economies

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Did Remittance Inflow in Bangladesh Follow the Gravity Path during COVID-19?

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Abstract: Remittances are one of the major driving forces of economic growth in Bangladesh. The paper's main objective is to empirically investigate the effect of COVID-19 on the remittance inflow to Bangladesh using a gravity model framework. We have employed monthly data of remittance inflow to Bangladesh from January 2018 to September 2022 with its top twelve partners, namely the Kingdom of Saudi Arabia, the United Arab Emirates, Kuwait, Qatar, Oman, Bahrain, Libya, the United Kingdom, Italy, Malaysia, Singapore, and Japan. Using the gravity equation, we tapped the COVID-19 dummy as the critical variable of our interest, along with COVID transmission, mortality, and vaccination data at home and abroad. Using Poisson pseudo-maximum likelihood (PPML), fixed-effect (FE), and random-effect (RE) estimations, we find that during the COVID-19 pandemic, remittance inflow to Bangladesh increased significantly after controlling for other Gravity variables.

Keywords: COVID-19; gravity model; remittance inflow; Bangladesh; panel data; South Asia

JEL Classification: F30; F24

Citation: Goswami, Gour Gobinda, Munim Kumar Barai, Mahnaz Aftabi Atique, and Mostafizur Rahman. 2023. Did Remittance Inflow in Bangladesh Follow the Gravity Path during COVID-19? *Economies* 11: 285. https://doi.org/10.3390/economies11110285

Academic Editor: Robert Czudaj

Received: 14 October 2023
Revised: 15 November 2023
Accepted: 16 November 2023
Published: 20 November 2023

1. Introduction

Remittance is considered one of the main supporting financial pillars of Bangladesh's economy. Trailing closely behind the export of ready-made garments (RMG), remittance sent home by expatriate workers is the second-largest source of foreign exchange earnings for the country. Therefore, remittance inflow is a substantial source of foreign exchange earnings in Bangladesh, extending a major external financial lifeline for its economy (Barai 2020). Approximately twelve million Bangladeshi citizens currently work as migrant workers worldwide, and cumulatively, they sent home more than 22 billion dollars in remittance earnings in the year 2022 (BMET 2022). With the level of remittance inflow in 2022, Bangladesh ranks seventh in the world and third in South Asia (World Bank/KNOMAD 2022a). Despite global turmoil due to COVID-19 and the Russo-Ukrainian War, inward remittance inflow in Bangladesh registered an annual growth of 2% in 2022 compared to 2021. It contributed around 4.6% of the country's GDP (Authors' compilation from (BMET 2022) data).

The spread of COVID-19, beginning in early 2020, was a sudden external shock to the global economy. Its impact on financial markets and economies was even farther-reaching, as the world experienced the worst recession in 2020 since the great depression. Indeed, Bangladesh's economy underwent a turbulent time during the COVID-19 pandemic. The global GDP contracted by 3.1% (IMF World Economic Outlook October 2021 (IMF 2021)), and the global unemployment rate soared to 6.5%, registering a 1.1% surge in unemployment compared to 2019 (United Nations 2021). During the onset of the pandemic, there were significant concerns regarding foreign remittance inflow to Bangladesh. Remittance as a source of finance is susceptible to global economic shocks because of its inbuilt external

dependence. Therefore, the remittance inflow in Bangladesh was forecasted to plummet mainly due to the following reasons.

First, to slow the spread of COVID-19, most countries adopted extreme containment measures, like shutting down international borders, mandating quarantine measures, and restricting resident movement entirely or partially. These restrictive measures often lasted for months together, and as a result, migrant-worker-dependent industries, like construction, mining, tourism, and hospitality were most adversely impacted. Consequently, many Bangladeshi migrant workers lost their jobs and were forced to return home because of contract termination, lack of health insurance or health benefits, inadequate quarantine facilities, etc. There was uncertainty regarding their duration of unemployment and whether they could return to their countries of employment overseas due to border shutdown and economic downturn in host countries due to the pandemic effect. In many countries, public health laws and protocols were used to justify the deportation of migrant workers (ILO 2021).

