COVID-19 and Exchange Rates: Spillover Effects of U.S. Monetary Policy

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Abstract This paper investigates the spillover effects of United States monetary policy on exchange rates of 11 emerging markets and 12 advanced economies during the pre-Coronavirus Disease 2019 (COVID-19) period of 2019 versus the COVID-19 period of 2020. The investigation was achieved via a structural vector autoregression model, where year-on-year changes in weekly measures of economic activity, exchange rates and policy rates were used. The empirical results suggest evidence for the spillover effects of United States monetary policy for several countries during the pre-COVID-19 period, whereas they have been effective only for certain countries during the COVID-19 period that can be explained by the disease outbreak channel. It is implied that policies keeping the pandemic under control may help mitigate the unforeseen economic effects of the COVID-19 crisis.

Keywords COVID-19 · Coronavirus · Exchange Rates · Monetary Policy · Spillover Effects

JEL E52 · E58 · F31 · F42

Introduction

The Coronavirus Disease 2019 (COVID-19) reduced economic activity in an unprecedented way. This reduction resulted in extraordinary unemployment levels around the world. Accordingly, several central banks, including the U.S.
Federal Reserve System, reacted to the economic developments due to COVID-19 by reducing their policy rates.

This paper investigates the spillover effects of U.S. monetary policy on exchange rates during the pre-COVID-19 period of 2019 and the COVID-19 period of 2020. The main objective was to investigate whether these spillover effects were effective during the COVID-19 period. The motivation for investigating these spillover effects comes from earlier studies (Maćkowiak, 2007; Ho et al., 2018; Hanisch, 2019; Tillmann et al., 2019) which showed that economic activities in both advanced economies and emerging markets were affected by the U.S. monetary policy. This may be due to international movement of capital through bond markets (Albagli et al., 2019) through bank capital flows (Bruno & Shin, 2015), or through portfolio flows into equity funds (Fratzscher et al., 2018). It is also possible for these spillovers to affect risk perceptions and thus domestic credit costs (Kalemli-Özcan, 2019). The corresponding effects on the exchange rates are due to the relative yield of dollar-denominated instruments as U.S. monetary policy changes portfolio positions between the U.S. and international assets (Albagli et al., 2019).

The magnitude of the spillover effects of U.S. monetary policy can be heterogeneous across countries depending on their reaction to the COVID-19 pandemic. The literature (Haroon & Rizvi, 2020; Iyke, 2020; Mdaghri et al., 2020; Feng et al., 2021; Garg & Prabheesh, 2021; Aloui, 2021) has shown that volatilities in exchange rates (or financial market frictions) are correlated with the country-specific developments in COVID-19 cases or deaths. Therefore, it is essential to conduct a country-specific investigation of spillovers, as achieved by the current paper. More importantly, as central banks in other countries may react to the U.S. monetary policy, as suggested by several studies (Gray, 2013; Obstfeld, 2021; Rey, 2015; Georgiadis, 2016; Chen et al., 2016; Albagli et al., 2019; Azad & Serletis, 2020), it is also important to control for the monetary policy of individual countries while investigating the spillover effects of U.S. monetary policy.

This paper estimates the spillover effects of U.S. monetary policy on exchange rates. Country-specific analyses were conducted for 11 emerging markets and 12 advanced economies, controlling for the monetary policies of these countries. The formal analysis was based on a structural vector autoregression (SVAR) model, where year-on-year growth rates of weekly measures of economic activity, exchange rates, and policy rates were used during the pre-COVID-19 versus COVID-19 periods.

The spillover effects of U.S. monetary policy are investigated by accepting the U.S. economy as an exogenous block to be used in the SVAR estimation of each country. The focus is on the cumulative impulse response of exchange rates (constructed as appreciation of currencies) to a negative shock to the (shadow) federal funds rate. Also investigated is the contribution of the (shadow) federal funds rate to the exchange rate volatility of domestic currencies based on the forecast error variance decomposition.

