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COVID-19 and Monetary Policy with Zero Bounds: A Cross-Country Investigation

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Using daily data on policy rates from 28 advanced economies and 32 emerging markets, this paper investigates the monetary policy reaction function of central banks during the Coronavirus Disease 2019 (COVID-19) outbreak. The results show that emerging markets or countries without a zero bound on their interest rates were able to reduce interest rates as a reaction to reduced economic activity and to the volatility in their exchange rates, whereas advanced economies or countries with a zero bound on their interest rates were not. Several policy implications follow for countries with a zero bound on their interest rates amid COVID-19.

JEL Classification: E52, E58

Key Words: COVID-19; Coronavirus; Monetary Policy; Reaction Function; Google Mobility; Exchange Rate

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Abstract

Using daily data on policy rates from 28 advanced economies and 32 emerging markets, this paper investigates the monetary policy reaction function of central banks during the Coronavirus Disease 2019 (COVID-19) outbreak. The results show that emerging markets or countries without a zero bound on their interest rates were able to reduce interest rates as a reaction to reduced economic activity and to the volatility in their exchange rates, whereas advanced economies or countries with a zero bound on their interest rates were not. Several policy implications follow for countries with a zero bound on their interest rates amid COVID-19.

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1 Introduction

Several governments have issued stay-at-home orders around the world to fight against the Coronavirus disease 2019 (COVID-19) pandemic. Even essential sectors (e.g., food production) have experienced shutdowns due to workers diagnosed with COVID-19, because COVID-19 spreads mainly through person-to-person contact (e.g., see Chan, Yuan, Kok, To, Chu, Yang, Xing, Liu, Yip, Poon, et al. (2020)). These developments have created unprecedented unemployment rates around the world. Accordingly, several central banks have reacted by changing their policy rates to help their economies (e.g., see Feldkircher, Huber, and Pfarrhofer (2020), Bhar and Malliaris (2020)).

This paper investigates the monetary policy reaction function of central banks for 28 advanced economies and 32 emerging markets during the COVID-19 pandemic covering the daily period between February 15th, 2020 and May 2nd, 2020.[1] Since inflation is mostly silent during this period (e.g., Draghi, Summers, Yellen, and Posen (2020), Cavallo (2020), Dell'Ariccia, Mauro, Spilimbergo, and Zettelmeyer (2020)), the reaction function focuses on the changes in economic activity measured by daily Google mobility data and the depreciation rate of currencies. The motivation is based on the corresponding literature during COVID-19, where volatilities in economic activity have been documented in studies such as by Ilzetzki, Reinhart, and Rogoff (2020) or Feng, Yang, Gong, and Chang (2021), and volatilities in exchange rates have been documented in studies such as by Altig, Baker, Barrero, Bloom, Bunn, Chen, Davis, Leather, Meyer, Mihaylov, et al. (2020). A panel estimation is achieved by taking the question of causality seriously, where a difference-in-difference approach is used with weekly changes in variables. In this panel estimation, time fixed effects, country fixed

[1] The reason for focusing on this sample period is to investigate the initial impact of COVID-19 on monetary policy as this development was a surprise to the global economy.

effects as well as the country-specific effects of the 100th COVID-19 case in each country are all controlled for.

Due to the significantly positive coefficients in monetary policy reaction functions, given that economic activity is reduced during the sample period, the panel empirical results based on the pooled sample suggest that central banks have reacted by reducing their policy rates. The panel empirical results also suggest that central banks have reacted to sustain the stability of their currencies, potentially to keep future inflation under control. These results are in line with earlier studies such as by Ball (1999), Taylor (1999), Svensson (2000) or Taylor (2001) who have shown evidence for the reaction of central banks to output volatility or exchange rate changes.