Second, migrant workers who managed to keep their jobs reported pay cuts without prior warnings, lesser job availability, temporary suspensions, and forced unpaid leaves. The initial COVID-19 assistance packages were prioritized for citizens only and systematically excluded migrant workers from social security in their host countries. ILO (2020) found that only 3% of international migrants received social benefits in their host countries. Unemployed and without any assistance, many migrant workers either had to break their savings or incurred new debts.

Lastly, most Middle Eastern and Southeast Asian countries completely halted recruiting new migrant workers from foreign countries due to lengthy paperwork, such as health protocols, vaccines, and COVID-19 negative certification; many workers migrating abroad either delayed or canceled their plans for an uncertain period. Therefore, the workforce export from Bangladesh was reduced compared to 2019. As a result, it was projected that inward remittance inflow would be adversely affected due to the COVID-19 pandemic in Bangladesh. However, proving all negative projections false, the remittance inflow to Bangladesh registered an 18.4% surge in the year 2020 compared to the year 2019. In 2021, the remittance inflow growth rate was 2.2% (World Bank/KNOMAD 2021, 2022b).

In this situation, the question arises: Did COVID-19 not influence the remittance inflow to Bangladesh amid a global recession, significant job losses, and stringent containment measures? Why did remittance inflow growth remain so resilient, and what were the motivations of migrant laborers for sending money back home? Using a gravity model framework, this paper seeks to determine the effect of the COVID-19 pandemic on the inflow of remittances to Bangladesh. We analyze monthly data on remittance inflows to Bangladesh from twelve partner countries, namely the Kingdom of Bahrain, Italy, Japan, Kuwait, Libya, Malaysia, Oman, Qatar, Saudi Arabia, Singapore, the United Arab Emirates, and the United Kingdom, from January 2018 through September 2022. The COVID-19 pandemic's effects on remittance inflow were examined using the PPML estimation methodology. To the best of our knowledge, this is the first study to use the Gravity Model to investigate the impact of COVID-19 on remittance inflow in Bangladesh.

The rest of the paper is organized as follows: Section 2 provides a detailed literature review, Section 3 contains an overview of the remittance sector in Bangladesh, Section 4 outlines the theoretical framework with model specification, Section 5 provides an overview of the data and variables used for empirical analysis, Section 6 reports the results of data analysis, model estimation, and their interpretation, and the paper concludes with Section 7, which provides policy recommendations.

2. Literature Review

Over the years, a growing body of literature has tried to identify the migrant worker's motive behind sending remittance to their home country. The "Altruistic" motive suggests that migrant workers send remittances to support their families and protect them from adverse economic shocks (Azizi 2021; Fonchamnyo 2012). On the contrary, the "Investment"

motive suggests migrant workers prioritize self-interest and remit money to their home country for investment purpose in expectation of future returns (Lueth and Ruiz-Arranz 2006; Cooray and Mallick 2013; Le 2011). Another theory suggests that a combination of both the "Altruistic" and "Investment" motives drives migrants' incentives (Lucas and Stark 1985; Silva et al. 2022). Here, we present our literature review in three segments. The first segment discusses the literature that attempted to identify the determinants of remittance. The second segment reviews papers investigating the impact of COVID-19 on remittance inflow. The last part identifies potential research gaps by reviewing documents that specifically used the gravity model to determine the effect of the COVID-19 pandemic on remittance.

2.1. Determinants of Remittance Inflow

The gravity model has been used extensively using country-specific time series and panel data to identify macro-determinants of remittance. Lueth and Ruiz-Arranz (2006) applied the gravity model on bilateral remittance inflow using annual data of eleven developing countries in Asia and Europe with 200 partner countries from 1980–2004. Estimations using pooled ordinary least square (OLS), fixed-effect (FE), and random-effect (RE) regression revealed that migrant stock, bilateral exchange rate, inflation, dependency ratio, and political environment in the home country are significant determinants of remittance inflow. The paper also reports a "pro-cyclical pattern" of remittance inflow that suggests migrant workers send higher remittance when the home country's economy fares well, supporting the "Investment" motive.