The empirical results suggest evidence for the spillover effects of U.S. monetary policy for almost all countries during the during the pre-COVID-19 period, whereas they have been effective for only certain countries during the COVID-19 period.
period. When the reasons behind the heterogeneity across countries are further investigated, the current study shows that only the exchange rates of countries that were successful in fighting against COVID-19 were subject to the spillover effects of U.S. monetary policy during the COVID-19 period, consistent with earlier studies (Haroon & Rizvi, 2020; Iyke, 2020; Mdaghrí et al., 2020; Feng et al., 2021; Garg & Prabheesh, 2021; Aloui, 2021) which have shown that volatilities in exchange rates (or financial market frictions) are correlated with the country-specific developments in COVID-19 cases or deaths. Important policy implications follow regarding how the disease outbreak channel (Iyke, 2020; Feng et al., 2021) can be considered to fight against the economic and financial implications of COVID-19 through government interventions.

Theoretical Motivation

This section discusses the transmission channels of U.S. monetary policy from a theoretical perspective. Keynesian and neo-Keynesian models, as well as models with financial market frictions, are discussed to understand how the literature connects U.S. monetary policy shocks to exchange rate movements in other countries.

As discussed in Rey (2016), in Keynesian models, U.S. monetary loosening would increase (import) demand in U.S. exports by other countries (i.e., demand-augmenting effect). At the same time, this U.S. monetary loosening would decrease bond returns in the U.S. relative to other countries, resulting in depreciation of the U.S. dollar and thus more imports by other countries (expenditure-switching effect). Overall, in normal times, both imports and exports of other countries can increase following a U.S. monetary loosening, meaning that the overall effects on the value of the U.S. dollar and other currencies are uncertain. As indicated in Vidya and Prabheesh (2020), this uncertainty increased even further during the COVID-19 outbreak as global trade networks were affected negatively, especially due to lockdowns in many countries resulting in the manufacturing sector coming to a standstill.

Similarly, there is a trade-off in neo-Keynesian models between output stabilization and strengthening of the terms of trade to achieve optimal monetary policy in all countries (Obstfeld & Rogoff, 2000, 2002; Corsetti & Pesenti, 2001; Benigno & Benigno, 2003). This trade-off also implies that U.S. monetary policy spillovers are not certain, especially when monetary authorities in other countries react to U.S. monetary policy.

Financial market frictions can also play an important role regarding the spillover effects of U.S. monetary policy (Bernanke & Gertler, 1989; Bernanke & Gertler, 1995; Bernanke et al., 1996; He & Krishnamurthy, 2013; Brunnermeier & Sannikov, 2014; Curdia & Woodford, 2016; Gertler & Karadi, 2015). Specifically, following a U.S. monetary loosening, excessive risk-taking through financial intermediation can result in an increase in U.S. asset prices, especially when the financial risk perception is higher in other countries (e.g., during the COVID-19 period). Therefore, although the reduction in the interest rate is usually associated with a depreciation of the U.S. dollar (and thus appreciation of other currencies), financial market frictions can reverse this relationship.
In sum, as indicated by Iyke (2018), several fundamental macroeconomic indicators, such as foreign interest rates (partly representing foreign monetary policy), terms of trade and financial indicators, play important roles in the determination of exchange rates and thus the spillover effects of U.S. monetary policy. As disease outbreak was identified as an alternative channel of exchange rate behavior during the COVID-19 outbreak (Iyke, 2020), it is implied that the spillover effects of U.S. monetary policy might have changed as well during this period. Therefore, the mixed theoretical evidence for the spillover effects of U.S. monetary policy to exchange rates requires an empirical investigation to understand which channels dominated in application before and during the COVID-19 outbreak, depending on the economic developments and financial risk perception. Accordingly, as COVID-19 affected both the economy and the financial risk perception in all countries, this paper investigates the pre-COVID-19 period represented by the year of 2019 and the COVID-19 period represented by the year of 2020 separately. This is essential to understand whether U.S. monetary policy spillovers were different during the COVID-19 period. As monetary authorities in other countries can react to U.S. monetary policy, this paper also controls for the monetary policy of other countries while investigating the spillover effects of U.S. monetary policy.

