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IN ADVANCED AND EMERGING ECONOMIES

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An Event Study of COVID-19 Central Bank Quantitative Easing in Advanced and Emerging Economies

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ABSTRACT

Amid the COVID-19 outbreak and related expected economic downturn, many developed and emerging market central banks around the world engaged in new long-term asset purchase programs, or so-called quantitative easing (QE) interventions. This paper conducts an event-study analysis of 24 COVID-19 QE announcements made by 21 global central banks on their local 10-year government bond yields. We find that the average developed market QE announcement had a statistically significant -0.14% 1-day impact, which is slightly smaller than past interventions during the Great Recession era. In contrast, the average impact of emerging market QE announcements was significantly larger, averaging -0.28% and -0.43% over 1-day and 3-day windows, respectively. Across developed and emerging bond markets, we estimate an overall average 1-day impact of -0.23%. We also show that all 10-year government bond yields in our sample rose sharply in mid-March 2020, but fell substantially after the period of QE announcements that we study in the paper.

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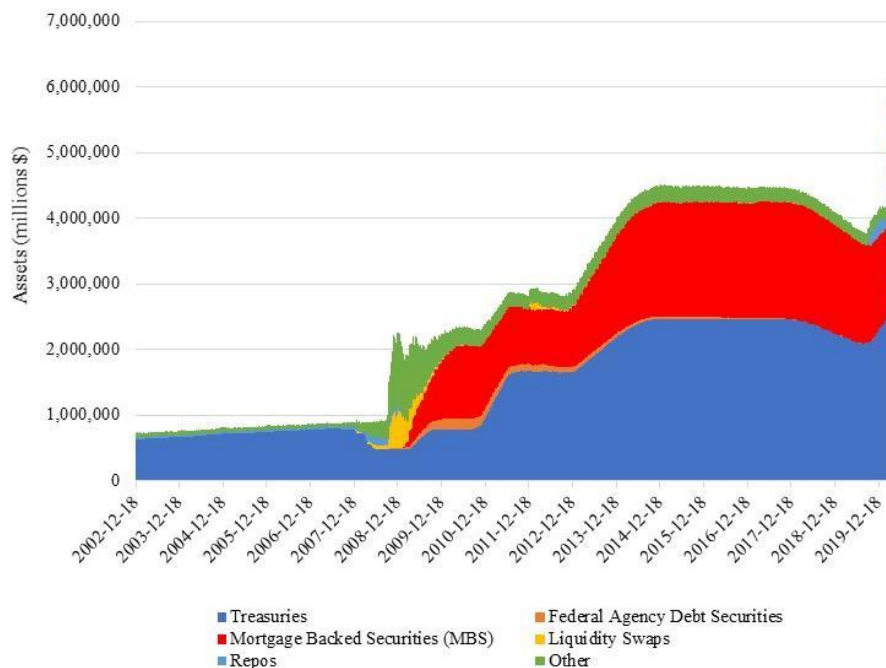
1. Introduction

As many advanced economies' central banks around the world were facing short-term interest rates nearing zero, or even dipping into negative territory, unconventional monetary policies in the form of large-scale asset purchases, commonly referred to as quantitative easing (QE), became an essential component of the policy toolbox during the Great Recession era.

Hitherto enacted primarily by G4 central banks as well as the Swiss National Bank and the Riksbank of Sweden, amid COVID-19, many more developed and emerging market central banks adopted this form of intervention. Figure 1 reports the Federal Reserve's balance sheet over time, showing that it started to expand during the 2008-2009 Great Recession—when the Fed bought primarily U.S. Treasury bonds and agency mortgage-backed securities (MBS)—till the end of 2014. It then grew very rapidly in 2020, during the period of the COVID-19 outbreak. From March 2020 through May 2020, Federal Reserve assets grew by almost \$3 trillion, or approximately 15% of U.S. GDP, which reflects additional purchases of U.S. Treasuries and MBS as well as purchases of corporate and municipal bonds for the first time.

At the same time, prior to the COVID-19 crisis, some observers had begun to cast doubts on the ability of QE to continue to be more effective than other new forms of monetary policy interventions such as negative interest rates, which are hindered by the inability of banks to pass through negative rates to deposit-holders.⁴

Figure 1. Federal Reserve Balance Sheet (2002-2020)



Notes: Federal Reserve Balance Sheet. Source: Federal Reserve Board of Governors.

⁴ On concerns regarding the effectiveness of QE, see Lawrence H. Summers and Anna Stansbury, “Whither Central Banking?” *Project Syndicate*, August 23, 2019. On concerns regarding the effectiveness of negative interest rates, see Eggertsson, Ragnar, Summers and Wold (2019).

This paper conducts an event study analysis of the impact of QE interventions on 10-year sovereign bond yields, across 1-day, 2-day and 3-day event windows following the announcement. In particular, we look at 24 COVID-19 QE announcements related to sovereign bond purchases from 21 global central banks. We focus on 10-year government bonds yields because this is the predominant type of asset purchases across all central banks engaged in QE.

We find that the average COVID-19 QE announcement, across both developed and emerging markets, had an -0.23% single day impact on a country's 10-year government bond yield, and a -0.29% and -0.31% cumulative impact over the following two and three days, respectively, in the ballpark of the existing estimates in the extant literature.

Looking separately at developed markets, many of which have seen prior QE interventions, and emerging markets that engaged in QE for the first time, tells a more nuanced story. In developed markets, the average COVID-19 QE announcement has had an estimated -0.14% single day impact on a country's respective 10-year government bond yield and a -0.14% and -0.11% cumulative impact over the following two and three days, respectively. In contrast, in emerging markets, the average COVID-19 QE announcement has had an estimated -0.28% single day impact on a country's 10-year government bond yield, and a -0.38% and -0.43% cumulative impact over the following two and three days. Thus, the results for developed economies are close to the lower end of the range of the existing estimates, while those for emerging markets are closer to the upper end of the range.

The first instance of modern quantitative easing was in March 2001, when the Bank of Japan (BOJ) introduced the quantitative easing policy (QEP) to fight deflation. Bernanke, Reinhart, and Sack (2004) report only a small effect of these Japanese Government Bond (JGB) purchases on longer-term yields.

Moving to the Great Recession-era interventions, Gagnon, Raskin, Remache, and Sack (2011) estimate that the Fed's QE1 reduced the U.S. term premium in a range between 0.3% and 1.50% at different maturities on the U.S. sovereign yield curve. They also find that QE1 not only depressed long-term yields of asset classes targeted directly, but also of assets not purchased such as corporate bond yields. However, this study considers not just the initial QE announcements but also all subsequent FOMC statements that affirm the continuation of such QE programs. Cumulating over all of these FOMC announcements might therefore include confounding new information about forward guidance.

Vissing-Jorgensen and Krishnamurthy (2011) examine the effect of Treasury and MBS purchases under the Fed's QE1 and QE2. They find that announcing MBS purchases during QE1 lowered MBS yields as well as corporate spreads. However, Treasuries-only purchases under QE2 had a disproportionate effect on Treasury yields and agency bond yields relative to MBS.