Poghosyan (2020) used the gravity model to analyze remittance flows in Russia, the Caucasus, and Central Asian (CCA) countries from 2010–2017. The difference between output gaps in sending and receiving countries affected remittance positively and significantly. This supports the counter-cyclical hypothesis, i.e., that remittance inflow increases when output is above potential in the host country or below potential in the receiving country. The altruistic motive can be used to justify the "counter-cyclical pattern" of remittance inflow, which suggests migrant workers send more money to their families when the home country faces difficult economic times (De et al. 2019).

Using the gravity model, McCracken et al. (2016) analyzed panel data from 27 Latin American and Caribbean countries from 1998–2007. The empirical findings from pooled OLS, FE, and RE estimation reveal that altruistic and self-interest motives are essential determinants of remittance inflow to the home country. The study also found that external shocks, like natural disasters, political instability, and demographic factors, impact remittance inflow positively and significantly.

Alam et al. (2015) adopted a gravity model approach using Bangladesh remittance earnings from thirteen host countries from 2002–2013. They found that a better economic condition of host countries increases remittance inflow significantly, but an appreciation of foreign exchange rate adversely affected remittance inflow. Ahmed and Martinez-Zarzoso (2014) also adopted the gravity model to analyze the bilateral remittance inflow to Pakistan from 23 destination countries for 2001–2011. Applying various estimation techniques, like pooled OLS, fixed-effects, two-stage least squares, Mundlak, and Hausman–Taylor methodology, they found that transaction cost, migration stock, and financial sector development in Pakistan significantly impacted remittance inflow.

2.2. COVID-19 and Its Impact on Remittance Inflow

Kpoder et al. (2022) analyzed monthly remittance inflow data from 52 countries and bilateral remittance data from 16 countries from January 2018 to December 2022. Using the local projection approach (LPA) and impulse response function (IRF) methodologies, they revealed an initial transitory dip in remittance inflow. However, a positive and significant relation between remittance inflows and the COVID-19 contamination rate in the home country could be observed during the pandemic, supporting an "altruistic" motive.

Similar results were reported by Shimizutani and Yamada (2021), who worked with household-level monthly data of Tajikistan for the period January 2018–December 2021. Using "seasonal trajectory" and before–after regression analysis using baseline data, they reported that remittance inflow declined significantly in April and May 2019. However, remittance inflow quickly increased again to the pre-pandemic level. Dinarte-Diaz et al. (2022) collected municipal-level data from Mexico for 2013–2020 and conducted OLS regression with time- and municipality-fixed effects. Their results suggest that during the pandemic, people sent more remittances using the formal channel as informal channels were less accessible due to border closures and movement restrictions.

Caruso et al. (2021) analyzed remittance inflow data of 17 Central American and Caribbean countries from the USA from 2004 to 2018. Using the country-fixed effects on the linear regression model, they projected a 14% decline in remittance inflow in 2020. Murakami et al. (2021) examined household-level data from the Philippines and applied a two-stage least squares regression that predicted a 14–20% decline in remittance inflow due to the COVID-19 pandemic. Gupta et al. (2021) used micro-level weekly household data from India's rural West Bengal region. Arellano–Bond instrumental variable regression revealed that remittance income fell by 63% in the first month of the lockdown during the first wave of the pandemic.

Chen et al. (2020) analyzed Samoa's monthly remittance inflow data with three partner countries, i.e., Australia, New Zealand, and the USA, from May 2022 to July 2022. Using the vector error correction model (VECM), they reported the heterogenic effect of the COVID-19 pandemic on remittance inflow in Samoa, where remittance inflow from Australia and New Zealand has increased, but that from the USA has decreased. Withers et al. (2021) conducted a systemic policy review for India, Nepal, and Sri Lanka. They predicted that countries with less diversified labor destinations would be hit more severely due to the temporary suspension of labor migration.