Estimation Methodology and Data

The current study examines the spillover effects of U.S. monetary policy on exchange rates of countries. This was achieved by using the SVAR model of $z_t = (\Delta y_{US}^t, \Delta i_{US}^t, \Delta e_{US}^t, \Delta y_c^t, \Delta i_c^t, \Delta e_c^t)^\prime$, where $\Delta y_{US}^t$ represents percentage changes in U.S. economic activity, $\Delta i_{US}^t$ represents changes in the U.S. policy rate, $\Delta e_{US}^t$ represents percentage changes in the U.S. exchange rate (constructed as the appreciation of the U.S. dollar), $\Delta y_c^t$ represents percentage changes in the economic activity of country $c$, $\Delta i_c^t$ represents changes in the policy rate of country $c$, and $\Delta e_c^t$ represents percentage changes in the exchange rate of country $c$ (constructed as the appreciation of the domestic currency).

In formal terms, the SVAR model is given by:

$$A_o z_t = a + \sum_{k=1}^{4} A_k z_{t-k} + u_t$$

where $z_t = (\Delta y_{US}^t, \Delta i_{US}^t, \Delta e_{US}^t, \Delta y_c^t, \Delta i_c^t, \Delta e_c^t)^\prime$ as described earlier. In this expression, $u_t$ is the vector of serially and mutually uncorrelated structural innovations. For estimation purposes, the model is expressed in reduced form as follows:

$$z_t = b + \sum_{k=1}^{4} B_k z_{t-k} + e_t$$
where $b = A_o^{-1} a$, $B_k = A_o^{-1} A_k$ for all $k$. It is postulated that the structural impact multiplier matrix $A_o^{-1}$ has a recursive structure such that the reduced form errors $e_t$ can be decomposed according to $e_t = A_o^{-1} u_t$.

The recursive structure imposed on $A_o^{-1}$ requires an ordering of the variables used in the estimation for which the one already given by the ordering of the variables in $z_t$ was used. Specifically, for the U.S. economy, the Federal Reserve System reacts to changes in output on impact, whereas output is not affected by the policy rate on impact (although it can be affected in later periods). Per Bjørnland (2009), the exchange rate is affected by changes in the policy rate on impact, whereas the policy rate is not affected by the exchange rate on impact (although it can be affected in later periods). When the spillover effects of U.S. monetary policy in country $c$ were investigated, block exogeneity was used to ensure that the variables in country $c$ (namely, $\Delta y_c^t, \Delta i_c^t$ and $\Delta e_c^t$) cannot have any impact on the U.S. variables (namely, $\Delta y_{US}^t, \Delta i_{US}^t$ and $\Delta e_{US}^t$). Finally, the same ordering of the domestic variables was considered within each country (as in the case for the U.S. economy).

All percentage changes are in annual terms, calculated using weekly data with respect to the previous year; i.e., they represent year-on-year growth rates in weekly variables. Thus, all variables are controlled for seasonality by construction. In order to compare the pre-COVID-19 and COVID-19 periods, two separate weekly sample periods, namely the weeks of 2019 and the weeks of 2020, were employed in the empirical investigation. When the spillover effects of U.S. monetary policy in country $c$ were investigated, individual estimations were achieved for 11 emerging markets and 12 advanced economies.1

Percentage changes in economic activity in the U.S. $\Delta y_{US}^t$ were measured by the Organisation for Economic Co-operation and Development (OECD, 2021) Weekly Tracker of Economic Activity. Changes in the U.S. policy rate $\Delta i_{US}^t$ were measured by using the updated version of the daily shadow federal funds rate provided by Ristiniemi and Rezende (2018) to control for the zero-lower bound. Percentage changes in the exchange rate of the U.S. $\Delta e_{US}^t$ were calculated by using the Trade Weighted U.S. Dollar Index obtained from Federal Reserve Economic Data (2021).