Swanson (2011) examines six different QE2 interventions as well as Operation Twist announcements, finding they cumulatively lowered long-term Treasury yields by 0.15%. D'Amico and King (2013) identify both stock and flow effects of QE, using CUSIP level data to identify which bonds are included in QE purchases, and found that the former were larger than the latter.

Vissing-Jorgensen, Krishnamurthy, and Nagel (2018) analyze QE in Europe finding that European Central Bank (ECB) Securities Markets Programme (SMP) and the Outright Monetary Transactions (OMT) had a considerable impact on European sovereign yields as well as other macro-spillovers, including boosting equity prices. Joyce, Lasasosa, Stevens, and Tong (2011) analyze the impact of financial crisis-era QE in the UK, finding that the average yield on five to twenty-five-year gilts fell by 1% cumulatively in a 2-day window surrounding the six key announcements they focus on.

Moving to the COVID-19 QE era, Lilley and Rogoff (2020) explore how inflation expectations and expectations for negative interest rates have changed during the COVID-19 period. Bahaj and Reis (2020a) and Bahaj and Reis (2020b) explore the impact of swap line announcements finding they were effective at reducing covered interest parity (CIP) deviations. Haddad, Moreira, and Muir (2020) examine the impact of Fed corporate bond asset purchase announcements finding that they were effective at boosting prices and lowering spreads. We complement these COVID-19 studies by comparing the short-term impacts of QE announcements on sovereign bond yields internationally.

Several papers have examined the selloff in Treasuries, with the corresponding rise in yields and fall in liquidity in mid-March 2020, prior to the "unlimited" Fed QE announcement on 03/23/2020. Schrimpf, Shin, and Sushko (2020) argue that CTA/momentum funds and risk parity funds are partially responsible for that sell off. Kargar, Lester, Lindsay, Liu, Weill, and Zúñiga (2020) similarly analyzes corporate bond liquidity amid the COVID-19 crisis. We document a reversal in the world bond markets following the QE interventions of major central banks, but we do not claim causation.

This paper proceeds as follows. Section 2 discusses the empirical strategy. Section 3 selects the announcement dates we focus on. Section 4 reports the results. Section 5 discusses the impact of QE interventions on world bond markets. Section 6 concludes. Supplementary material is reported in Appendix.

2. Empirical Strategy

An event-study analysis uses changes in asset prices within short windows of time around known announcement dates to measure the financial market effects of those announcements.

The event study design used in the extant literature to study the impact of QE on interest rates—including Vissing-Jorgensen and Krishnamurthy (2011), Swanson (2011), and Gagnon et al. (2011)—closely follows the approach initially proposed by Fama, Fisher, Jensen, and Roll (1969), hereafter FFJR (1969). FFJR (1969) make three critical assumptions, namely that (i) the event is unexpected, (ii) there are no confounding factors impacting the asset prices being studied, and (iii) that markets are efficient.

Although with the onset of the COVID-19 pandemic and economic crisis, the market might have expected a monetary policy response through QE in broad terms, the specific timing of the QE interventions that we study could not have been anticipated. Furthermore, we consider only the impact of initial QE announcements (similar to Vissing-Jorgensen and Krishnamurthy (2011) and Swanson (2011)), which are more likely to be a surprise. Other studies like Gagnon et al. (2011) also consider subsequent dates updating the QE program's growth that are less likely to contain surprises but can lead to larger cumulative effects.

With respect to confounding factors, one particular concern is the simultaneous implementation of monetary policy actions, including interest rate changes. It is also possible that a QE announcement signals that central banks intend to keep short-term rates lower for a longer period of time in the future (forward guidance). While we do not control for forward guidance communications at the zero-lower bound, we evaluate the effects of QE announcements with and without accompanying interest rate cuts. For robustness, in fact, we also estimate the average impact of QE interventions excluding announcements with simultaneous benchmark interest rate cuts on the same day.

It is also possible that the simultaneous announcement of purchases of other non-sovereign assets (i.e. corporate bonds) spills over onto sovereign bond yields. This problem, however, is relevant only for the

Fed's intervention on 03/23/2020, when the US central bank announced both "unlimited" Treasury and MBS QE as well as its new corporate bond buying facilities. As we will see, the 1-day impact of this particular announcement is smaller than the one on 3/16/2020. The Bank of England, Bank of Japan and Banco de Mexico also simultaneously announced corporate bond and government bond purchases.

To take into account the likely market inefficiencies during times of acute stress, with respect to the third assumption, in both sets of markets, we consider multiple-day event windows, rather than only one-day windows. Multiday windows take into account that bond prices might not react fully and instantaneously in response to a policy announcement, especially in emerging markets. Vissing-Jorgensen and Krishnamurthy (2011) and Swanson (2011) use two-day windows, while Gagnon et al. (2011) uses 1-day event windows. We consider cumulative changes in sovereign bond yields over 1-day, 2-day, and 3 day event windows.

That being said, Jones, Lamont, and Lumsdaine (1998) and Fleming and Remolona (1999) provide evidence of market efficiency in bond markets in days following major macroeconomic announcements, finding no statistically significant evidence of either momentum or mean-reversion in yields. We also note that the 10-year sovereign bond markets in advanced economies are among the most liquid and efficient (Du, Im, and Schreger, 2018), and during crisis times they often become safe-havens, although COVID-19 briefly disrupted the U.S. government bond market in mid-March 2020. In emerging markets, efficiency and liquidity can be easily disrupted by large local shocks. However, during the initial phase of the pandemic that we consider, dollar shortages were at the core of the plumbing system, driven by spillovers from pandemic news in China, the US and Europe being the dominating factor.

Under these assumptions, one can test the null hypothesis that QE announcements have no significant impact on 10-year government bond yields. The statistic we focus on is the change in yields during each window divided by the corresponding unconditional standard deviation of the 1, 2 and 3-day 10-year government bond yield change prior to the announcement date. We compute these standard deviations using the time series of daily 10-year government bond yields data from January 1, 2017 through the day prior to the QE announcement. We compute the standard deviation beginning in 2017 to have a long enough sample (with nearly 1,000 observations in each country) so as to obtain a reliable measure of a given government bond yield's unconditional variance. To calculate statistical significance for the average developed market, average emerging market, as well as the overall average, we compare the arithmetic average of the 1-day, 2-day and 3-day impacts with the unconditional standard deviation of this average, based on pre-event window data series as in the case of country-specific impacts.

Note finally that, while the FFJR (1969) approach generally attempts to measure abnormal returns of stocks by subtracting realized returns from predicted returns using regression coefficients from a pre-event window, the event studies analyzing fixed income markets of Vissing-Jorgensen and Krishnamurthy (2011) and Gagnon et al. (2011) do not subtract average yield changes from the pre-event window, as daily average yield changes during pre-event window periods are often very small/negligible.