Akter et al. (2022) analyzed monthly remittance data of Bangladesh from January 2008 to December 2021 and applied the autoregressive distributive lag (ARDL) estimation technique. They revealed that remittance inflow increased during the pandemic, supporting the "Altruistic" motive. In addition, they found that the exchange rate positively and significantly affects remittance inflow in the long run. On the contrary, Hossain (2021) examined yearly data on GDP and remittance from 1971 to 2019. Using time series forecasting methodology, he predicted a 19.73% decline in remittance inflow to Bangladesh during the pandemic.

In addition, several other scenario analyses and policy papers discussed and recommended policies to mitigate the adverse impact of the COVID-19 pandemic on remittance inflow in the context of Bangladesh (Karim et al. 2020; Chowdhury and Chakraborty 2021).

2.3. COVID-19 and Its Impact on Remittance Inflow: Gravity Model Approach

The gravity model provides the opportunity to include external shocks like natural disasters, political instability, etc., as dummy variables in analyzing remittance flow across borders. Shastri (2021) examined the impact of five infectious diseases (not including COVID-19) on remittance inflow in India from 99 host countries from 2000–2018. Using a gravity model and pooled OLS, FE, RE, and Hausman–Taylor estimation techniques, he found that infectious diseases have significantly reduced remittance inflow in India. The paper also reported a "counter-cyclical" pattern of remittance inflow in India, which implies migrant workers send more remittance in times of domestic economic crisis.

Silva et al. (2022) incorporated COVID-19-related government measures as dummy variables in an extended gravity model. They analyzed bilateral remittance earnings using quarterly panel data of 10 Latin American countries for 2019–2020. Using Poisson pseudo-maximum likelihood (PPML) estimation, they analyzed the effect of containment measures on remittance inflow in Latin American countries. They found that migrant workers sent higher amounts of inward remittance when restrictive measures such as a lockdown or movement restrictions were gradually eased in their home country. However,

the restrictive measures taken in host countries were found to be insignificant for Latin American countries.

As per our findings, no paper has yet analyzed the impact of COVID-19 on remittance inflow using the gravity model in the context of Bangladesh, a country in South Asia where remittance is a crucial driver of economic growth.

3. Overview of the Remittance Sector in Bangladesh

Remittance earnings sent by expat workers have contributed as one of the primary drivers of economic growth in Bangladesh for the last two decades. As a net source of foreign exchange inflow, the remittance sent home by the migrant workers plays a pivotal part in Bangladesh's economic development in many ways. For example, remittance strengthens the balance of payment, enriches the foreign exchange reserve, and stimulates national savings (Chowdhury and Chakraborty 2021). In addition, remittance plays a vital role in alleviating poverty and inequality (Azizi 2021; Barai 2020; Combes et al. 2014). Similarly, the opportunity to work abroad reduces the unemployment problem in the domestic labor market as it creates new employment opportunities abroad. According to BMET (2020), more than 700,000 Bangladeshi workers seek employment abroad yearly. Apart from macro indicators, remittance inflow is also known to have a positive micro-level impact on household savings and investment, school enrollment, educational attainment, and women's empowerment (Wadood and Hossain 2017).

From Bangladesh, workforce export takes place in both temporary and permanent forms. Most migrant workers from Bangladesh are either unskilled or low-skilled laborers. These workers predominantly work in the plantation, hospitality, construction, and mining sectors as temporary labor on a short-term contract basis. They either return home once their contracts expire or re-apply for a contract extension. However, these unskilled workers cannot apply for citizenship due to strict permanent immigration laws. Many unauthorized Bangladeshi migrant workers also work in the informal sectors of these countries without proper and valid documents.

On the other hand, skilled and highly educated workers can permanently obtain "white collar" jobs and apply for citizenship in the long term. Therefore, temporary workers primarily send home more remittances as they want to invest in properties in Bangladesh and support their families. On the other hand, permanent workers eventually shift their families abroad and prefer to invest in their country of residence.

