomberg also asked: "If you expect new long-term loans, when do you expect the ECB to announce and allot the first ones?"
Sources: Bloomberg L.P. and Thomson Reuters Eikon, 1 March 2019.

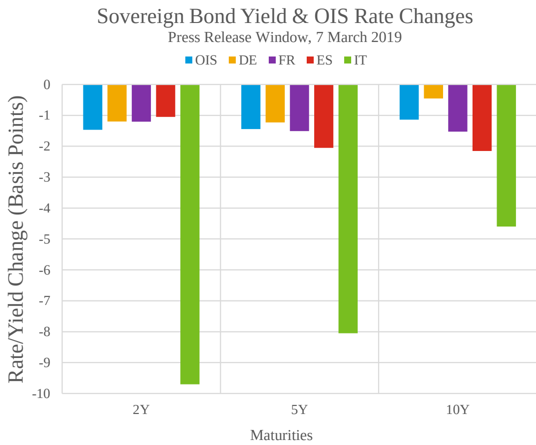
3.3 The Monetary Policy Press Release of 7 March 2019

The focus of this paper is on the announcement of TLTROIII: the press release at 13:45 CET was followed directly by a repricing in sovereign bond yields (Figures 3a and 3b). Most price action occurred for Italian sovereign bond yields: in terms of yields, the largest tightening was seen at the two-year maturity (-9.6 basis points), while in terms of bond prices, the most significant correction took place at the ten-year maturity (-4.4%). Mild spread-tightening (versus German government bond yields) was also seen for Spanish government bonds, at the five and ten-year maturities.

The monetary policy decisions of 7 March 2019 also came with an adjustment of the ECB's forward guidance.[12] Our focus is exclusively on the impact of the TLTROIII announcement, and the next subsection discusses how to disentangle the contributions of these different factors to the observed market reaction.



(a) Intraday two-year Italian government bond yield.



(b) Change of sovereign yields and overnight indexed swap rates, press release window.

Figure 3

3.4 Isolating the TLTROIII Announcement Effect

This paper focuses on the impact of the announcement of TLTROIII. Unfortunately, monetary policy decisions almost always come in a package, i.e. as a combination of decisions. Even choosing not to make a decision is, in itself, a decision, and it can influence the market if it

[12]The monatery policy decisions of January 2019 contained a sentence: "The Governing Council expects the key ECB interest rates to remain at their present levels at least through the summer of 2019, and in any case for as long as necessary to ensure the continued sustained convergence of inflation to levels that are below, but close to, 2% over the medium term." In the monetary policy decisions of 7 March, the phrase "at least through the summer of 2019" was replaced by "at least through the end of 2019."

contrasts with prior expectations. This poses the challenge of separating out the market reaction to the different aspects of the announced monetary policy package. Notably, the monetary policy decisions of 7 March 2019 also contained a tweak of the ECB's forward guidance, besides the announcement of TLTROIII.

We use the methodology of Swanson (2021) and Altavilla et al. (2019) to "strip off" the contribution of standard monetary policy factors from the observed market reaction. Specifically, on a dataset of the high-frequency market reactions to ECB monetary policy press releases (see Appendix A), we identify three factors that can be interpreted as the "target", "forward guidance" and "quantitative easing" factors. The residuals, reflecting the part of the market reaction that cannot be explained by those three factors, are interpreted as the market impact of the announcement of TLTROIII.

In this analysis, we first identify the impact of the TLTROIII on the risk-free curve. Secondly, we use the identified factor loadings to estimate the impact of the TLTROIII on sovereign spreads.

Risk free curve

Consider RF as the $N \times M$ matrix of risk-free interest rate changes during the press-release time-window, over N events and measured at $M = 7$ different maturities. The columns represent the 1, 3, 6-month and 1-year OIS rates and the 2, 5 and 10-year German government bond yields, in line with Altavilla et al. (2019).[13] Following Swanson (2021) and Altavilla et al. (2019), we consider a factor model of the form

$$RF = \tilde{F}\Lambda + \epsilon, \tag{8}$$

where $\tilde{F}_t$ is a vector of $q \leqslant M$ latent factors and Λ is a $q \times q$ matrix. We identify three factors using the rank test of Cragg and Donald (1997) (see Appendix B). It is worth noting that Altavilla et al. (2019) only finds 1 significant factor in the press release window. Their result is not in contradiction with ours (Table 4), as we have a longer time-series that allows us to identify the other two factors. A rotation of the first three principle components, following Swanson (2021) and Altavilla et al. (2019), then allows an interpretation in terms of "target", "forward guidance factor" and "quantitative easing" factors.

We identify the impact of the TLTROIII on the risk-free rate curve as the residuals in

[13] The German government bond yields were used to model the longer tenors of the risk-free curve, as high-frequency OIS data were not available for the whole sample at those tenors.