Percentage changes in economic activity $\Delta y_c^t$ of country $c$ were again measured by the OECD (2021) Weekly Tracker of Economic Activity. Changes in the policy rate of country $c$, $\Delta i_c^t$, were measured by using the updated version of the daily shadow policy rate provided by Ristiniemi and Rezende (2018) to control for the zero-lower bound in Sweden, the Euro Area and the United Kingdom. For other countries, they were calculated by using the daily central bank policy rates obtained from the Bank for International Settlements (2021a). Percentage changes in the exchange rate of country $c$, $\Delta e_c^t$, were calculated by using the daily effective exchange rate indices obtained from Bank for International Settlements (2021b).

1 These are the only countries available based on the intersection of all data sets. The list of emerging markets is as follows: Argentina, Brazil, China, Colombia, India, Indonesia, Mexico, Romania, Russia, South Africa and Turkey. The list of advanced economies is as follows: Australia, Canada, Czechia, Denmark, the Euro Area, Iceland, Israel, Korea, New Zealand, Norway, Sweden, and the United Kingdom.
The time-series properties of the model variables were confirmed to be stable as none of the roots were outside the unit circle. The estimation was achieved by a Bayesian approach with independent normal-Wishart priors. This corresponds to generating posterior draws for the structural model parameters by transforming each reduced-form posterior draw. In particular, for each draw of the covariance matrix from its posterior distribution, the corresponding posterior draw for \( A_o^{-1} \) was constructed by using triangular factorization so that the sizes of the shocks were standardized to unity.

In the Bayesian framework, a total of 2,000 samples was drawn, where a burn-in sample of 1,000 draws was discarded. The remaining 1,000 draws were used to determine the structural impulse responses and the forecast error variance decomposition. While the median of each distribution was considered as the Bayesian estimator, the 16th and 84th quantiles of distributions were used to construct the 68% credible intervals (which is the standard measure in the Bayesian literature).

**Estimation Results**

Since interest is in the spillover effects of U.S. monetary policy on the exchange rates of countries, especially during the COVID-19 period, the focus was on the cumulative impulse response of exchange rates (constructed as appreciation of currencies) to a negative shock to the (shadow) federal funds rate. Also investigated was the contribution of the (shadow) federal funds rate to the exchange rate volatility of domestic currencies based on the forecast error variance decomposition. These investigations were achieved for the weeks of 2019 and 2020 separately.

For the year of 2019, cumulative impulse responses of domestic exchange rates (constructed as appreciation of currencies) after one year following a negative shock to the (shadow) federal funds rate are given in Table 1 for all countries and as continuous responses in Fig. 1 for selected countries.\(^2\) As is evident, following a negative shock on the federal funds rate, the U.S. dollar depreciates for any period after the shock. Based on the earlier discussion during the theoretical motivation, it was implied (according to Keynesian models) that the demand-augmenting effect was more active during the pre-COVID-19 period. It was also implied that (unexpected) lower interest rates in the U.S. might have resulted in capital outflows due to financial arbitrage opportunities in other countries during the pre-COVID-19 period.

Regarding the spillover effects of U.S. monetary policy, domestic exchange rates (constructed as appreciation of currencies) increased for almost all countries during the pre-COVID-19 period represented by the year of 2019, except for Brazil, India, and Turkey for which the credible intervals included insignificant effects on exchange rates after one year. These results suggesting that there is evidence for the spillover effects of U.S. monetary policy are consistent with earlier studies (e.g., Maćkowiak, 2007; Georgiadis, 2016; Chen et al., 2016; Ho et al., 2018; Hanisch, 2019; Albagli et al., 2019; Azad & Serletis, 2020). Based on the discussion in the