3. Event Dates

Table 1 summarizes the list of 24 COVID-19 QE announcements from 21 central banks around the world that we analyze. A short narrative description of each event is reported in Appendix A. Since our main goal is to study the impact of QE announcements related to sovereign bond purchases, we select only quantitative easing announcements involving buying or plans to buy additional sovereign or government-backed bonds.

We exclude event dates such as the Bank of Japan’s announcement on 03/16/2020 relating to additional purchases of corporate bonds, stocks, and real estate ETF purchases. We also exclude Chile’s 03/23/2020 announcement related to the intention to buy only bank debt. We thus isolate 9 QE announcements made by 8 developed market central banks and 15 QE announcements made by 13 emerging market central banks for a total of 24 QE announcements from 21 central banks.

Three central banks had multiple QE announcements. Specifically, the Fed initially announced a \$700 billion purchase of MBS and Treasuries on 03/16/2020 and then announced a commitment to “unlimited” purchases on 03/23/2020. The National Bank of Poland announced purely sovereign purchases on its first intervention on 03/17/2020 and then subsequently announced it would include state-government backed bonds on 04/08/2020. The Hungarian National Bank suggested on 03/24/2020 that it would soon announce a new round of mortgage bond purchases, and on 04/28/2020 it followed-up by announcing the corresponding program which also included sovereign bonds in addition to exact amounts. For simplicity, we treat these multiple interventions as independent events. The Fed and the central bank of Poland interventions are more than three days apart. In the case of Hungary, the first intervention was a “promise” and the second one spelled out the details of the purchasing program.

Table 1. Key COVID-19 Quantitative Easing Announcements

Country	Central Bank	Country Date #	Date	Size	Type of Asset Purchase
Developed Markets					
U.S.	Federal Reserve	1	3/16/2020	700 billion USD	Sovereign, MBS
U.S.	Federal Reserve	2	3/23/2020	Unlimited	Sovereign, MBS, Corporate Bonds
U.K.	Bank of England	1	3/19/2020	200 billion GBP	Sovereign, Corporate Bonds
Europe	European Central Bank	1	3/18/2020	750 billion EUR	Sovereign
Japan	Bank of Japan	1	4/26/2020	Unlimited JGBs, 20 trillion yen in corporates	Sovereign, Corporate Bonds
Canada	Bank of Canada	1	3/27/2020	3.5 billion CAD per week	Sovereign
Australia	Reserve Bank of Australia	1	3/19/2020	Unlimited	Sovereign
New Zealand	Reserve Bank of New Zealand	1	3/23/2020	30 billion NZD	Sovereign
Sweden	Riksbank	1	3/16/2020	300 billion SEK	Sovereign
Emerging Markets					
Israel	Bank of Israel	1	3/23/2020	50 billion ILS	Sovereign
Korea	Bank of Korea	1	3/25/2020	Unlimited repos for 3 months	Repos
Colombia	Banco de la República	1	3/24/2020	12 trillion COP	Sovereign
South Africa	South Africa Reserve Bank	1	3/25/2020	Unspecified amount	Sovereign
Poland	Narodowy Bank Polski	1	3/17/2020	Unspecified amount	Sovereign
Poland	Narodowy Bank Polski	2	4/8/2020	Unspecified amount	Sovereign, State-Guaranteed Bonds
Romania	Banca Națională a României	1	3/20/2020	Unspecified amount	Repos, Local Government Bonds
Hungary	Magyar Nemzeti Bank	1	3/24/2020	Considering resuming its mortgage bond asset purchases	Sovereign, MBS
Hungary	Magyar Nemzeti Bank	2	4/28/2020	1 trillion HUF in govt and 300 billion HUF in mortgage bonds	Sovereign, MBS
Croatia	Hrvatska narodna banka	1	3/13/2020	Unspecified amount	Sovereign
Philippines	Bangko Sentral ng Pilipinas	1	3/24/2020	300 billion PHP	Sovereign
Mexico	Banco de Mexico	1	4/21/2020	100 billion MXN	Sovereign, Corporate Bonds
Turkey	Central Bank of the Republic of Turkey	1	3/31/2020	Unspecified amount	Sovereign
India	Reserve Bank of India	1	3/20/2020	400 billion INR	Sovereign
Indonesia	Bank Indonesia	1	4/1/2020	Unspecified amount	Sovereign

Notes: The events listed represent all sovereign bond long term asset purchase QE announcements during the COVID-19 pandemic.

4. Impact of COVID-19 Quantitative Easing Event on Sovereign Bond Yields

All impacts on sovereign bonds yields are evaluated using daily 10-year bond yields data from Reuters. These bond yields are plotted in Appendix Figures 1a and 1b since January 1, 2020 together with the respective QE announcement dates, for developed and emerging markets, respectively.

Table 2. COVID-19 QE Announcement Impacts

Country	Central Bank	Country	Date #	Date	RIC Ticker	Cumulative Change In 10-Year Govt Bond Yield					
						1-Day (%)		2-Day (%)		3-Day (%)	
Developed Markets						-0.14	***	-0.14	***	-0.11	**
U.S.	Federal Reserve		1	3/16/2020	US10YT	-0.21	***	0.08		0.24	***
U.S.	Federal Reserve		2	3/23/2020	US10YT	-0.16	***	-0.08		-0.04	
U.K.	Bank of England		1	3/19/2020	DE10YT	-0.17	***	-0.23	***	-0.37	***
Europe	European Central Bank		1	3/18/2020	GB10YT	-0.01		-0.10	**	-0.15	***
Japan	Bank of Japan		1	4/26/2020	JP10YT	0.01		-0.02		-0.03	
Canada	Bank of Canada		1	3/27/2020	CA10YT	-0.12	***	-0.09		-0.13	**
Australia	Reserve Bank of Australia		1	3/19/2020	AU10YT	-0.23	***	-0.40	***	-0.36	***
New Zealand	Reserve Bank of New Zealand		1	3/23/2020	NZ10YT	-0.52	***	-0.47	***	-0.36	***
Sweden	Riksbank		1	3/16/2020	SE10YT	0.14	***	0.07		0.17	**
Emerging Markets						-0.28	***	-0.38	***	-0.43	***
Israel	Bank of Israel		1	3/23/2020	IL10YT	-0.30	***	-0.39	***	-0.46	***
Korea	Bank of Korea		1	3/25/2020	KR10YT	-0.04		-0.20	***	-0.17	***
Colombia	Banco de la República		1	3/24/2020	CO10YT	-0.50	***	-1.35	***	-2.15	***
South Africa	South Africa Reserve Bank		1	3/25/2020	ZA10YT	-0.66	***	-0.90	***	-0.73	***
Poland	Narodowy Bank Polski		1	3/17/2020	PL10YT	-0.45	***	-0.28	***	-0.08	
Poland	Narodowy Bank Polski		2	4/8/2020	PL10YT	-0.05		-0.14	**	-0.19	***
Romania	Banca Națională a României		1	3/20/2020	RO10YT	-1.50	***	-1.53	***	-1.80	***
Hungary	Magyar Nemzeti Bank		1	3/24/2020	HU10YT	-0.51	***	-0.36	***	-0.50	***
Hungary	Magyar Nemzeti Bank		2	4/28/2020	HU10YT	0.01		-0.41	***	-0.59	***
Croatia	Hrvatska narodna banka		1	3/13/2020	HR10YT	0.17	***	0.19	***	0.24	***
Philippines	Bangko Sentral ng Pilipinas		1	3/24/2020	PH10YT	-0.23		-0.48	**	-0.55	**
Mexico	Banco de Mexico		1	4/21/2020	MX10YT	-0.03		-0.25	**	-0.26	**
Turkey	Central Bank of the Republic of Turkey		1	3/31/2020	TR10YT	-0.01		0.29		0.75	
India	Reserve Bank of India		1	3/20/2020	IN10YT	-0.15	***	-0.03		-0.11	
Indonesia	Bank Indonesia		1	4/1/2020	ID10YT	0.03		0.13		0.19	
Total						-0.23	***	-0.29	***	-0.31	***