As illustrated in Figure 1, countries in the Middle East are the most significant employers of Bangladeshi temporary workforce, followed by Southeast Asian countries, namely Malaysia, Singapore, and Japan. Hence, the remittance inflow to Bangladesh is affected by this employment pattern, as Middle Eastern countries share 72%, and Southeast Asian countries constitute 13% of the total. Figure 1 presents a breakdown of remittance inflow to Bangladesh from the partner countries. The regional pattern of remittance earnings depicts an exciting story about Bangladesh's excessive dependence on Middle Eastern sources. In 2022, approximately one-fourth of the total remittances came from the Kingdom of Saudi Arabia alone.

The main factors behind significant differences in remittance inflow between countries are internal job market requirements in destination countries, diplomatic relations, religious and cultural similarities, and historical ties. For example, Middle Eastern countries mostly require low-skilled/unskilled manual labor, and Bangladesh, an overly populated country, has abundant such labor. Additionally, Bangladesh has historically sent laborers to countries like Saudi Arabia, the UAE, Kuwait, and Malaysia because of similarities in religion and Islamic culture. Bangladesh has had historical ties to the UK since the colonial era. On the other hand, Japan, Singapore, and Italy are comparatively newer expat destinations that primarily seek high-skill labor. Additionally, language and cultural differences are a considerable barrier to entry into these job destinations.

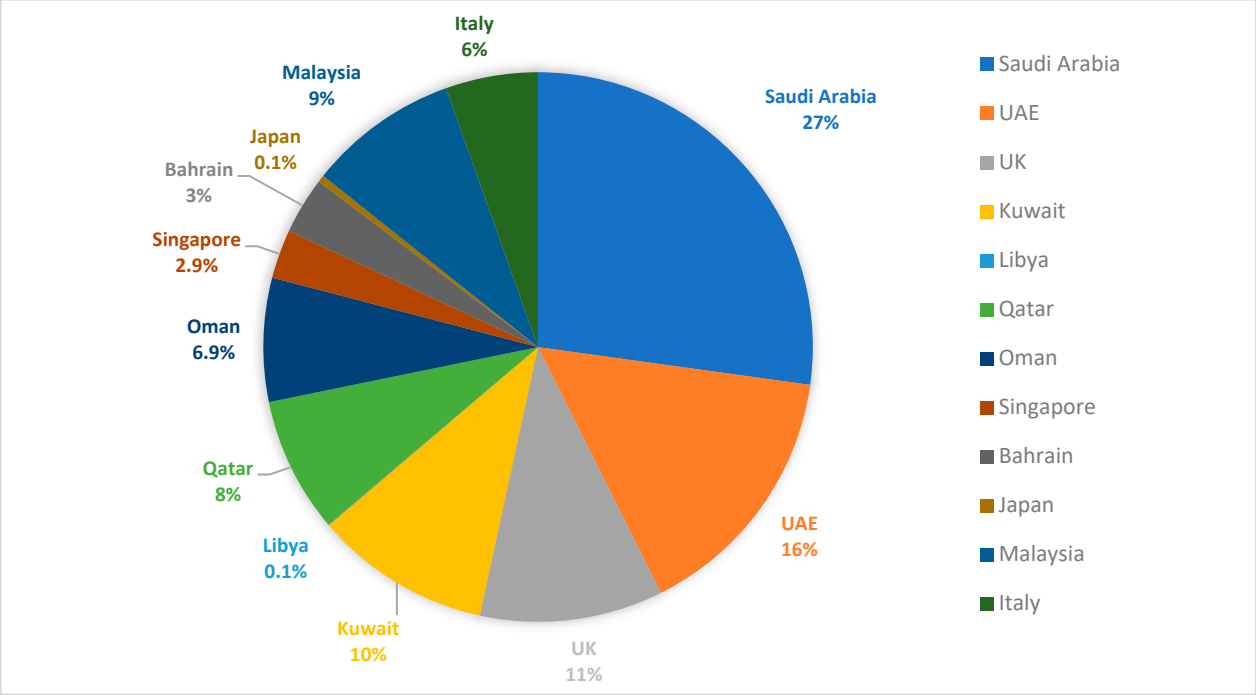

Figure 1. Partner-wise remittance inflow into Bangladesh. Source: (author's compilation from Bangladesh Bank monthly remittance data).