Equation (8) on the 7th of March 2019, i.e. $RF^{\text{TLTRO}} = \epsilon_{07/03/2019}$. Figure 4 shows the decomposition of the market reaction during the press release of the monetary policy decisions of 7 March 2019. The shift in the risk-free curve can largely be explained by the forward guidance factor. Figure 5 shows confidence intervals for the residuals, based on a bootstrap approach whereby the events in the database are sampled (10000x) with replacement.[14] The residual is not significant, with the exception of the 3-month maturity; nonetheless, at 0.4 basis points, this is not economically significant. It should be noted that –arguably– the economic significance of the shift in the risk-free curve was small, peaking at around −1.5 basis points at the 2 and 5-year maturities. More significant price action occurred on the side of sovereign spreads, which is the focus of the discussion below.

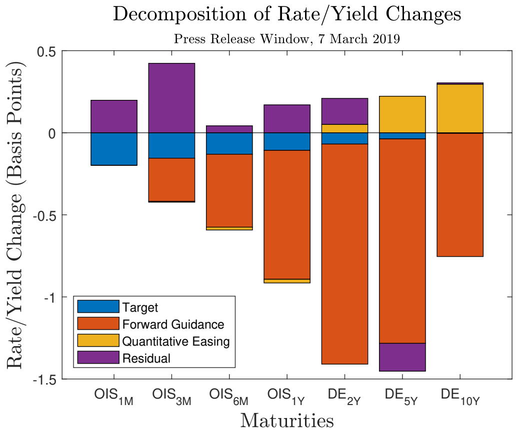


Figure 4: Decomposition of interest rate changes during the monetary policy press release window on 7 March 2019.

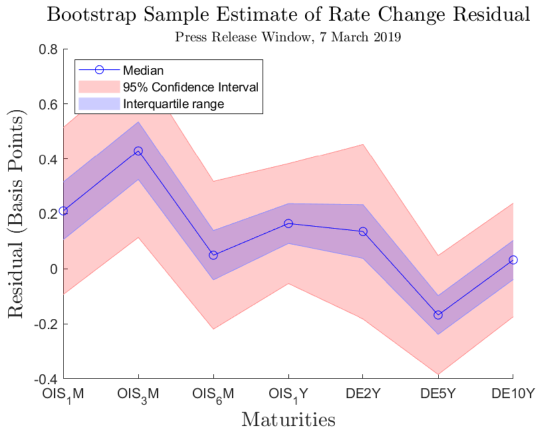


Figure 5: Residuals of interest rate changes with confidence intervals, based on a bootstrap sample ($n = 10000$).

3.4.1 Spreads

The shift in risk-free rates can largely be explained by the the forward guidance factor; but below, we will show that the tightening in Italian spreads can only partially be explained by the three identified factors (Target, FG and QE). Similar to the risk-free curve, we identify the unexplained residual of the spread-tightening as driven by the TLTROIII announcement. Throughout this paper, "spreads" refer to the yield differential versus the comparable maturity German government bond.

In line with Swanson (2021), we assume that the identified factor (see Equation 8) also drive

[14]The bootstrap procedure is explained in more detail in section 5.

a change in spreads. We estimate the relationship between the three monetary policy factors and sovereign spreads by regressing spreads on the factors loadings. Let Spread^i be the $N \times m$ matrix of spreads where $i \in \{\text{IT}, \text{ES}, \text{FR}\}$ labels the individual countries, and the $m = 3$ columns reflect the three maturities $\{2\text{Y}, 5\text{Y}, 10\text{Y}\}$. We estimate the regression:[15]

$$\text{Spread}^i = b^i F + \epsilon^i. \tag{9}$$

As for the risk free-curve, we identify the impact of the announcement of TLTROIII on spreads as the residuals $\text{Spread}^i_{\text{TLTROIII}} = \epsilon^i_{07/03/2019}$. Figure 6 shows the resulting decomposition of the spread-widening for Italian government bonds, as observed during the press release window on 7 March 2019. A bootstrap estimate provides a confidence interval for the residual, which is shown to be significant.[16] In other words, a significant part of the spread-widening for Italian government bonds cannot be explained by the regular (Target, FG, QE) monetary policy factors.