Notes: The table reports 1-day, 2-day, and 3-day cumulative change in a country's 10-year government bond yield following a QE announcement as well as averages for both developed and emerging market countries. * indicates statistical significance at the 10% level, ** indicates statistical significance at the 5% level and *** indicates statistical significance at the 1% level.

Table 2 below provides the data tickers and reports the estimation results. We report daily changes in individual sovereign bond yields, on the same day (1-day window), the day of and the day after (2-day window), and the day of, the day after the announcement, and the subsequent day (3-day window). As some of the interventions that we evaluate refer to “unlimited commitments”, like in the case of the Fed on 03/23/2020, we do not adjust these impacts for size of the purchases.

The first Fed's announcement on Sunday, 03/15/2020 had a -0.21% statistically significant single-day impact on the U.S. 10-year Treasury yield on the first subsequent trading day, Monday, 3/16/2020. The subsequent announcement on 3/23/2020 had a smaller, -0.16%, but statistically significant single-day impact despite the open-ended nature of the commitment. Treasury yields rose in the two days after the first intervention and fell in the two days after the second announcement, but only the cumulative impact of the first announcement is statistically significant.

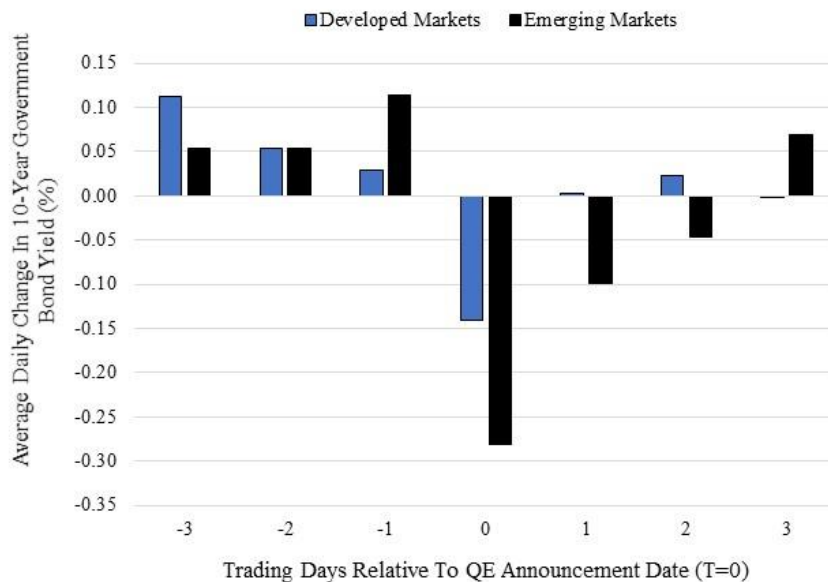
The European Central Bank (ECB) announced on 03/19/2020 it would purchase an additional 750 billion EUR worth of European sovereign bonds. While the ECB is mandated to purchase sovereign bonds from all member countries, for comparability with the Fed's interventions, we evaluate the impact on the 10-year German Bund yield. While initially the Bund was essentially unchanged, over a three-day window, it fell by a cumulative -0.15%, which is only slightly larger than the estimated 1-day impact of the first Fed intervention on 3/16/2020. A critical and interesting difference, however, is that the German Bund yield

fell while being in markedly negative territory (Appendix Figure 1a). This suggests that QE and negative interest rates can be complementary rather than substitute policy instruments.

Relative to the previous literature, these estimates are very close to the cumulative -0.13% to -0.16% impact on the 10-year Treasury yield estimated by Swanson (2011) for the “Operation Twist”. The estimate is also close to the -0.22% single-day impact estimated by Vissing-Jorgensen and Krishnamurthy (2011) for the initial Federal Reserve QE1 LSAP announcement on 11/25/2008. When analyzing the initial Federal Reserve QE2 announcements on 08/10/2020 and 09/21/2020, Vissing-Jorgensen and Krishnamurthy (2011) found two-day impacts on the U.S. 10-year Treasury yield to be -0.14% and -0.16% respectively, adding up to a -0.30% cumulative impact that is similar to our estimates. The evidence reported, therefore, is consistent with the view that QE interventions might gradually lose effectiveness over time.

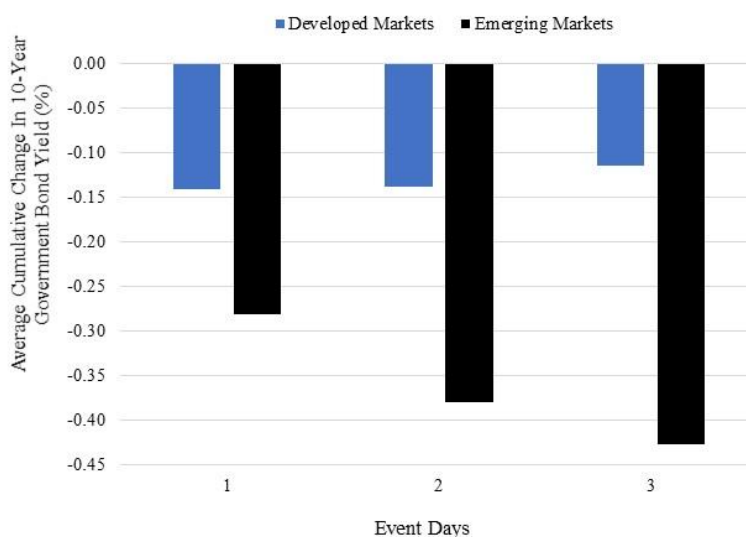
Looking at other developed countries, 1-day impacts varied in a range between statistically significant -0.23% and -0.36% for Australia and New Zealand, to the muted effect of -0.01% for Japan, with Canada and the UK showing 1-day impacts comparable to those in the United States. The only developed country in which QE intervention appears to have had counterproductive effects is Sweden.