The following graphical presentations (Figure 2) depict monthly remittance inflow data to Bangladesh from 12 partner countries from January 2018 to September 2022.

Since we are working with monthly data, there are inherent seasonality trends. For example, religious occasions like the month of Ramadan or Eid will result in higher remittance inflow than rest of the months. Additionally, political turmoil, change in government regime or immigration laws, and fear of deportation due to government sanctions are various causes that may result an unusual spike in remittance flow's time series data. On the other hand, government incentive to send money via official channels, strict laws against hundi business, or the introduction of online overall money transfer services may have a sudden positive impact. However, the overall trend shows a clear upward pattern in remittance flow in 2020 and 2021, and most countries' remittance inflow growths remained quite robust.

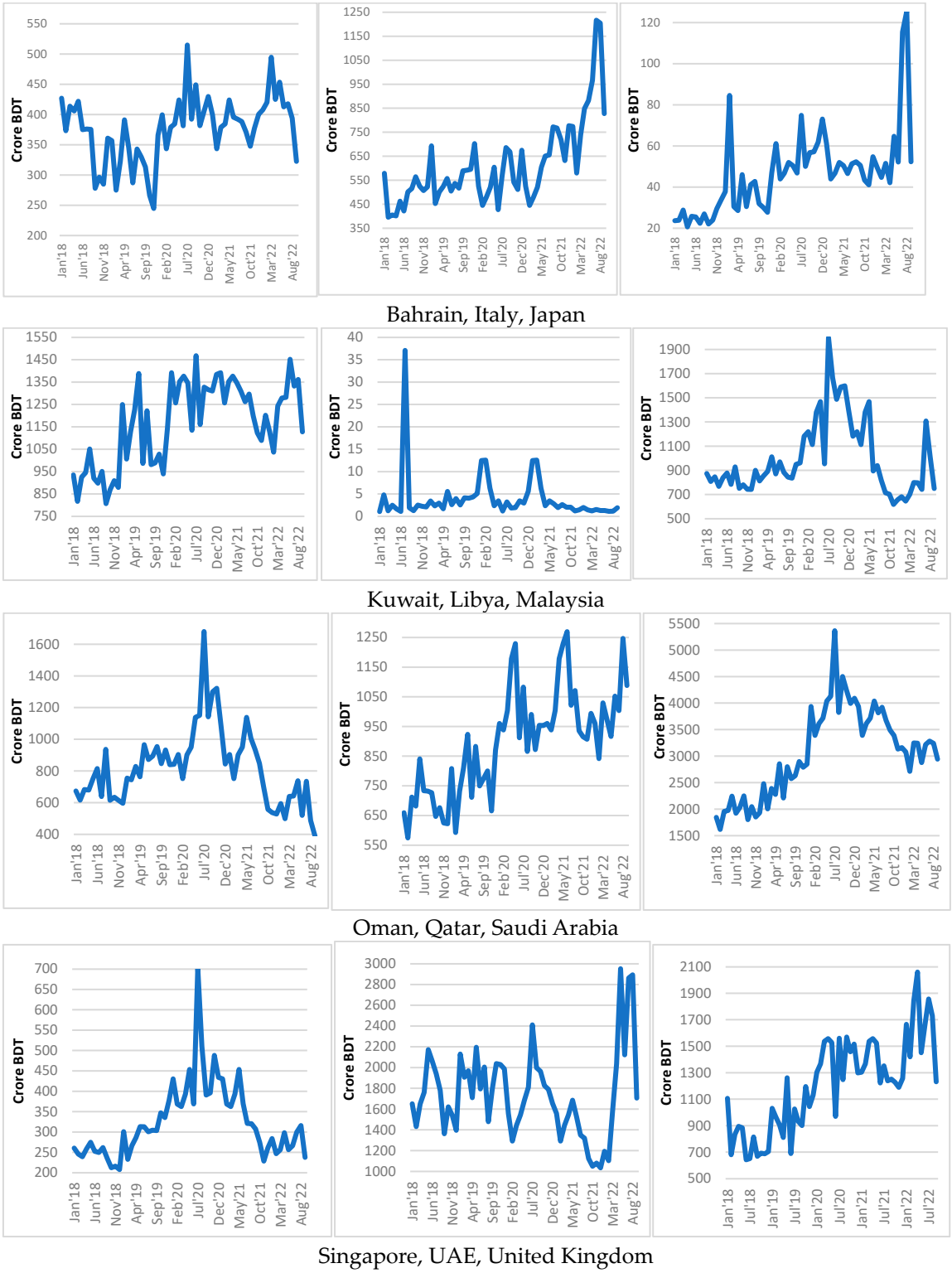

Figure 2. Remittance inflow (in crore BDT) from Bangladesh's 12 major partner countries.

4. Theoretical Framework and Model Specification

The gravity model based on Newton's gravity theory is one of the most widely used spatial interaction models in economics. Tinbergen (1962) adopted the gravity model in Economics to explain bilateral trade flow between two countries. Later on, the gravity model was utilized extensively to define other macroeconomic variables, like foreign direct

investment (Kahouli and Maktouf 2015), tourism receipts (Morley et al. 2014), cross-border migration (Beine et al. 2015), etc.

We built our empirical model of remittance inflow using the gravity framework based on the approach proposed by Lueth and Ruiz-Arranz (2008), Ahmed and Martinez-Zarzoso (2014), Silva et al. (2022), and Ahmed et al. (2021). The basic model for remittances between two countries, "*i*" (home country) and "*j*" (sending country), takes the form of:

$$Rem_{ijt} = \beta_0 \cdot \frac{GDP_{it}^{\beta_1} \, GDP_{jt}^{\beta_2}}{Distance_{ij}^{\beta_3}} \varepsilon_{ijt} \quad (1)$$

The model assumes remittance flow is directly proportional to home and partner countries' GDPs and inversely proportional to distance. Taking the natural log on both sides, Equation (1) can be rewritten as:

$$lnRem_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 \ln Distance_{ij} + \varepsilon_{ijt} \quad (2)$$