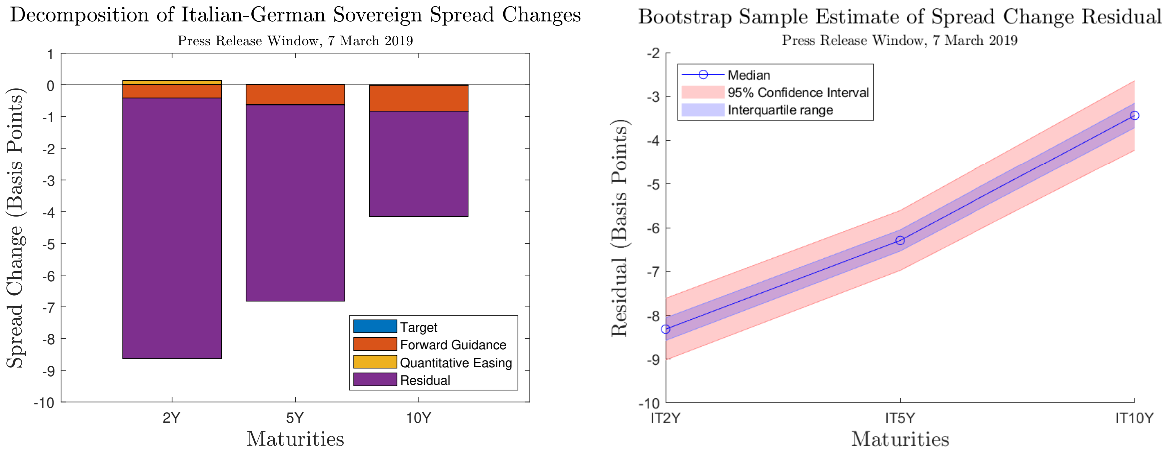


Figure 6: Decomposition of rate/yield and spread changes during the monetary policy press release window on 7 March 2019.

4 Results

This section presents the results of our analysis. To summarize our methodology, we apply equation 6, using the survey-based probabilities from section 3.2 and for the yield-impact $\Delta y^{\text{TLTROIII}}$, we use the residuals from the factor-decomposition in section 3.4.1. Our focus is on sovereign

[15] We do not include a constant on the basis of an economic argument; conceptually we do not allow for a consistent and perpetual positive or negative spread-impact that would be independent of the specific policy decisions.

[16] The bootstrap procedure is explained in more detail in section 5.

spreads, and in particular on the Italian and Spanish spreads versus the German sovereign curve.

Figure 7 illustrates the point estimates of the market impact for the three outcomes: the realized scenario of the TLTROIII announcement on March 7, and the “no TLTROIII in March” (baseline A) and “TLTROIII excluded” (baseline B) outcomes described in section 3.2. Figure 7 shows the results for the Italian and Spanish spreads, respectively. The estimated *full effect* of the TLTROIII announcement, versus the two different baselines, is provided in the most-left column of table 2. The second and third columns contain confidence intervals for the point-estimates. The confidence intervals are based on a bootstrap-approach that is explained in section 5.

The results suggest that the “no TLTROIII in March” baseline (A) would have led to limited spread-widening for both Italy and Spain (Figure 7). This is consistent with the idea that only a minority of survey respondents expected that TLTROIII would already be announced in the April meeting. In other words, postponement of the decision would not have been a major surprise.

The “TLTROIII excluded” baseline (B) however, would likely have led to significant spread-widening; especially for Italy.

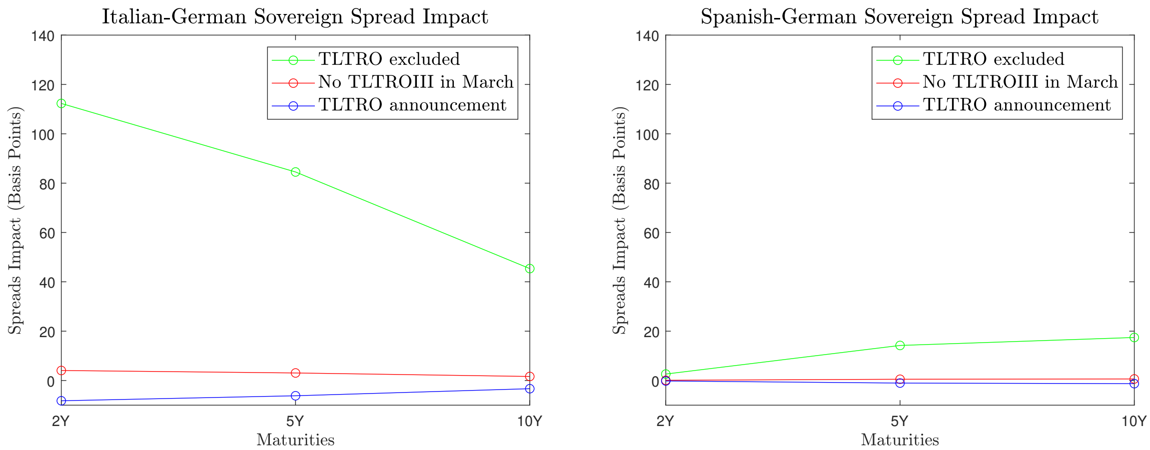


Figure 7: Point estimates for the market impact of the various outcomes.