Figure 2a. Average Developed and Emerging Markets in 10-Year Government Bond Yields: Daily Change



Notes: The figure compares the QE impacts on 10-year government bond yields in emerging markets and advanced economies. Each bar represents the average *daily change* in a country’s 10-year government bond yield relative to its respective QE announcement date. This is calculated by taking the daily time series for each individual 10-year government bond yield and aligning it according to the QE event dates reported in Table 1.

Figure 2b. Average Developed and Emerging Markets in 10-Year Government Bond Yields: Cumulative Change



Notes: The figure compares the QE impacts on 10-year government bond yields in emerging markets and advanced economies. Each bar represents the average *cumulative* change in a country’s 10-year government bond yield relative to its respective QE announcement date. This is calculated by taking the daily time series for each individual 10-year government bond yield and aligning it according to the QE event dates reported in Table 1 and then summing across event days.

In emerging markets, the responses of government bond yields to QE announcements were on average substantially larger (Figure 2a and 2b). In response to COVID-19, many emerging market central banks announced quantitative easing measures for the first time ever, which could explain why these interventions may have had larger impacts. For instance, in Romania, the central bank QE announcement had a statistically significant one-day impact of -1.50% (Table 2). South Africa, Poland, Colombia, and Hungary all had statistically significant one-day impacts between -0.45% and -0.66%. Indeed, in some cases, we find that the QE announcement had a much larger impact than the beginning of the actual bond buying program. For instance, while the 10-year yield changed by -0.50% and -0.59% over the 3 days following the Hungarian National Bank’s QE announcements on 03/24/2020 and 04/28/2020, respectively, the yield change over the 3 days following the beginning of the actual bond buying on 05/04/2020 was only 0.05%.

Table 2, Figure 2a, and 2b also report the simple average of the country-specific impacts. Across developed markets, the average QE announcement has had an approximate -0.14% single day impact on 10-year bond yields, close to the three-day impact. This is at the lower-end of the range of estimates in the literature, i.e., with estimated impacts on the 10-year yield between -0.15% and -1.00%. However, if we exclude developed market QE announcements accompanied by cuts to benchmark rates, which are listed in Appendix Table 1, the average 1-day impact falls to -0.11% (from -0.14%), while the average 2-day and 3-day impacts fall to -0.12% (from -0.14%) and -0.08% (from -0.11%), respectively. Thus, again, pointing to slightly weaker effects than previously estimated. Appendix Table 1 lists countries with simultaneous benchmark rate cuts along with the average 10-year interest rate QE impacts when excluding simultaneous benchmark rate cuts as well as including them (as Table 1 reports).

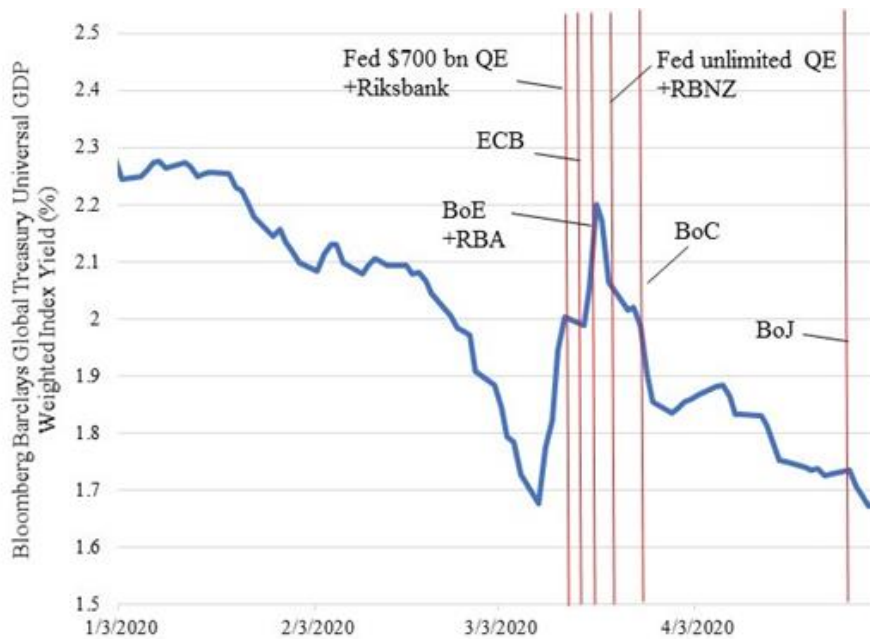
The average impact is significantly larger and becomes strong over time in emerging markets. Figure 2a and Figure 2b compare the results for the average developed market and average emerging market relative to the announcement date, daily and cumulatively, respectively. In emerging markets, the QE announcement had an average -0.28% 1-day impact on 10-year government bond yields that is twice the size of the advanced economy 1-day impact. Interestingly, in emerging markets, the 2-day and the 3-day impacts are also statistically significant, with a -0.43% cumulative impact over three days, suggesting either less market efficiency or more persistent effects, or a likely combination of both factors in these markets. If we exclude QE announcements accompanied by cuts to benchmark rates, in emerging markets (also listed in Appendix Table 1), the average 1-day impact falls to -0.20% (from -0.28%). However, the average 2-day and 3-day impact drops only to -0.32% (from -0.38%) and -0.37% (from -0.43%), respectively.

5. Quantitative Easing and the World Interest Rate

COVID-19 brought about a major financial shock, briefly also disrupting the U.S. government bond market, with yield increases comparable to, or even larger, than those materialized in the aftermath of Lehman Brothers’ failure in 2008 (not reported). As we can see from Appendix Figure 1a and 1b, all 10-year yields in advanced and emerging markets all increased sharply in mid-March 2020, to then revert and continue trending downward.

The event study methodology that we adopted in this paper does not allow us to evaluate the longer-term effects of the QE interventions that we considered. Similarly, the methodology used does not allow to make statements on the impacts of the central bank interventions listed in Table 1 on the world real interest rate, which is an unobservable variable. Nonetheless, as we can see from Figure 3 below, a naïve measure of the nominal world interest rate fell considerably and persistently after peaking on 03/19/2020.

Figure 3. Bloomberg Barclays Global Treasury Universal GDP Weighted Index (%)



Notes: The figure plots the yield for the Bloomberg Barclays Global Treasury Universal GDP Weighted Index. The vertical bars indicate developed market QE intervention dates listed in Table 1. The Bloomberg Barclays Global Treasury Universal Index tracks fixed-rate, local currency government debt in both developed and emerging

markets. The index represents the treasury sector of the Barclays Global Aggregate Universal Index and contains issues from 51 countries. The index uses GDP (a proxy of a country's ability to service its debt) as the basis for country-level weights. GDP weights are announced in early November, reflected in the December forward (projected) universe and take effect as of the annual rebalancing date on January 1. Monthly rebalancing occurs for underlying bonds entering and exiting the specific country sub-indices.