\(^2\) The corresponding figures for all countries are available in the Online Supplemental Appendix.
| Country          | Advanced | Reaction to Federal Funds Rate in 2019 | Reaction to Federal Funds Rate in 2020 |
|------------------|----------|----------------------------------------|----------------------------------------|
|                  |          | Median | Credible Interval | Median | Credible Interval |
| United States    | 1        | -44.4  | [-69.6, -29.9]    | -6.8   | [-40.4, 14.3]     |
| Argentina        | 0        | 180.9  | [116.5, 267.4]    | -5.6   | [-47.8, 38.7]     |
| Australia        | 1        | 38.2   | [24.3, 58.4]      | 47.4   | [-5.2, 105.4]     |
| Brazil           | 0        | -12.7  | [-82.6, 38.0]     | -20.5  | [-44.7, 8.0]      |
| Canada           | 1        | 39.4   | [18.7, 68.8]      | 6.9    | [-3.8, 22.6]      |
| China            | 0        | 39.6   | [19.9, 68.0]      | 31.5   | [10.9, 62.3]      |
| Colombia         | 0        | 154.6  | [68.8, 336.9]     | 8.7    | [-12.6, 36.4]     |
| Czechia          | 1        | 58.1   | [39.0, 89.1]      | 10.1   | [-11.1, 35.9]     |
| Denmark          | 1        | 44.7   | [27.5, 73.7]      | 25.1   | [-3.5, 64.2]      |
| Euro Area        | 1        | 39.6   | [21.8, 63.6]      | 24.2   | [-11.6, 76.1]     |
| Iceland          | 1        | 137.9  | [92.1, 211.7]     | 12.0   | [-11.3, 46.5]     |
| India            | 0        | -87.0  | [-408.9, 0.8]     | 6.1    | [-5.4, 25.2]      |
| Indonesia        | 0        | 45.6   | [12.2, 78.1]      | -2.9   | [-11.5, 11.9]     |
| Israel           | 1        | 70.7   | [47.0, 111.1]     | -0.3   | [-11.1, 14.1]     |
| Korea            | 1        | 33.5   | [12.5, 66.4]      | 19.5   | [-0.4, 43.9]      |
| Mexico           | 0        | 49.7   | [10.4, 107.6]     | 0.4    | [-32.0, 48.4]     |
| New Zealand      | 1        | 31.2   | [13.5, 60.1]      | 76.9   | [38.5, 148.0]     |
| Norway           | 1        | 115.9  | [28.2, 379.7]     | 18.3   | [-9.2, 58.3]      |
| Romania          | 0        | 26.0   | [5.4, 45.6]       | 18.8   | [-5.3, 48.3]      |
| Russia           | 0        | 130.8  | [90.2, 195.0]     | -49.4  | [-90.8, -20.3]    |
Table 1 (continued)

| Country       | Advanced | Reaction to Federal Funds Rate in 2019 | Reaction to Federal Funds Rate in 2020 |
|---------------|----------|----------------------------------------|----------------------------------------|
|               |          | Median | Credible Interval | Median | Credible Interval |
| South Africa  | 0        | 144.6  | [96.6, 218.7] | -21.0  | [-58.4, 17.3]    |
| Sweden        | 1        | 45.4   | [25.5, 80.5]  | 7.5    | [-29.0, 42.2]    |
| Turkey        | 0        | 30.4   | [-362.1, 214.3]| 114.9  | [-58.6, 681.9]   |
| United Kingdom| 1        | 90.1   | [53.7, 152.1] | 16.6   | [-5.8, 49.5]     |
| Average       | 0.5      | 58.5   | [-4.1, 123.2]  | 14.1   | [-19.2, 70.0]    |
| Advanced      | 1        | 53.9   | [25.7, 106.6] | 19.8   | [-8.0, 55.5]     |
| Emerging      | 0        | 63.9   | [-39.4, 142.8] | 7.4    | [-32.4, 87.1]    |

Source: Own calculations using data from Bank for International Settlements (2021a, b), Federal Reserve Economic Data (2021) and OECD (2021) Weekly Tracker of Economic Activity. Notes: Reaction to Federal Funds Rate shows the cumulative impulse response of country-specific exchange rates (constructed as appreciation of local currencies) to a negative shock on Federal Funds Rate after 52 weeks. Advanced takes a value of 1 if the country is an advanced economy and takes a value of 0 if the country is an emerging market. The summary results for advanced economies and emerging markets at the bottom of the table represent the corresponding average values.
Fig. 1  Cumulative Impulse Responses of Exchange Rates to a Negative Shock on the U.S. Policy Rate in 2019 Notes: The solid lines represent the estimates, while dashed lines represent lower and upper bounds that correspond to the 68% credible intervals. The vertical axes represent the cumulative impulse responses of exchange rates in percentage terms (constructed as appreciation of currencies) following a negative 1% shock to the U.S. policy rate.
theoretical motivation section, it was implied that exchange rates of several countries appreciated through financial arbitrage opportunities (capital inflows) following an unexpected U.S. monetary loosening during the pre-COVID-19 period, except for certain countries with potential higher financial risk perceptions in 2019.