In additional analyses, countries have been categorized as advanced economies versus emerging markets as well as those with and without zero lower bounds on their interest rates. The latter categorization is essential, because fighting against COVID-19 through monetary policy may be constrained by the zero lower bound.[2] Specifically, monetary policy can have magnified effects amid COVID-19 by preventing firm exits as long as it is unimpeded by the zero lower bound as suggested in studies such as by Guerrieri, Lorenzoni, Straub, and Werning (2020). Correcting asset prices in the financial markets during COVID-19 is also related these zero lower bounds (e.g., see Aksit (2020)). Moreover, the uncertainty in future variables created by zero lower bounds generates further volatilities in macroeconomic variables, resulting in welfare costs (e.g., see Basu and Bundick (2017)).

The corresponding panel estimation results show that emerging markets or countries without a zero lower bound on their interest rates were able to reduce their interest rates as

[2] Although the restrictive effects of having a zero lower bound are trivial, the objective here is to investigate whether central banks have in fact been restricted by it as they may well be subject to other constraints such as their independence or other institutional problems.

a reaction to reduced economic activity and to the volatility in their exchange rates, whereas advanced economies or countries with a zero lower bound on their interest rates were not. It is implied that advanced economies or countries with a zero lower bound on their interest rates were not able to counteract the reduction in demand due to COVID-19. This not only results in unemployment or pessimistic expectations for the future but also results in reduced investment that further affects productivity growth as suggested by Fornaro and Wolf (2020).

Regarding policy implications, advanced economies or countries with a zero lower bound on their interest rates can benefit more from alternative policies, such as unconventional monetary or fiscal policies; e.g., see Fleming, Sarkar, Van Tassel, et al. (2020) for the details of unconventional policies conducted by the U.S. Federal Reserve Bank. This is in line with earlier studies such as by Benmelech and Tzur-Ilan (2020) who suggest that higher-income countries have lowered their rates less than low-income countries during COVID-19 and were more likely to use unconventional monetary policy tools. This is also consistent with earlier studies such as by Almunia, Benetrix, Eichengreen, OâĂŹRourke, and Rua (2010) who argue that fiscal stimulus is most effective when banking systems are dysfunctional and monetary policy is constrained by the zero bound. The latter argument is further supported by studies such as by Christiano, Eichenbaum, and Rebelo (2011), Ramey and Zubairy (2018) or Miyamoto, Nguyen, and Sergeyev (2018) who have shown that fiscal multipliers are higher during the periods of zero lower bounds. Nevertheless, as suggested by Benmelech and Tzur-Ilan (2020), the ability to conduct fiscal policies together with a zero lower bound on interest rates is limited by a country's access to credit markets. It is implied that the credit rating of countries with a zero lower bound on their interest rates is the most important determinant of effective policy design during the COVID-19 period.

The rest of the paper is organized as follows. The next section introduces the estimation methodology used. Section 3 introduces the data set used in the empirical investigation. Section 4 depicts empirical results, while Section 5 concludes.

2 Estimation Methodology

This section introduces the estimation methodology used. The section starts with the estimation of a monetary policy reaction function based on a panel of countries. It continues with distinguishing between the monetary policy reaction functions of countries with and without zero lower bounds in their interest rates as well as between advanced economies versus emerging markets.

2.1 Monetary Policy Reaction Function

The original monetary policy reaction function proposed by Taylor (1993) is based on the reaction of central banks to the inflation rate and output volatility through changing their policy rates. In open economies, this reaction function has been modified in studies such as by Ball (1999), Taylor (1999), Svensson (2000) or Taylor (2001) by including changes in exchange rates as they affect future inflation through production costs. Since inflation is silent during the COVID-19 pandemic due to the lack of demand, the monetary policy reaction function in this paper focuses on the economic activity and the depreciation of the exchange rate. The formal investigation is achieved by using the following difference-in-difference specification in order to consider causality, where changes in economic activity and the depreciation of

currencies are considered as continuous treatments:

$$\Delta i_{c,t} = \beta_0 + \beta_1 \Delta x_{c,t} + \beta_2 \Delta e_{c,t} + \varphi_c \times 1\left(100thCase_{c,t}\right) + \theta_c + \gamma_t + \varepsilon_{c,t} \tag{1}$$