This remarkable turnaround in world government bond markets was likely aided also by the central bank dollar swap announcements coordinated by the Fed. On 03/15/2020, the financial crisis era swap lines between the Federal Reserve, the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank and the Swiss National Bank were reactivated. On 03/19/2020, the central bank swap lines were expanded to 9 additional central banks, including the Reserve Bank of Australia, the Banco Central do Brasil, the Danmarks Nationalbank, the Bank of Korea, the Banco de Mexico, the Norges Bank, the Reserve Bank of New Zealand, the Monetary Authority of Singapore, and the Sveriges Riksbank. Finally, on 03/20/2020, further coordinated action between the Federal Reserve, the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank and the Swiss National Bank was announced, increasing the frequency of 7-day maturity operations from weekly to daily. Nonetheless, the turnaround in global bond markets and the subsequent persistent decline in yields suggest that, central banks, and particularly the Fed, were effective in stabilizing global bond markets in response to COVID-19.

6. Conclusion

Amid the COVID-19 outbreak and ensuing market panic and economic collapse, global central banks announced new long-term asset purchase quantitative easing (QE) programs, including several emerging markets for the first time. This paper reports an event-study analysis of the impact of 24 COVID-19 QE announcements from 21 central banks around the world on 10-year sovereign bond yields.

The QE announcements considered across both developed and emerging markets had an overall average 1-day impact on countries' respective 10-year yields of -0.23%, as well as -0.29% and -0.31% average impacts over two and three days respectively. We also showed that, after the QE interventions in developed government bond markets that we consider and the coordinated international swap line announcements, a broad-based GDP-weighted average of the 10-year yields fell considerably and persistently. This is circumstantial evidence that monetary policy was effective in stabilizing global bond markets under COVID-19 stress.

In developed markets, the average COVID-19 QE announcement had estimated statistically significant -0.14% 1-day and 2-day impacts, and a slightly smaller -0.11% 3-day effect. However, excluding QE announcements accompanied by cuts to benchmark rates leads to estimated impacts around -0.10% regardless of the window. This points to weaker effects than previously estimated in developed markets.

In contrast, in emerging markets, the average COVID-19 QE announcement had a significantly larger estimated 1-day effect of -0.28%, as well as -0.38% and -0.43% 2-day and 3-day impacts, respectively, which are only slightly smaller if we exclude announcements of simultaneous reductions in interest rates. These larger impacts could be a result of a greater surprise component of these announcements, as emerging market central banks engaged in QE for the first time, or lesser liquidity of emerging market government bonds compared to developed market government bonds, or a combination of both factors.

In light of the tremendous economic and financial stress imparted by COVID-19 on emerging markets and the lack of international cooperation to provide effective economic and financial relief, it is encouraging to observe that emerging market central banks were able to loosen monetary policy

aggressively without adverse reactions in domestic government bond markets. This broadening of the emerging markets policy toolkit is a remarkable and welcome new policy development.

The paper is silent on the effectiveness of QE interventions in stabilizing the real economy, the ultimate objective of monetary policy. An interesting area of future research is to examine the impact of QE on high frequency indicators of real economic activity such as cellphone-based mobility indicators now available on a global scale.

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Appendix Table 1. QE Announcements and Central Bank Interest Rate Changes

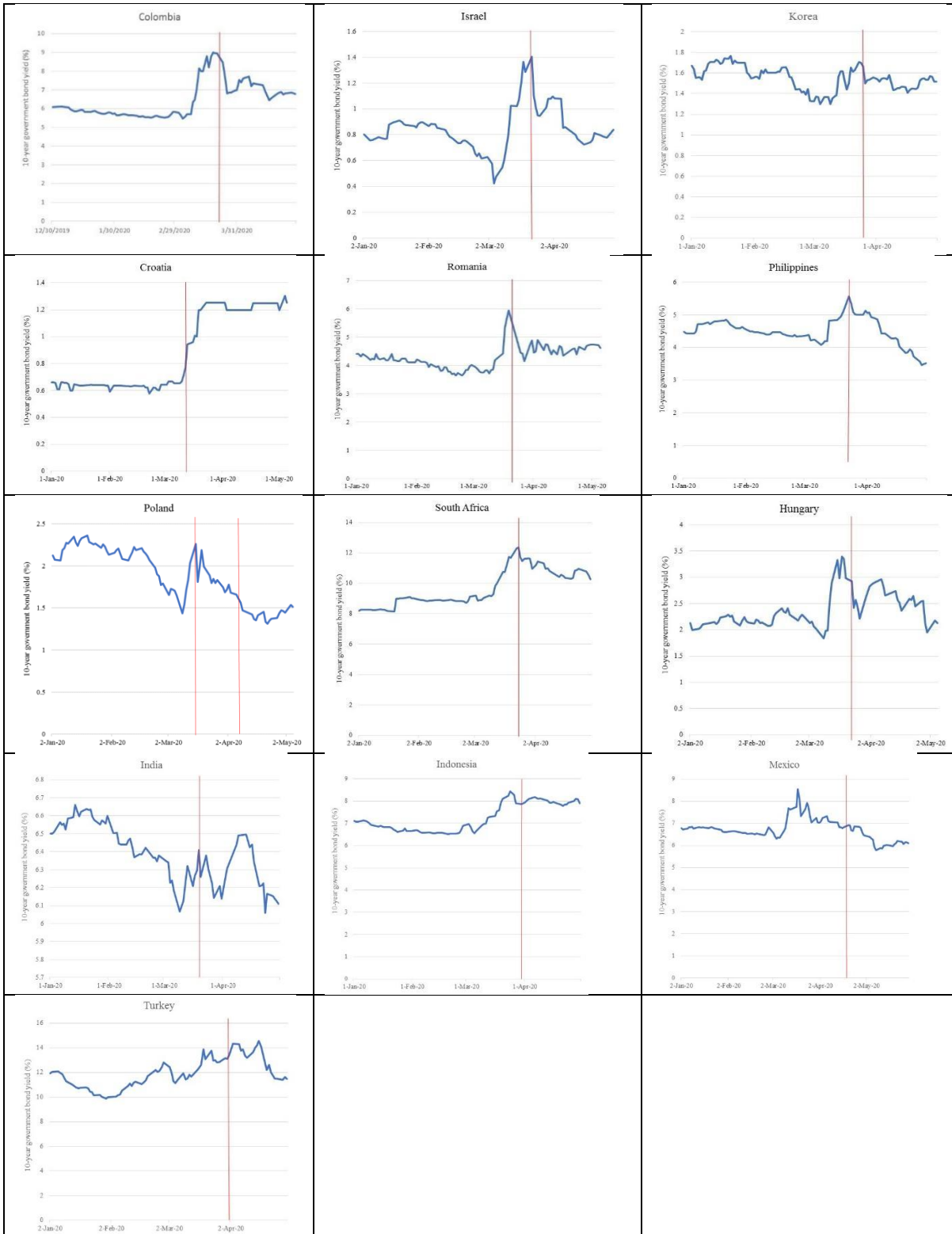
Country	Central Bank	Country Date #	Event Date	Concurrent Rate Change	Previous Interest Rate (%)	New Interest Rate (%)	Cumulative Ch. In 10-Year Yield			
							1-Day (%)	2-Day (%)	3-Day (%)	
Developed Markets							Including Simultaenous Benchmark Rate Cuts	-0.14	-0.14	-0.11
							Excluding Simultaenous Benchmark Rate Cuts	-0.11	-0.12	-0.08
U.S.	Federal Reserve	1	3/16/2020	Yes	1.00-1.25	0.00-0.25	-0.21	0.08	0.24	
U.S.	Federal Reserve	2	3/23/2020	No			-0.16	-0.08	-0.04	
U.K.	Bank of England	1	3/19/2020	Yes	0.25	0.10	-0.17	-0.23	-0.37	
Europe	European Central Bank	1	3/18/2020	No			-0.01	-0.10	-0.15	
Japan	Bank of Japan	1	4/26/2020	No			0.01	-0.02	-0.03	
Canada	Bank of Canada	1	3/27/2020	Yes	0.75	0.25	-0.12	-0.09	-0.13	
Australia	Reserve Bank of Australia	1	3/19/2020	Yes	0.50	0.25	-0.23	-0.40	-0.36	
New Zealand	Reserve Bank of New Zealand	1	3/23/2020	No			-0.52	-0.47	-0.36	
Sweden	Riksbank	1	3/16/2020	No			0.14	0.07	0.17	
Emerging Markets							Including Simultaenous Benchmark Rate Cuts	-0.28	-0.38	-0.43
							Excluding Simultaenous Benchmark Rate Cuts	-0.20	-0.32	-0.37
Israel	Bank of Israel	1	3/23/2020	No			-0.30	-0.39	-0.46	
Korea	Bank of Korea	1	3/25/2020	No			-0.04	-0.20	-0.17	
Colombia	Banco de la Republica	1	3/24/2020	No			-0.50	-1.35	-2.15	
South Africa	South Africa Reserve Bank	1	3/25/2020	No			-0.66	-0.90	-0.73	
Poland	Narodowy Bank Polski	1	3/17/2020	Yes	1.00	0.50	-0.45	-0.28	-0.08	
Poland	Narodowy Bank Polski	2	4/8/2020	Yes	0.50	0.00	-0.05	-0.14	-0.19	
Romania	Banca Națională a României	1	3/20/2020	Yes	2.50	2.00	-1.50	-1.53	-1.80	
Hungary	Magyar Nemzeti Bank	1	3/24/2020	No			-0.51	-0.36	-0.50	
Hungary	Magyar Nemzeti Bank	2	4/28/2020	No			0.01	-0.41	-0.59	
Croatia	Hrvatska narodna banka	1	3/13/2020	No			0.17	0.19	0.24	
Phillipines	Bangko Sentral ng Pilipinas	1	3/24/2020	No			-0.23	-0.48	-0.55	
Mexico	Banco de Mexico	1	4/21/2020	Yes	6.50	6.00	-0.03	-0.25	-0.26	
Turkey	Central Bank of the Republic of	1	3/31/2020	No			-0.01	0.29	0.75	
India	Reserve Bank of India	1	3/20/2020	No			-0.15	-0.03	-0.11	
Indonesia	Bank Indonesia	1	4/1/2020	No			0.03	0.13	0.19	
Total							Including Simultaenous Benchmark Rate Cuts	-0.23	-0.29	-0.31
							Excluding Simultaenous Benchmark Rate Cuts	-0.17	-0.26	-0.28