		Total Impact vs. Baseline (A) Baseline (A): No TLTROIII in March			**Total Impact vs. Baseline (B)** Baseline (B): TLTROIII excluded		
		estimate	*95% confidence interval*		*estimate*	*95% confidence interval*	
			p fixed	p not fixed		p fixed	p not fixed
IT	2Y	-12.3	(-13.5,-11.2)	(-16.6,-9.9)	-120.5	(-132.4,-109.9)	(-380.0,-66.7)
	5Y	-9.2	(-10.4,-8.2)	(-12.6,-7.4)	-90.7	(-102.5,-81.0)	(-290.4,-50.1)
	10Y	-5.0	(-6.3,-3.7)	(-7.3,-3.5)	-48.7	(-62.0,-36.7)	(-166.7,-25.7)
ES	2Y	-0.3	(-0.9,0.3)	(-1.0,0.3)	-2.8	(-9.2,3.3)	(-15.8,4.1)
	5Y	-1.6	(-2.1,-1.0)	(-2.4,-1.0)	-15.3	(-20.9,-10.1)	(-52.9,-7.4)
	10Y	-1.9	(-2.8,-1.3)	(-3.1,-1.2)	-18.7	(-27.4,-12.7)	(-68.1,-9.3)

Table 2: Estimates of the total impact of the TLTROIII announcement on sovereign spreads, versus baselines (A) and (B) respectively (in basis points).

5 Robustness

In this section we test the most important assumptions that were made in the application of our methodology to the case of TLTROIII. Our methodology relies on an algebraic equation (Equation 5); therefore, the uncertainty in our estimates stems from the ability to "measure" or estimate the quantities on the right-hand-side of that equation:

1. $\Delta p_{\text{TLTROIII}}$ *The surprise effect of the TLTROIII announcement.* The monetary policy announcement of the April 2019 meeting also contained information w.r.t. other monetary policy factors, notably a tweak of the ECB's forward guidance. Our methodology to "isolate" the TLTROIII announcement effect from other monetary policy factors, described in section 3.4, introduces uncertainty.

2. π^*_{TLTROIII} *The risk-neutral probability.* The risk-neutral probability is in turn determined here on the basis of the estimates of a) the real-world probability and b) the difference between the risk-neutral and real-world probabilities.

   (a) π_{TLTROIII} *The real-world probability.* We consider survey-implied probabilities by taking the mean of the survey responses. However, a different selection of the survey panel of economists could have yielded a different result - some randomness is at play.

   (b) m_{TLTROIII} *The difference between the real-world and risk-neutral probabilities, through the stochastic discount factor* m_{TLTROIII}. We assume that the difference between real-world and risk-neutral probabilities is small - negligible. Deviations from this assumption introduce uncertainty in our estimates.

In this section we will assess our estimates' confidence intervals and the uncertainty stemming from each of these individual three sources. We will also aggregate the uncertainty stemming from the above-mentioned components 1. and 2. to obtain a confidence interval for our key results.[17]

5.1 Disentangling the impact of the TLTROIII announcement

In section 3.4 we single out the contribution of the TLTROIII announcement to the market reaction to the press release of 7 March 2019 by "stripping off" the contributions stemming from the target, forward guidance and quantitative easing factors. For the sovereign spreads, our key variables of interest, both equation 8 as well as equation 9 introduce uncertainty in our estimates.

We use a bootstrap approach and sample, with replacement, from the monetary policy events in our dataset. The number of events in each sample is held constant – and equal to the length of the original sample. The number of pre- and post-QE samples is also held fixed (the distintion between pre- and post-QE events is relevant for the factor identification), and obviously the March 2019 datapoint is kept apart and included in each sample.

The resulting estimates provide the confidence intervals shown in Figure 8, as well as in the second column of Table 2. Note that at this point, we consider point estimates for the risk-neutral probabilities based on the survey-mean.

The bootstrap-based 95% confidence intervals reveal that the impact of TLTROIII on the Spanish spreads is not significant at the two-year maturity point.

[17]Here we assume that the obtained distributions for our estimates of 1. and 2. are independent.