where $\Delta i_{c,t}$ represents the change of policy rate in country c at time t, $\Delta x_{c,t}$ measures the percentage change of economic activity in country c at time t, and $\Delta e_{c,t}$ is the percentage change in exchange rate (measured as the depreciation of the currency) in country c at time t. $1\left(100thCase_{c,t}\right)$ takes a value of zero (one) for country c at time t before (after) it experiences the $100th$ COVID-19 case, and φ_c is the corresponding country-specific coefficient for country c; therefore, $\varphi_c \times 1\left(100thCase_{c,t}\right)$ captures the country-specific timing for the beginning of COVID-19 cases. For robustness, we achieve our estimations with and without $\varphi_c \times 1\left(100thCase_{c,t}\right)$ below. In this framework, country fixed effects are represented by θ_c's, whereas time fixed effects are represented by γ_t's. Finally, $\varepsilon_{c,t}$ represents residuals.

Panel estimation results of Equation 1 would provide useful information on the monetary policy reaction function of countries based on their economic activity and the value of their currencies. Due to its difference-in-difference design, where changes in economic activity and the depreciation of currencies are considered as continuous treatments, it answers the following question: have policy rates of countries with higher reductions in their economic activity or higher appreciation rates in their currencies (the treatment group) been reduced compared to those with lower reductions in their economic activity or higher depreciation rates in their currencies (the control group)? According to this question, a positive value of β_1 (β_2) would suggest that the treatment group has experienced a reduction in their policy rates compared to the control group due to the reduction in their economic activity (due to the appreciation of their currency).

2.2 Zero Lower Bounds and Country Groups

In order to investigate whether the experience of countries with zero bounds on their interest rates have been different, we would like to distinguish between the monetary policy reaction function of countries with and without zero bounds on their interest rates. Similarly, we would also like to know whether advanced economies versus emerging markets have experienced alternative monetary policy reaction functions during this period. To focus on these two additional questions, Equation 1 can be modified as follows:

$$\Delta i_{c,t} = \beta_0 + \sum_{g=1}^{2} \beta_1^g \Delta x_{c,t} + \sum_{g=1}^{2} \beta_2^g \Delta e_{c,t} + \varphi_c \times 1\left(100thCase_{c,t}\right) + \theta_c + \sum_{g=1}^{2} \gamma_t^g + \varepsilon_{c,t} \qquad (2)$$

where $g \in \{1, 2\}$ represent either country groups with and without zero bounds on their interest rates or advanced economies versus emerging markets. This modification is useful to distinguish between country groups within the treatment group and within the control group. According to this expression, the coefficient β_1^g in front of $\Delta x_{c,t}$, the coefficient β_2^g in front of $\Delta e_{c,t}$, and time fixed effects (γ_t^g's) are now country-group specific.

Although the distinction between advanced economies versus emerging markets is trivial, distinguishing between country groups with and without zero bounds on their interest rates requires further technical details. Accordingly, we consider a country on a particular day to have a zero lower bound on its interest rate if its interest rate is below a certain threshold on that day. In more formal terms, country c at time t has a zero lower bound on its interest rate if $i_{c,t} < \tau$, where τ represents the threshold interest rate. Therefore, country groups with and without zero bounds on their interest rates are determined in a continuous way as

countries are allowed to switch between groups over time. For robustness, we consider two alternative threshold interest rates, namely $\tau = 1\%$ and $\tau = 0.5\%$.

3 Data Set

For the estimation of Equations 1 and 2, data for daily policy rates have been obtained from the web pages of central banks for 28 advanced economies and 32 emerging markets.[3] Daily country-level economic activity is measured by Google mobility data for visits to public transport hubs (e.g., subway, bus, and train stations) as economic activity is achieved by the mobility of individuals, either for production or consumption purposes.[4] Exchange rate is measured by the amount of local currencies that can be purchased with one U.S. dollar; hence, an increase in exchange rate corresponds to the depreciation of the local currency.[5] Daily country-level data on COVID-19 cases and deaths have been obtained from the European Centre for Disease Prevention and Control.[6] The combination of all data sets has determined the daily sample for 60 countries around the world covering the period between February 15th, 2020 and May 2nd, 2020. All variables are represented as weekly percentage changes to control for seasonality by construction.