Appendix Figure 1a. COVID- QE Announcements and 10-Year Government Bond Yields: Developed Markets



Notes: The figure plots daily market closing 10-year government bond yields for developed markets, from 01/01/2020 to 4/30/2020. Red bars represent central bank QE announcement dates listed in Table 1. Source: Reuters.

Appendix Figure 1b. COVID-19 QE Announcements and 10-Year Government Bond Yields: Emerging Markets



Notes: The figure plots daily market closing 10-year government bond yields for emerging markets, from 01/01/2020 to 4/30/2020. Red bars represent central bank QE announcement dates listed in Table 1. Source: Reuters.

Appendix A. Event Dates

U.S. Federal Reserve

On 03/15/2020, the Fed announced 700 billion USD of new Treasury and MBS QE in addition to cutting the federal funds rate range from 1.00%-1.25% to 0.00%-0.25%. We select 03/16/2020 (the first subsequent trading date) as one event date since the Fed decision is related to direct purchasing of government bonds. On 03/23/2020, the Fed announced potentially “unlimited” MBS and Treasury QE (meeting our criteria for an event date) as well as a host of new facilities including the Primary Market Corporate Credit Facility (PMCCF) and Secondary Market Corporate Credit Facility (SMCCF).

Later, on 04/09/2020, the Fed announced it would include high yield bonds in the PMCCF and the SMCCF that had at least one investment grade rating prior to 03/23/2020 and at least two current BB ratings. We do not include this as an event date since the announcement does not involve the direct purchase of government bonds.

During this period, the Fed also made several announcements related to the establishment of international swap lines. On 03/15/2020, the Fed announced it was reactivating its Great Recession era permanent U.S. dollar liquidity swap line arrangements with the Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank. On 03/19/2020, the Fed announced new central bank swap lines with 8 additional central banks (in Australia, Brazil, South Korea, Mexico, Singapore, Sweden, Denmark, Norway and New Zealand), with a commitment to provide \$60 billion in U.S. dollar liquidity for each central bank over a period of 6 months. On 03/20/2020, they announced coordinated action to further enhance the provision of global liquidity. Note that while the G7 on a conference call on 03/03/2020 agreed to taking coordinated stimulus measures, they postponed any action. We also note that there were no instances of coordinated QE.

Bank of England

On the evening of 03/18/2020, the Bank of England (BoE) announced it would purchase 200 billion GBP worth of U.K. gilts, hence we include it as an event date.

European Central Bank

On 03/19/2020, the European Central Bank (ECB) announced it would purchase 750 billion EUR worth of various European sovereign bonds.

Bank of Japan

On 03/16/2020, the Bank of Japan pledged to buy risky assets such as exchange-traded funds at an annual pace of around ¥12 trillion JPY (approximately \$112.55 billion USD), double its previous pace. It also created a new loan program to extend one-year, zero-rate loans to financial institutions to provide lending to firms hit by the virus outbreak. We do not include this event as it only pertains to risky assets and not sovereign bonds.

On 04/27/2020, the Bank of Japan also committed to buy unlimited amounts of government bonds (JGBs) by discarding previous guidance to buy them at an annual pace of 80 trillion yen and said it would boost three-fold the maximum amount of corporate bonds and commercial paper it buys to 20 trillion yen (approximately \$186 billion USD). We include this as an event date since it pertains to the direct purchase of sovereign bonds.

Bank of Canada

On 03/27/2020, the Bank of Canada (BoC) announced it would purchase \$3.5 billion CAD per week of Canadian sovereign bonds, marking the first foray into large scale asset purchases by the BoC. Meanwhile, the Canada Mortgage Housing Corporate (CMHC) previously announced it would be buying Canadian mortgage bonds. We do not include the latter in our event study since it is not a direct purchase of sovereign bonds. The central bank also cut its benchmark interest rate on 3/27/2020 from 0.75% to 0.25%.