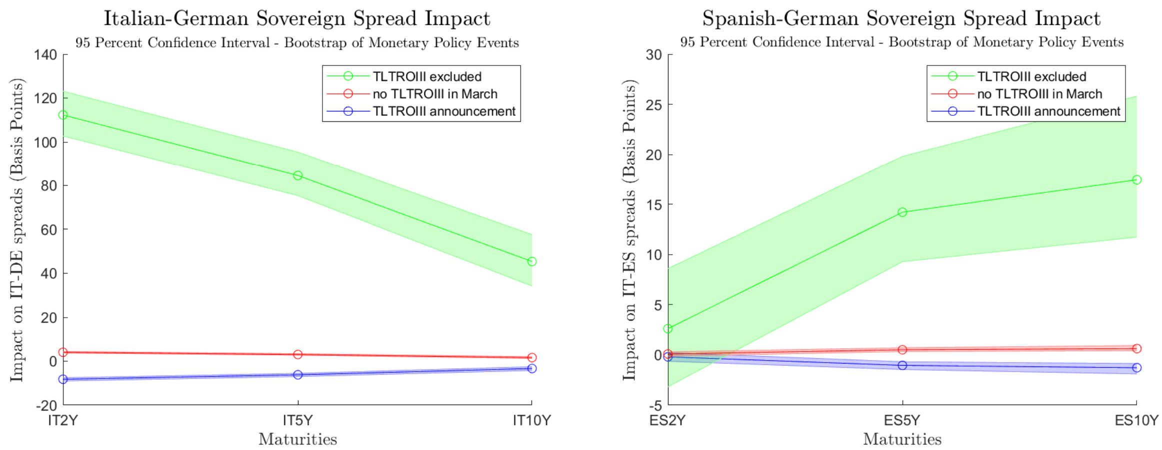


Figure 8: Bootstrap analysis of the counterfactual impacts based on 10000 draws of the survey results, and 10000 draws from the monetary events. Shaded areas reflect the 95% confidence intervals.

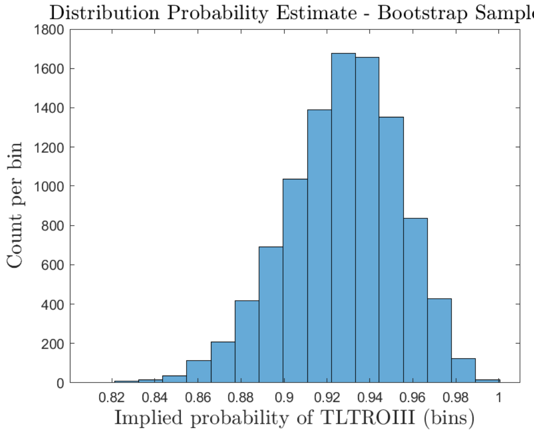
5.2 Probability Estimates

Turning to the second important source of uncertainty in our estimates, we need to assess a) the use of survey data to estimate real-world probabilities, and b) deviations between the risk-neutral and real-world probabilities. The largest source of uncertainty in our approach comes from this probability estimate, and as we will show, mostly from the first-mentioned step (a). Equation 5 is non-linear in π_1, and the term in brackets diverges as $\pi_1 \to 1$. Due to the non-linear nature of the factor $(1 - \pi^*)^{-1}$, the impact of uncertainty in our estimate of π^* on our results is also asymmetric. Small upward deviations from our survey-based estimate of π_1 drive relatively large deviations in our result under baseline B (see Table 1).

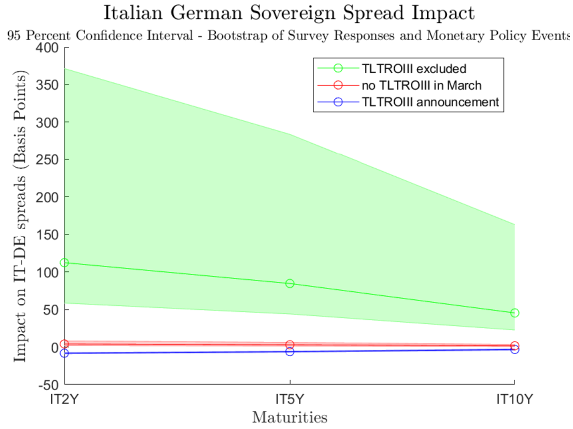
Figure 9a illustrates the uncertainty in our estimate for π^{TLTROIII} (see Section 3.2), based on a bootstrap approach where we draw, with replacement, from the survey respondents, while maintaining the sample size.[18] In order to determine the uncertainty around our estimate of $\pi^{\text{TLTROIII}}_{\text{March}}$, we also sample from the survey responses to the question about the expected timing of TLTROIII.

Figure 9b shows, for the Italian spreads, the combined uncertainty stemming from the factor analysis (see Subsection 5.1 above) and the probability estimates, assuming independence of the distributions. As mentioned before, the confidence interval around the "TLTROIII excluded" scenario is largest and asymmetric, due the divergence of $(1 - \pi)^{-1}$ as $\pi \to 1$.

[18] A closed-form expression also exists.



(a) Distribution of our estimate for π^{TLTROIII}, based on a the bootstrap sample of the survey respondents.



(b) Uncertainty around our estimates for the impact of the various scenarios on Italian spreads, based on a bootstrap approach. Shaded areas indicate 95% confidence intervals.