The variables are summarized for advanced economies versus emerging markets in Figure 1. Similarly, they are summarized for countries with and without zero bounds on their

[3] The list of emerging markets is as follows: Argentina, Bahrain, Botswana, Brazil, Bulgaria, Chile, Colombia, Croatia, United Arab Emirates, Hungary, India, Indonesia, Kazakhstan, Kuwait, Libya, Malaysia, Mauritius, Mexico, Nepal, Oman, Pakistan, Philippines, Poland, Qatar, Romania, Saudi Arabia, South Africa, Sri Lanka, Thailand, Trinidad and Tobago, Turkey, Venezuela. The list of advanced economies is as follows: Australia, United Kingdom, Canada, Czechia, Denmark, Austria, Belgium, Germany, Estonia, Spain, Finland, France, Ireland, Italy, Lithuania, Luxembourg, Malta, Netherlands, Israel, Japan, New Zealand, Norway, Singapore, South Korea, Sweden, Switzerland, Liechtenstein, Taiwan.

[4] The web page is https://www.google.com/covid19/mobility/.

[5] Daily exchange rate data have been downloaded from https://www.x-rates.com.

[6] The web page is https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide.

interest rates in Figure 2, where countries with zero lower bound on interest rates are defined as those that have a policy rate below 0.5% as of May 2nd, 2020 (although a continuous measure through threshold interest rates introduced above is used in formal estimations). As is evident, although the reduction in economic activity starting from March 2020 is very similar across country groups, the policy rate changes and depreciation rates are highly different. This suggests that alternative country groups might have reacted differently to the reduction in their economic activity, although this will be investigated formally by using the estimation results based on Equation 2 below.

4 Estimation Results

This section depicts the estimation results based on Equations 1 and 2.

4.1 Monetary Policy Reaction Function

The panel estimation results based on the pooled sample according to Equation 1 are given in Table 1, where, independent of the regression specification used, the coefficients in front of economic activity and depreciation are significantly positive. Given that economic activity is reduced during the sample period, it is implied that central banks have reacted by reducing their policy rates. It is also implied that central banks have reacted to sustain the stability of their currencies, potentially to keep future inflation under control. These results are in line with earlier studies such as by Ball (1999), Taylor (1999), Svensson (2000) or Taylor (2001) who have shown evidence for the reaction of central banks to output volatility or exchange rate changes.

4.2 Zero Lower Bounds and Country Groups

When the reaction of central banks in advanced economies is compared with that in emerging markets according to Equation 2, the results are given in Table 2. As is evident, although central banks in emerging markets have reacted to the reduction in their economic activity and changes in the value of their currencies by reducing their policy rates (due to the significantly positive coefficients), the central banks in advanced economies were not successful (due to the significantly negative coefficients). This is in line with earlier studies such as by Benmelech and Tzur-Ilan (2020) who suggest that higher-income countries have lowered their rates less than low-income countries during COVID-19. Since Figure 1 suggests that emerging markets had higher flexibility in changing their policy rates compared to advanced economies, this may be due to advanced economies facing zero bounds on their interest rates.

Accordingly, reactions of central banks in countries with and without zero bounds on their interest rates are compared in Table 3 and Table 4, where alternative threshold interest rates, namely $\tau = 1\%$ and $\tau = 0.5\%$, are used to define zero bounds on interest rates for robustness (i.e., a zero lower bound exists if $i_{c,t} < \tau$ for country c at time t). As is evident, independent of the threshold interest rate considered, central banks in countries without zero bounds on their interest rates have reacted to the reduction in economic activity or changes in the value of their currencies by reducing their policy rates (due to the significantly positive coefficients). However, due to the significantly negative or insignificant coefficients, central banks in countries without zero bounds on their interest rates were not successful in reacting either to the reductions in their economic activity or to the volatilities in their exchange rates.