The same investigation was achieved for the year of 2020, with the corresponding results for the COVID-19 period displayed in Table 1 and Fig. 2, where the value of the U.S. dollar was mostly stable following a negative shock to the federal funds rate. This can be explained by the U.S. dollar being a safe-haven currency during economic crises, as indicated by Iyke (2020). Based on the earlier theoretical motivation discussion, this result is also consistent with earlier theoretical models, where the demand-augmenting effect was cancelled by the expenditure-switching effect according to the Keynesian view, a trade-off between output stability and strengthening the terms of trade according to the neo-Keynesian view, or higher financial risk perception in other countries which has resulted in an increase in U.S. asset prices according to financial market frictions.

Regarding the spillover effects of U.S. monetary policy during the COVID-19 period, domestic exchange rates were stable in almost all countries (i.e., credible intervals include insignificant effects on exchange rates) following a negative shock to the federal funds rate in 2020. The only exceptions were the currencies of China and New Zealand that appreciated following a negative shock to the federal funds rate during the COVID-19 period.

Studies (Haroon & Rizvi, 2020; Iyke, 2020; Mdaghri et al., 2020; Feng et al., 2021; Garg & Prabheesh, 2021; Aloui, 2021) have shown that volatilities in exchange rates (or financial market frictions) are related to the developments of COVID-19 cases or deaths. Thus, further investigations were conducted to determine whether two exception currencies (China and New Zealand) can be explained by the same developments. When focusing on the number of COVID-19 cases obtained from Our World in Data (2021), it was observed that China and New Zealand are the only countries in our sample with COVID-19 cases per million people below 1000 during 2020. Similarly, when focusing on the number of COVID-19 deaths obtained from Our World in Data (2021), China and New Zealand were the only countries in our sample with the number of COVID-19 deaths per million people below ten during 2020.

It is implied that policies keeping the pandemic under control may help mitigate the unforeseen economic effects of the COVID-19 crisis. This possibility was further investigated by using several alternative COVID-19 policies conducted by governments that were obtained from the COVID-19 Government Response Tracker (2021). Based on this data set, China and New Zealand are the countries that had the most effective contact tracing among all countries in our sample. Therefore, as China and New Zealand also had the lowest number of COVID-19 cases and deaths, by using contact tracing, policy makers may mitigate not only the pandemic but also the corresponding unforeseen economic effects.³ For sure, this policy suggestion is

³ This is also consistent with earlier studies (Baker et al., 2020; Summers et al., 2020; Bradshaw et al., 2021; Browne, 2022) who showed evidence for the effectiveness of contact tracing in reducing the spread of COVID-19.
Fig. 2 Cumulative Impulse Responses of Exchange Rates to a Negative Shock on the U.S. Policy Rate in 2020 Notes: The solid lines represent the estimates, while dashed lines represent lower and upper bounds that correspond to the 68% credible intervals. The vertical axes represent the cumulative impulse responses of exchange rates in percentage terms (constructed as appreciation of currencies) following a negative 1% shock to the U.S. policy rate.
not without caveats as the deviation of China and New Zealand from other countries may also be due to China being the first country exposed to COVID-19 (and thus taking policy measures earlier than other countries) or due to the exchange rate volatility in New Zealand during 2020, partly due to the internal political climate.