Figure 9

5.3 Real-World vs. Risk-Neutral Probabilities

In our application of the methodology outlined in section 2 to the TLTROIII announcement, we have worked under the assumption that the real-world probabilities π_s closely approximate the risk-neutral probabilities π_s^*. In this subsection we revisit that assumption.

In line with Cochrane (2009) we use $E(\cdot)$ to denote the expectation value of a variable with respect to the underlying real-world probability distribution, while $E^*(\cdot)$ is the expectation value with respect to the risk-neutral measure. For an asset with a state-contingent pay-out X_{t+1} at time $t+1$, and no intermediate cash flows, its price p_t at time t is given by

$$p_t = E_t\left(m_{t+1}X_{t+1}\right) \tag{10}$$

$$= \frac{1}{R^f}E_t^*\left(X_{t+1}\right) \tag{11}$$

where m_{t+1} is the stochastic discount factor

$$m_{t+1} = \beta\frac{u'(c_{t+1})}{u'(c_t)}, \tag{12}$$

and R^f is the risk-free rate given by $R^f \equiv 1/E^*(m)$. u denotes the utility function, and u' its first derivative. Now consider a discrete set of outcomes denoted by $\{s\}$. The risk-neutral probabilities π_s^* are related to the real-world probabilities π_s by

$$\pi_s^* = \pi_s m_{t+1}^s R^f. \tag{13}$$

Our premise that real-world probabilities closely align with risk-neutral probabilities is grounded in two underlying assumptions:

1. $R_f \approx \beta \approx 1$. This assumption is based on the fact that the time-interval between the survey and the policy decisions was short (recall, in our case we have $R_f = 1 + O(10^{-4})$).
2. u is approximately linear. Here, we relied on the observation that the assets sensitive to the TLTROIII decision only make up for a small proportion of the prototypical investor's wealth, suggesting that the utility function may be approximately linear in the range of interest.

If these conditions are satisfied, we find that equation 13 simplifies to $\pi_s^* \approx \pi_s$.

Below, we radically deviate from the second assumption by considering a concentrated "TLTROIII portfolio" in combination with a concave utility function, and assess how robust our results are under this variation. We will continue to assume that $R_f\beta \approx 1$. We will proceed with the —-perhaps extreme-— case of an investor who, for its consumption in period $t + 1$, solely depends on its investment returns (i.e. does not have other sources of income in period $t + 1$). As mentioned, its investment is entirely allocated to the "TLTROIII portfolio," which has a 100% allocation to the asset that showed the largest market reaction after the TLTROIII announcement: the ten-year Italian government bond. Third, we will assume that the investor has a logarithmic utility function: the logarithmic utility function, represented as $u(c) = \log(c)$, is a classic example of a concave utility function used to model risk-averse behavior. This setup provides us with what can be seen as an upper bound for the deviation between risk-neutral and real-world probabilities.

Tables 3 shows the deviations between the real-world and risk-neutral probabilities, with the latter being based on the logarithmic utility function. These deviations are small compared to the uncertainty stemming from the use of survey results for our probability estimates (see Subsection 5.2). Note, the risk-neutral probability for the "positive" outcome (TLTROIII introduced) is smaller than the corresponding real-world probability, in line with asset pricing theory.

In principle, one could consider a utility function that is (even) more concave, but the fact remains that "TLTROIII sensitive assets" make up for a small part of the market portfolio. Recall: in the above-mentioned example, we considered the "TLTROIII portfolio" which is concentrated in the ten-year Italian government bond.

Table 3: Risk-neutral probabilities under linear and logarithmic utility function assumptions

π^*	linear utility ($\pi^* = \pi$)	logarithmic utility, "TLTRO portfolio"	deviation from main result
TLTROIII in March or later	0.9318	0.9287	-0.33 %
TLTROIII not excluded in March	0.3306	0.3296	-0.33 %
$(1-\pi^*)^{-1}$	linear utility ($\pi^* = \pi$)	logarithmic utility, "TLTRO portfolio"	deviation from main result
TLTROIII in March or later	14.66	14.03	-4.35 %
TLTROIII not excluded in March	1.4939	1.4916	-0.15 %

5.4 Other sources of uncertainty

In our analysis we make a number of simplifying assumptions that cannot be tested analytically. Most notably, we simplify the TLTROIII "decision tree" by treating it as having two distinct outcomes (see Table 1), albeit in two different configurations (A and B). However, the outcome space is not binary; for example, the market reaction to the announcement could partially have been driven by the operation's features and conditions. Nonetheless, there are compelling arguments that support treating the event as binary. First, very few details were given in the announcement ("Further details on the precise terms of TLTROIII will be communicated in due course."). The maturity of the operations (two years) was given, as well as the date for the first allotment. The statement mentioned that the rate for the operations would be linked to the interest rate on the main refinancing operations and the deposit facility rate, but did not disclose a spread. Second, the maturity of the operations was in line with market participants' expectations.[19] A third argument suggests that more detailed conditions, like pricing terms, might not have been pivotal for the announcement's influence on sovereign yields through the liquidity channel; though such terms could have been more significant for bank-specific aspects such as profitability.