4.3 Discussion of Results

It is implied that advanced economies or countries with a zero lower bound on their interest rates can benefit more from alternative policies, such as unconventional monetary or fiscal policies. This is in line with earlier studies such as by Benmelech and Tzur-Ilan (2020) who suggest that higher-income countries have lowered their rates less than low-income countries during COVID-19 and were more likely to use unconventional monetary policy tools. This is also consistent with earlier studies such as by Almunia, Benetrix, Eichengreen, OâĂŹRourke, and Rua (2010) who argue that fiscal stimulus is most effective when banking systems are dysfunctional and monetary policy is constrained by the zero bound.

The effectiveness of fiscal policies for countries with a zero lower bound on their interest rates is also supported by studies such as by Christiano, Eichenbaum, and Rebelo (2011), Ramey and Zubairy (2018) or Miyamoto, Nguyen, and Sergeyev (2018) who have shown that fiscal multipliers are higher during the periods of zero lower bounds. Nevertheless, as suggested by Benmelech and Tzur-Ilan (2020), the ability to conduct fiscal policies together with a zero lower bound on interest rates is limited by a country's access to credit markets. It is implied that the credit rating of countries with a zero lower bound on their interest rates is the most important determinant of effective policy design during the COVID-19 period.

5 Conclusion

This paper has analyzed whether central banks were able to react to the economic developments amid COVID-19 pandemic. The investigation has been achieved by using weekly changes in daily variables of policy rates, economic activity (measured by Google mobility)

and exchange rates for a panel of 28 advanced economies and 32 emerging markets. In order to consider causality, a difference-in-difference approach has been taken, where country fixed effects, time fixed effects as well as country-specific effects of the 100th COVID-19 case in each country have been controlled for.

Due to the significantly positive coefficients in monetary policy reaction functions, given that economic activity is reduced during the sample period, the panel empirical results based on the pooled sample suggest that central banks have reacted by reducing their policy rates. The panel empirical results also suggest that central banks have reacted to sustain the stability of their currencies, potentially to keep future inflation under control.

In additional analyses, countries have been categorized as advanced economies versus emerging markets as well as those with and without zero bounds on their interest rates. The corresponding panel estimation results show that emerging markets or countries without a zero lower bound on their interest rates were able to reduce their interest rates as a reaction to reduced economic activity and to the volatility in their exchange rates, whereas advanced economies or countries with a zero lower bound on their interest rates were not.

Several policy implications follow for countries with a zero lower bound on their interest rates during COVID-19. These include considering alternative policies such as unconventional monetary or fiscal policies as they have been shown to work better for countries with a zero lower bound on their interest rates. However, as the ability of these countries to conduct fiscal is limited by their access to credit markets, countries should pay more attention to their credit rating if they would like to be successful in fighting against the economic implications of COVID-19.