Reserve Bank of Australia

On 03/19/2020, the Reserve Bank of Australia announced it would purchase an unlimited amount of Australian sovereign bonds, hence we include it as an event date. The central bank also cut its benchmark interest rate on 3/19/2020 from 0.50% to 0.25%.

Reserve Bank of New Zealand

On 03/23/2020, the Reserve Bank of New Zealand announced it would purchase 30 billion NZD of New Zealand sovereign bonds, hence we include it as an event date. The central bank previously cut its benchmark interest rate from 1.00% to 0.25% on 03/16/2020.

Riksbank

On 03/16/2020, the Riksbank announced it was buying an additional 300 billion SEK of government bonds in 2020. Hence, we include it as an event date. In addition, the Riksbank said on the prior Friday, 03/13/2020, it would lend up to 500 billion SEK to Swedish companies via banks. We do not include this as a separate event.

Bank of Israel

On 03/23/2020, the Bank of Israel committed to buying 50 billion ILS of Israeli government bonds. Hence, we include it as an event date. Later, on 04/10/2020, it reduced its benchmark interest rate from 0.25% to 0.10%

Bank of Korea

On 03/25/2020, the Bank of Korea announced plans to offer “unlimited” repos for three months. Hence, we include it as an event date. It previously cut its benchmark interest rate from 1.25% to 0.75% on 03/17/2020.

Banco de la República

Colombia's central bank announced QE measures during an emergency session on 03/23/2020, the first time any South American central bank announced QE, where it would buy government bonds. Hence, we include it as an event date. The same measure authorized the central bank to buy up to 2 trillion COP worth of Colombia Treasury bonds (TES) before the end of March. It subsequently cut its benchmark interest rate from 4.25% to 3.75% on 03/27/2020 and again to 3.25% on 04/30/2020.

Banco Central de Chile

On 03/23/2020, Chile's central bank announced the creation of a conditional credit facility (FCIC) providing a special financial line to banks, with incentives for refinancing loans to homes and companies. The bank approved the norms that regulate this facility and announced the activation of a liquidity credit

line (LCL). The two credit lines are for up to 15% of the banks' commercial and consumer portfolio. Banks can use government bonds, corporate bonds or highly rated large commercial loans as collateral for these lines. Since the Banco Central de Chile is not buying (sovereign) bonds directly, we do not include this event our analysis.

South Africa Reserve Bank

On 3/25/2020, the South African Reserve Bank (SARB) announced it would begin an unspecified amount of South African government bond asset purchases. Hence, we include it as an event date. It previously cut its benchmark interest rate from 6.25% to 5.25% on 03/20/2020 and again to 4.25% on 4/15/2020.

National Bank of Romania/Banca Națională a României

On 03/20/2020, the Romanian central bank had a surprise meeting, announcing it would provide liquidity to banks via repo transactions and purchase local leu-denominated debt on the secondary market to consolidate structural liquidity. Hence, we include it as an event date. Romania's central bank also cut its benchmark interest rate by from 2.5% to 2.0% on this date.

National Bank of Poland/Narodowy Bank Polski

On 03/17/2020, the National Bank of Poland received approval to buy an unspecified amount of Polish government bonds from commercial banks. Hence, we include it as an event date. On the same date, it also announced an extension of repo operations increasing banks' liquidity. The National Bank of Poland also announced it was cutting its benchmark interest rate from 1.0% to 0.5% on 03/17/2020. On 04/08/2020, the National Bank of Poland announced it would ramp up its QE further by announcing it would not only buy government bonds but other bonds with state guarantees, including those issued by the Polish Development Fund, and we include this second event date. The National Bank of Poland announced it was cutting its benchmark interest rate again from 0.5% to 0% on 04/08/2020.

National Bank of Hungary/Magyar Nemzeti Bank

On 03/24/2020, the National Bank of Hungary announced it was considering resuming its mortgage bond asset purchase program while keeping its rates unchanged. On 04/28/2020, the National Bank of Hungary announced it would indeed commence its long term asset purchases of government bonds and mortgage bonds on 05/04/2020, including buying 100 billion HUF per week in government bonds and would re-examine its approach upon hitting HUF 1,000 billion in government securities and HUF 300 billion in mortgage bonds. We include 3/24/2020 and 4/28/2020 as event dates. During this period, the central bank has kept rates unchanged.

Croatia National Bank/Hrvatska Narodna Banka

On 03/13/2020, the Croatian National Bank (CNB) announced it had started to purchase Republic of Croatia government bonds with the aim of maintaining stability in the market of government securities. Hence, we include 3/13/2020 as an event date.

Bangko Sentral ng Pilipinas

On 03/23/2020, after trading hours, the Philippine Monetary Board authorized the Bangko Sentral ng Pilipinas to purchase securities from the Bureau of Treasury (BTr) under a repurchase agreement in the amount of 300 billion PHP with a maximum repayment period of 6 months. We include this event, but we date it 03/24/2020 to evaluate its the financial market impact. The central bank previously cut its benchmark interest rate from 3.75% to 3.25% on 03/19/2020 and again to 2.75% later on 04/17/2020.

Banco de Mexico

On 04/21/2020, the Banco de Mexico announced 750 billion MXN of economic support, including 100 billion MXN of Mexican government long-term bond asset purchases in addition to a 100 billion MXN corporate securities repurchase facility for securities issued by private nonfinancial institutions. Hence, we include 04/21/2020 as an event date. On the same day, the central bank also cut its benchmark interest rate from 6.5% to 6.0%.

Central Bank of the Republic of Turkey

On 03/31/2020, the Central Bank of Turkey announced it was commencing the purchase of several billion TRY of Turkish government bonds. Hence, we include 03/31/2020 as an event date. Previously, on 03/17/2020, the central bank cut its benchmark interest rate from 10.75% to 9.75%. Later, on 04/22/2020, the central bank cut its benchmark interest rate from 9.75% to 8.75% and again to 8.25% on 05/21/2020.

Reserve Bank of India

On 03/18/2020 and 03/20/2020, the Bank of India announced asset purchases of government bonds. While the announcement on 03/18/2020 only included government bonds up to five years in maturity (for a total amount of 100 billion INR), the second announcement on 03/20/2020 (for a total amount of 300 billion INR) included government bonds up to 9 years in maturity. To avoid the potential event window overlap (given that the events are only 2 days apart) and focus on the long-term government bond yield QE impact, we only include 03/20/2020 as an event date. The central bank also later cut its key benchmark interest rate on 03/27/2020.

Bank Indonesia

On 04/01/2020, Bank Indonesia announced the expansion of its authority to purchase long-term government securities (SBN) and government Islamic securities (SBSN) in the primary market. Hence, we include 04/01/2020 as an event date. The central bank had previously cut its benchmark interest rate on 03/19/2020.