[19] Market reports considered the two-year maturity as the base case, with a three year maturity as an unlikely but possible alternative.

6 Conclusions and Discussion

In this paper we derive the full effect of an event based on its observed surprise effect, as seen through the lens of financial markets. We applied a simple concept derived from basic asset pricing theory (equation 5), and leveraged survey data to obtain knowledge about the event's anticipated probabilities prior to its occurrence. We applied this methodology to the case of the ECB's announcement of TLTROIII. Based on this exercise, we have 1) drawn conclusions about the full effect of the TLTROIII announcement, and 2) gained insights into the effectiveness and applicability of our methodology.

6.1 Event Study Conclusions

Our analysis suggests that the announcement of TLTROIII did not significantly move the risk-free curve. Instead, the lion-share of the shift of the risk-free curve after the March 2019 monetary policy press release can be explained by the adjustment of the ECB's forward guidance.

The price action in sovereign spreads cannot fully be explained by standard monetary policy factors - the target, forward guidance, and quantitative easing factors. This suggests that the spread-tightening versus the German sovereign curve, most pronounced for Italian government bonds, was driven by the TLTROIII announcement.

Leveraging survey-implied probabilities, we find estimates for the full effect of the introduction of TLTROIII. For the announcement's full effect versus the "TLTROIII excluded" baseline, we estimated a considerable impact for the Italian sovereign spreads, peaking at 120 basis points at the two-year maturity. The impact on Spanish spreads is more limited, peaking at the 10-year maturity at 19 basis points.

An important conclusion is therefore that the TLTROIII announcement has had a strongly heterogeneous impact on euro area jurisdictions, whereby Italian spreads have been particularly sensitive. While Spanish banks would also have faced a liquidity shortfall (outstanding TLTROIIs > excess liquidity) in the absence of TLTROIII, Spanish sovereign spreads appear to be much less sensitive than their Italian counterparts. Possible explanations for the observed sensitivity of Italian spreads may stem from a stronger bank-sovereign nexus, differences in the overall health of the banking sector, or simply by virtue of the fact that the liquidity shortfall was larger for Italian banks.

6.2 Lessons on the use of survey-data by policy makers

From a conceptual point of view, our study opens an interesting avenue for the use of surveys by policy makers. Central banks already make extensive use of survey data for the purpose of measuring bank lending conditions [20] and consumer expectations [21]. Surveys are also used by central banks to gauge expectations of forecasters and analysts.[22] The ECB's Survey of Monetary Analysts (SMA) is particularly interesting, as it could be used in the context of our event-study methodology. An interesting feature of this survey is its use of probabilistic survey questions; the ECB explains that the survey "makes use of probabilistic questions to elicit the likelihood that respondents assign to different future events. This type of question is particularly suitable where there is a bimodality of expectations." Probabilistic survey questions can provide a better estimate of the probabilities for the type of events to which our methodology may be applied: events with a binary outcome. At the same time, policy makers' use of surveys may lead to information leakage, and/or unintended interpretation of survey questions by market participants. The ECB conducts the SMA eight times per year; this corresponds with the monetary policy meeting cycle of Governing Council meetings, whereby the response-window closes two weeks before the policy meeting. While monetary policy cannot be conducted in a laboratory setting where external conditions can be controlled, our methodology could be used as a one-shot "monetary policy experiment."

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[20] For example, see the Euro area bank lending survey.
[21] For example, see the ECB's Consumer Expectations Survey
[22] For example, see the ECB's Survey of Professional Forecasters and the Survey of Monetary Analysts.

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A Data

Market Data

High-frequency market date comes from the Euro Area Monetary Policy event study Database (EA-MPD) presented in Altavilla et al. (2019). The dataset is constructed using minute frequency data. The pre-press-release quote is defined as the median price in the 13:25-13:35 interval, the post-press-release quote is defined as the median price in the 14:00-14:15 interval, the pre-conference quote is defined as the median price in the 14:15-14:25 interval and the post-conference quote is the median price in the 15:40-15:50 interval. Using this data, three monetary policy windows are defined: the *press-release time window* is the yield change between the post and pre press-release quotes, the *press-conference time window* is the yield change between the post and pre press-conference quotes and the *monetary policy event window*, that includes the two other events, is measured as the difference between the pre-press-release and post-conference quotes. Variables covered include overnight indexed swap rates, sovereign bond yields for Germany, France, Spain and Italy, as well as some exchange rates (EURUSD, EURGBP, EURJPY) and the EURO STOXX 50 equity Index and its banking sector sub-index.