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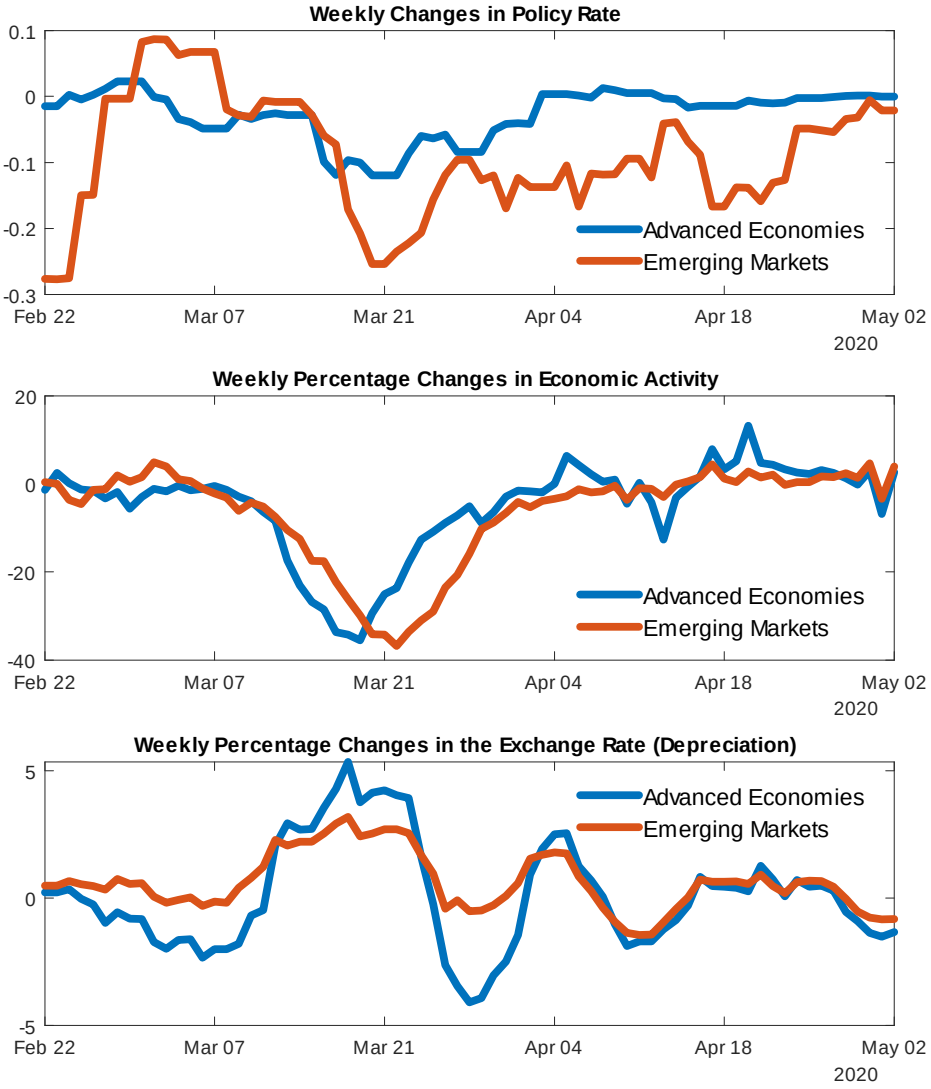
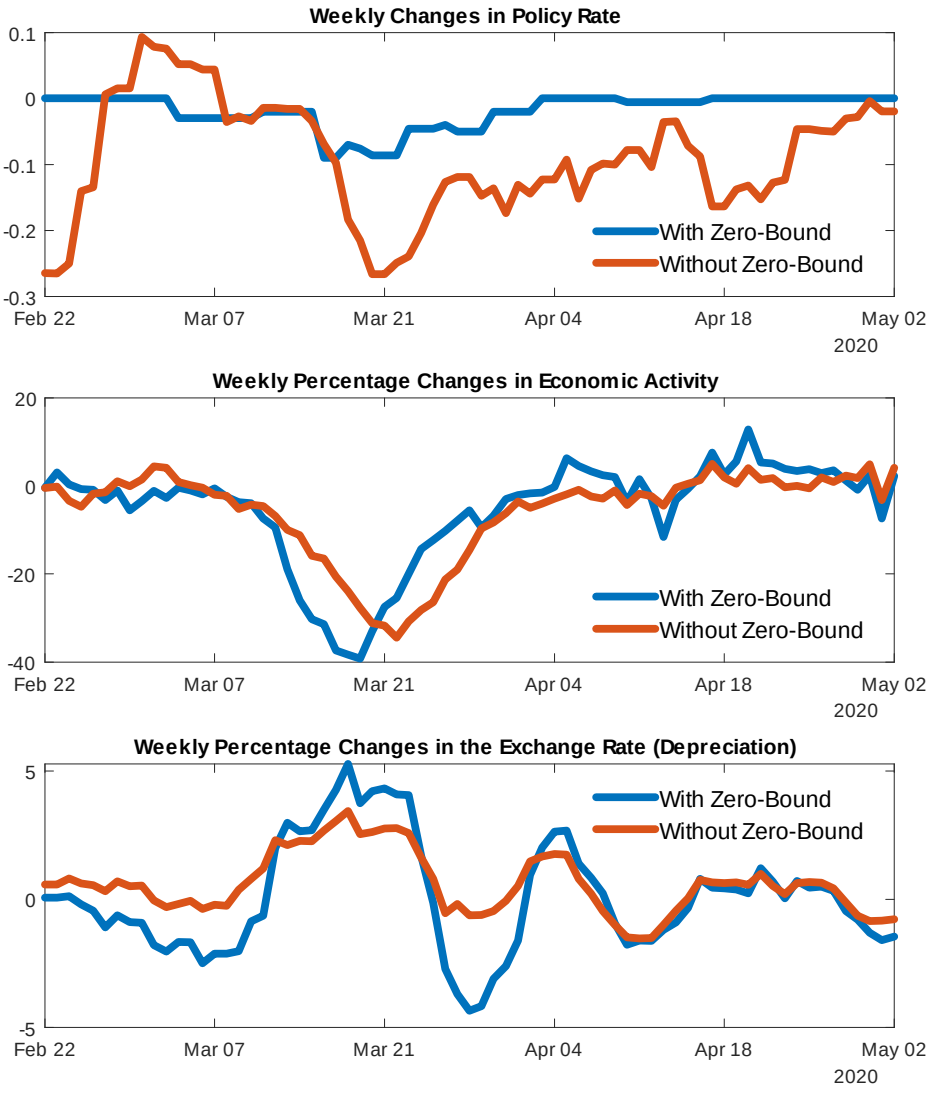
Figure 1 - Advanced Economies versus Emerging Markets