Overall, similar to Aloui (2021) who showed that the unforeseen COVID-19 crisis disturbed and modified investor behavior, the results of the current paper imply

| Country         | Advanced | Median % Contribution of Federal Funds Rate in 2019 | Credible Interval | Median % Contribution of Federal Funds Rate in 2020 | Credible Interval |
|-----------------|----------|---------------------------------------------------|-------------------|---------------------------------------------------|-------------------|
| United States   | 1        | 57.3 [% 37.5, 74.2]                               | 7.4 [% 2.3, 18.8]  |
| Argentina       | 0        | 46.4 [% 28.3, 64.2]                               | 4.9 [% 1.4, 11.8]  |
| Australia       | 1        | 41.9 [% 21.0, 59.9]                               | 18.3 [% 4.9, 42.7] |
| Brazil          | 0        | 10.0 [% 3.3, 25.3]                                | 16.4 [% 6.6, 31.5] |
| Canada          | 1        | 26.3 [% 6.8, 49.7]                                | 11.9 [% 5.6, 23.0] |
| China           | 0        | 34.5 [% 12.2, 60.1]                               | 12.5 [% 2.8, 28.4] |
| Colombia        | 0        | 23.5 [% 7.3, 48.7]                                | 14.0 [% 7.0, 23.3] |
| Czechia         | 1        | 50.1 [% 31.6, 69.0]                               | 14.9 [% 6.8, 26.5] |
| Denmark         | 1        | 29.1 [% 7.8, 55.1]                                | 4.7 [% 0.9, 15.9]  |
| Euro Area       | 1        | 33.3 [% 10.9, 56.0]                               | 5.0 [% 1.1, 15.5]  |
| Iceland         | 1        | 63.6 [% 42.9, 78.7]                               | 6.3 [% 2.2, 16.3]  |
| India           | 0        | 19.2 [% 5.6, 43.5]                                | 15.8 [% 7.9, 28.0] |
| Indonesia       | 0        | 33.1 [% 9.6, 58.5]                                | 11.0 [% 5.8, 19.9] |
| Israel          | 1        | 51.4 [% 21.4, 70.7]                               | 6.6 [% 2.0, 15.1]  |
| Korea           | 1        | 16.9 [% 4.7, 38.6]                                | 9.3 [% 3.2, 22.8]  |
| Mexico          | 0        | 19.6 [% 6.2, 39.1]                                | 17.2 [% 8.2, 31.4] |
| New Zealand     | 1        | 15.3 [% 4.7, 34.7]                                | 27.5 [% 9.1, 49.1] |
| Norway          | 1        | 15.6 [% 3.3, 41.0]                                | 14.1 [% 7.0, 25.9] |
| Romania         | 0        | 13.9 [% 3.3, 32.9]                                | 6.4 [% 2.4, 16.5]  |
| Russia          | 0        | 63.5 [% 46.6, 79.2]                               | 19.2 [% 10.6, 32.1]|
| South Africa    | 0        | 60.1 [% 40.3, 75.6]                               | 13.1 [% 5.5, 26.9] |
| Sweden          | 1        | 28.4 [% 9.3, 51.5]                                | 4.5 [% 1.3, 13.1]  |
| Turkey          | 0        | 12.5 [% 2.9, 35.6]                                | 4.7 [% 1.0, 15.9]  |
| United Kingdom  | 1        | 55.0 [% 29.5, 74.6]                               | 5.9 [% 1.7, 16.4]  |
| Average         | 0.5      | 34.2 [% 16.5, 54.9]                               | 11.3 [% 4.5, 23.6] |
| Advanced        | 1        | 37.2 [% 17.8, 58.0]                               | 10.5 [% 3.7, 23.2] |
| Emerging        | 0        | 30.6 [% 15.1, 51.2]                               | 12.3 [% 5.4, 24.2] |