Here, Rem_{ijt} = remittance flow to home country i from country j at time t, GDP_{it} = GDP of country i (home country at time t, GDP_j = GDP of country j (partner country) at time t, $Distance_{ij}$ = distance between country i and j, and ε_{ijt} is the random error term.

Since our paper deals with remittance inflow to Bangladesh (home country) from 12 partner countries, we can replace "*i*" with "BD" in the equation. The model can be further extended using a set of suitable control variables X_{BDjt}.

$$lnRem_{BDjt} = \beta_0 + \beta_1 \ln GDP_{BDt} + \beta_2 lnGDP_{jt} + \beta_3 \ln Distance_{BDj} + \varphi X_{BDjt} + \varepsilon_{BDjt} \quad (3)$$

To extend the gravity model of remittance inflow, first, we take a standard set of gravity control variables like population, contiguity, common language, and shared colonial history from the dynamic gravity dataset (Gurevich and Herman 2018). We also take one period lag of remittance inflow as our control variable.

In addition, migration stock is included as a control variable. Migration stock and remittance inflow are closely linked. As more migrant workers become able to work in foreign countries, they earn more remittance to remit to their home country (Lueth and Ruiz-Arranz 2008; Freund and Spatafora 2008). The government of Bangladesh regularly takes diplomatic and bureaucratic measures to reduce transaction costs and expedite the application procedures so that labor export can be encouraged to enrich migration stocks beyond borders.

The bilateral exchange rate also plays a complex role in remittance inflow. Domestic currency depreciation in the home country means a higher purchasing power of the remitted amount. Therefore, as the domestic currency depreciates (foreign currency appreciates), migrant workers may be incentivized to remit more for their family's well-being. On the contrary, high remittance inflow, especially in developing economies, may result in an appreciation of the real exchange rate that may cause the "Dutch Disease" effect (Barajas et al. 2010; Hassan and Holmes 2013). Therefore, the extended gravity model also includes the bilateral exchange rate as a control variable. Since exchange rates are expressed in different foreign currency units, we constructed a bilateral exchange rate index (BER) to achieve unit-free currency values. First, the real exchange rate of the domestic currency—in this case, the taka—is multiplied by one hundred, and then the result is divided by the value of the partner country's currency (Smith 2023).