Notes: Lines represent the averages across countries within each group.

Figure 2 - Countries with and without Zero Bounds on Interest Rates



Notes: Lines represent the averages across countries within each group. Countries with zero bound on interest rates are defined as those that have a policy rate below 0.5% as of May 2nd, 2020.

Table 1 - Estimation Results for All Countries

	Dependent Variable: Weekly Changes in Policy Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Economic Activity (Weekly % Change)	0.0021**		0.0021**	0.0019**		0.0020**
	(0.0007)		(0.0007)	(0.0006)		(0.0006)
Depreciation (Weekly % Change)		0.0103**	0.0103**		0.0089*	0.0094*
		(0.0038)	(0.0037)		(0.0040)	(0.0040)
Time Fixed Effects	YES	YES	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES	YES	YES
Country-Specific 100th Case	NO	NO	NO	YES	YES	YES
Sample Size	4254	4260	4254	4254	4260	4254
R-Squared	0.124	0.122	0.126	0.270	0.268	0.271
Adjusted R-Squared	0.096	0.095	0.098	0.236	0.235	0.238

Notes: The panel estimation includes all countries in the sample. Robust standard errors are given in parentheses.

Table 2 - Estimation Results for Advanced Economies versus Emerging Markets

	Dependent Variable: Weekly Changes in Policy Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Economic Activity (Weekly % Change)	-0.0013***		-0.0012***	-0.0011***		-0.0010***
(Advanced Economies)	(0.0003)		(0.0003)	(0.0003)		(0.0003)
Economic Activity (Weekly % Change)	0.0039***		0.0039***	0.0033**		0.0035**
(Emerging Markets)	(0.0011)		(0.0011)	(0.0011)		(0.0011)
Depreciation (Weekly % Change)		-0.0106**	-0.0101*		-0.0095*	-0.0092*
(Advanced Economies)		(0.0040)	(0.0040)		(0.0043)	(0.0042)
Depreciation (Weekly % Change)		0.0165**	0.0168**		0.0133*	0.0144**
(Emerging Markets)		(0.0054)	(0.0054)		(0.0055)	(0.0056)
Group-Specific Time Fixed Effects	YES	YES	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES	YES	YES
Country-Specific 100th Case	NO	NO	NO	YES	YES	YES
Sample Size	4254	4260	4254	4254	4260	4254
R-Squared	0.140	0.136	0.143	0.284	0.281	0.286
Adjusted R-Squared	0.097	0.094	0.101	0.238	0.235	0.240