Source: Own calculations using data from Bank for International Settlements (2021a, b), Federal Reserve Economic Data (2021) and OECD (2021) Weekly Tracker of Economic Activity. Contribution of Federal Funds Rate shows the part of exchange rate volatility explained by Federal Funds Rate based on forecast error variance decomposition after 52 weeks. Advanced takes a value of 1 if the country is an advanced economy and takes a value of 0 if the country is an emerging market. The summary results for advanced economies and emerging markets at the bottom of the table represent the corresponding average values.
Fig. 3 Contribution of Federal Funds Rate to the Exchange Rate Volatility in 2019
Notes: The solid lines represent the estimates, while dashed lines represent lower and upper bounds that correspond to the 68% credible intervals. The vertical axes represent the contribution of federal funds rate to the forecast error variance decomposition of the exchange rate in percentage terms.
Fig. 4 Contribution of Federal Funds Rate to the Exchange Rate Volatility in 2020 The solid lines represent the estimates, while dashed lines represent lower and upper bounds that correspond to the 68% credible intervals. The vertical axes represent the contribution of federal funds rate to the forecast error variance decomposition of the exchange rate in percentage terms.
that the unexpected shocks to federal funds rates were not effective on the exchange rates of several countries during the COVID-19 period. This contrasts with the results based on the pre-COVID-19 period during 2019, when there is evidence for the spillover effects of the U.S. monetary policy on the currencies of almost all countries. Therefore, the unforeseen COVID-19 crisis in fact disturbed and modified the behavior of investors in the global financial markets.

The sharp difference between the pre-COVID-19 period and the COVID-19 period can be observed in Table 1. As is evident based on the median values, the cumulative reaction of domestic currencies was about 59% for the average country during the pre-COVID-19 period. It was reduced to about 14% during the COVID-19 period. Although the reactions of domestic currencies were similar for advanced economies versus emerging markets during the pre-COVID-19 period, they were higher for advanced economies during the COVID-19 period. This result is also consistent with earlier studies (Georgiadis, 2016; Albagli et al., 2019; Azad & Serletis, 2020) which showed evidence for heterogeneity across countries regarding the spillover effects of U.S. monetary policy.

The current study investigated the contribution of the (shadow) federal funds rate to the exchange rate volatility of domestic currencies based on the forecast error variance decomposition. The corresponding results are in Table 2 for all countries (reported after one year) and in Figs. 3 and 4 for selected countries in a continuous way. As is evident, the spillover effects of U.S. monetary policy were much higher during the pre-COVID-19 period compared to the COVID-19 period. Specifically, the contribution of a shock to the federal funds rate was about 34% for the average country during the pre-COVID-19 period, whereas it was reduced to about only 11% during the COVID-19 period. This comparison holds for the average advanced country and the average emerging market as well.

In sum, there is evidence for the spillover effects of U.S. monetary policy for almost all countries during the during the pre-COVID-19 period. They were effective for only certain countries during the COVID-19 period. This can be explained by the disease outbreak channel as in studies such as Iyke (2020).

Concluding Remarks and Policy Suggestions

This paper investigated the spillover effects of U.S. monetary policy on exchange rates of 11 emerging markets and 12 advanced economies during the pre-COVID-19 and COVID-19 periods. The formal investigation utilized country-specific structural vector autoregression models, where year-on-year percentage changes in weekly economic activity, exchange rates and policy rates were employed. The results suggest that evidence exists for the spillover effects of U.S. monetary policy for almost all countries during the pre-COVID-19 period, whereas they have been effective only for certain countries during the COVID-19 period, explained by the disease outbreak channel as in Iyke (2020).

Important policy implications follow. China and New Zealand were the only countries whose currencies appreciated following a negative shock to the federal funds rate during the COVID-19 period. These are also the only countries in our
sample that were successful in keeping their COVID-19 cases and deaths under control. Thus, it is implied that the unforeseen effects of the COVID-19 crisis that disturbed and modified the behavior of investors, as in Aloui (2021), can be avoided by keeping the pandemic (i.e., COVID-19 cases and deaths) under control.

As discussed in Feng et al. (2021) in the context of exchange rate volatility, controlling the pandemic can be achieved through government interventions, such as restricting internal movement, public information campaigns or closing schools. Such an approach is also consistent with earlier studies (Haroon & Rizvi, 2020; Mdaghi et al., 2020) which showed that flattening the curve of coronavirus infections can help reduce uncertainty among international investors, which in turn can result in the appreciation of domestic currencies following a negative shock to the federal funds rate due to higher international liquidity.

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