Survey Data

Survey data comes from two surveys conducted by Bloomberg L.P. and Thomson Reuters Refinitiv.

The Reuters poll was conducted between 22-28 February 2019 among 92 economists, and was released on 28 February 2019. The relevant question used in this paper was formulated as follows:

- *"Will the ECB launch a new targeted long-term refinancing operation (TLTRO) in 2019?"*

The Bloomberg survey was conducted between 21-26 February with a response count of 34 (33), and was released 1 March 2019. Two of its questions were used in this paper:

- 4.1) *"TLTROs will expire between June 2020 and March 2021. How do you expect the ECB will deal with that?"*

  1. *The ECB will offer new targeted long-term loans*
  2. *The ECB will offer new long-term loans not specifically targeted to lending*

3. *The ECB won't offer new long-term loans*

- 4.2) *"If you expect new long-term loans, when do you expect the ECB to announce and allot the first ones?"*

B Monetary Policy Events Factor Analysis

In section 3 we apply the methodology of Gürkaynak et al. (2005b); Swanson (2021); Altavilla et al. (2019) in order to identify three monetary policy factors (target, FG, and QE), and use these to determine the residual market reaction on 7 March 2019. Here, we provide some additional details.

While Altavilla et al. (2019) finds only one factor for the press release window, we identify three. In particular, the Wald the test shows that there is one latent variable before introduction of asset purchase programmes, and three if we consider the whole period. The results of this rank test are summarized in table 4.

The factors are extracted initially using a Principal Component Analysis and projecting the series RF on the eigenvectors with the highest eigenvalues. In a second step, we rotate the factors using the methodology introduced in Swanson (2021) to interpret them as target, forward guidance and QE factors. The orthogonal rotation is constructed such that shorter maturity movements are influenced by the target factor only. The remaining two-dimensional space is decomposed into a QE and a FG factor. The variance of the QE factor is minimised before the introduction of QE. The FG factor is orthogonal to the QE factor.

We use press-release window data from the 2nd of January 2002 to the 1st of October 2021. Figure 10 shows the factors and their loadings. As expected, the target factor is dominant in the shorter maturities and vanishes for longer maturities. The FG peaks for at the two-year maturity and falls off at longer tenors, while the QE factor is dominant for the longer maturities.

Rank dimension	Pre-QE	Full period
$k = 0$	69.847	62.066
	(0.000)	(0.000)
$k = 1$	21.966	33.058
	(0.079)	(0.003)
$k = 2$	12.601	18.679
	(0.126)	(0.017)
$k = 3$	3.089	6.560
	(0.378)	(0.087)

Table 4: Table report the Wald statistics and the p-values for the rank test in Cragg and Donald (1997). The values for k in the rows represent the null hypothesis. If the p-values is smaller than 0.05, then the null hypothesis is rejected in favour of the alternative hypothesis $k > k_0$.

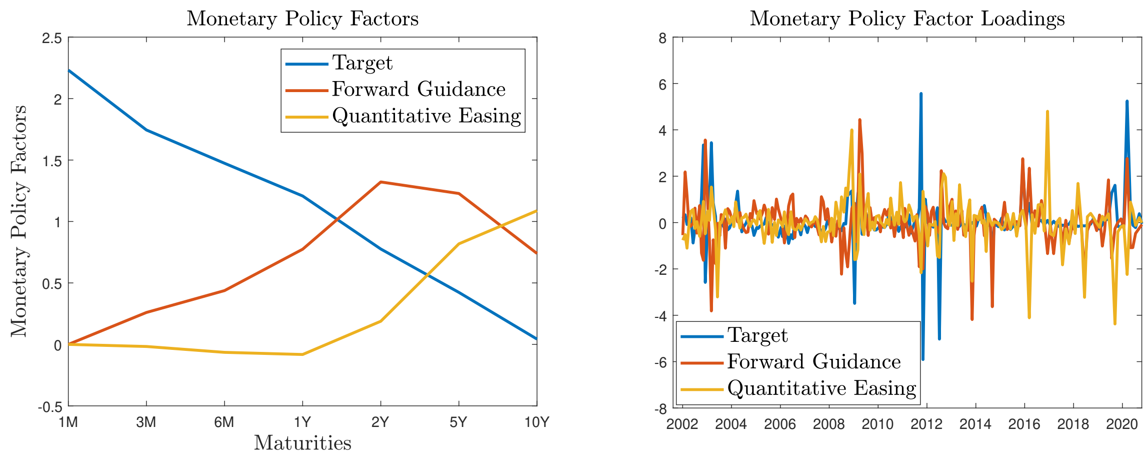

Figure 10: Monetary policy factors and factor loadings.

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