Notes: The panel estimation includes all countries in the sample. Robust standard errors are given in parentheses.

Table 3 - Estimation Results Based on Zero-Bounds on Interest Rates #1

	Dependent Variable: Weekly Changes in Policy Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Economic Activity (Weekly % Change)	-0.0006+		-0.0009**	-0.0005+		-0.0008*
(with a Zero-Bound on Interest Rates)	(0.0003)		(0.0003)	(0.0003)		(0.0003)
Economic Activity (Weekly % Change)	0.0033***		0.0035***	0.0029**		0.0031**
(without a Zero-Bound on Interest Rates)	(0.0010)		(0.0010)	(0.0009)		(0.0010)
Depreciation (Weekly % Change)		0.0035	-0.0000		0.0032	0.0001
(with a Zero-Bound on Interest Rates)		(0.0036)	(0.0035)		(0.0038)	(0.0038)
Depreciation (Weekly % Change)		0.0094*	0.0121*		0.0071	0.0101*
(without a Zero-Bound on Interest Rates)		(0.0047)	(0.0049)		(0.0047)	(0.0049)
Group-Specific Time Fixed Effects	YES	YES	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES	YES	YES
Country-Specific 100th Case	NO	NO	NO	YES	YES	YES
Sample Size	4254	4260	4254	4254	4260	4254
R-Squared	0.139	0.134	0.141	0.283	0.279	0.284
Adjusted R-Squared	0.096	0.091	0.098	0.237	0.233	0.238

Notes: The panel estimation includes all countries in the sample. Robust standard errors are given in parentheses. Monetary policy reaction function with a zero-bound on interest rates are defined as those that have a policy rate lower than 1% on a particular day (i.e., as a continous variable).

Table 4 - Estimation Results Based on Zero-Bounds on Interest Rates #2

	Dependent Variable: Weekly Changes in Policy Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Economic Activity (Weekly % Change)	-0.0010***		-0.0014***	-0.0009**		-0.0012***
(with a Zero-Bound on Interest Rates)	(0.0003)		(0.0003)	(0.0003)		(0.0003)
Economic Activity (Weekly % Change)	0.0034***		0.0036***	0.0030**		0.0032***
(without a Zero-Bound on Interest Rates)	(0.0010)		(0.0010)	(0.0009)		(0.0009)
Depreciation (Weekly % Change)		0.0050	0.0014		0.0049	0.0020
(with a Zero-Bound on Interest Rates)		(0.0045)	(0.0045)		(0.0048)	(0.0048)
Depreciation (Weekly % Change)		0.0085*	0.0115**		0.0063	0.0096*
(without a Zero-Bound on Interest Rates)		(0.0043)	(0.0045)		(0.0043)	(0.0045)
Group-Specific Time Fixed Effects	YES	YES	YES	YES	YES	YES
Country Fixed Effects	YES	YES	YES	YES	YES	YES
Country-Specific 100th Case	NO	NO	NO	YES	YES	YES
Sample Size	4254	4260	4254	4254	4260	4254
R-Squared	0.139	0.134	0.141	0.284	0.279	0.285
Adjusted R-Squared	0.097	0.091	0.098	0.237	0.233	0.238

Notes: The panel estimation includes all countries in the sample. Robust standard errors are given in parentheses. Monetary policy reaction function with a zero-bound on interest rates are defined as those that have a policy rate lower than 0.5% on a particular day (i.e., as a continous variable).