Since our objective is to measure the impact of COVID-19 on remittance inflow, we first include a COVID dummy in the gravity model. The COVID dummy variable assumes a value of 0 for pre-COVID periods and a value of 1 for periods after the COVID breakout. The COVID dummy will be able to capture the effects of movement restriction and social distancing restriction imposed during COVID-19 pandemic period. The estimation of the COVID dummy basically explains how much remittance flow has changed during COVID-19 pandemic compared to the pre-COVID period. In addition, we also run estimates with

the following explanatory variables: number of COVID cases, mortality, and vaccination rollout in home and partner countries. The extended linear models can be written as:

$$lnRem_{ijt} = \beta_0 + \beta_1 \ln GDP_{BDt} + \beta_2 lnGDP_{jt} + \beta_3 \ln Distance_{BDj} + \beta_4 lnMigS_{BDjt} + \beta_5 BER_{BDjt} + \beta_6 Covidt + \beta_7 CovidCases_{BDt} + \beta_8 CovidCases_{jt} + \varphi X_{BDjt} + \eta_{BDjt} \ldots \quad (4)$$

$$lnRem_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 \ln Distance_{ij} + \beta_4 lnMigS_{ijt} + \beta_5 BER_{ijt} + \beta_6 Covidt + \beta_7 CovidMortality_{BDt} + \beta_8 CovidMortality_{jt} + \varphi X_{BDjt} + \eta_{BDjt} \ldots \quad (5)$$

$$lnRem_{ijt} = \beta_0 + \beta_1 \ln GDP_{BDt} + \beta_2 lnGDP_{jt} + \beta_3 \ln Distance_{BDj} + \beta_4 lnMigS_{BDjt} + \beta_5 BER_{BDjt} + \beta_6 Covidt + \beta_7 Vaccination_{it} + \beta_8 CovidVaccination_{jt} + \varphi X_{ijt} + \eta_{ijt} \ldots \quad (6)$$

Traditionally, FE and RE-based methodologies have been widely used to empirically estimate the panel gravity model. However, FE methods cannot estimate the effect of variables that remain constant over time, i.e., distance between countries, colonial origin, contiguity, common language, etc. Even though RE estimations can incorporate time-invariant variables, these estimations become unreliable in the presence of heteroskedasticity, multicollinearity, and autocorrelation. Since gravity models employ multiple dummy variables that can only assume 0 or 1 values, panel OLS gravity estimations are more susceptible to the problem of multicollinearity.

Silva and Tenreyro (2011) state that the Poisson pseudo-maximum likelihood (PPML) methodology is better suited for gravity model estimation, as it accounts for heteroskedasticity and zero values in the dataset being non-linear estimators. Using the Monte Carlo estimate, they showed that PPML methodology generates more robust estimates than OLS, even when zero values appear sporadically in the dependent variable. The PPML estimator is a particular case of the generalized linear model (GLM) framework. PPML can be applied to estimate constant elasticity, assuming a proportional relation between variance and means. It utilizes an exponential function instead of a linear function, and therefore, Equations (4)–(6) are now transformed into the following exponential format:

$$Rem_{BDjt} = exp\Big(\beta_0 + \beta_1 \ln GDP_{BDt} + \beta_2 lnGDP_{jt} + \beta_3 \ln Distance_{BDj} + \beta_4 lnMigS_{BDjt} + \beta_5 BER_{BDjt} + \beta_6 Covidt + \beta_7 CovidCases_{BDt} + \beta_8 CovidCases_{jt} + \varphi X_{BDjt}\Big)\eta_{BDjt} \ldots \quad (7)$$

$$Rem_{BDjt} = exp\Big(\beta_0 + \beta_1 \ln GDP_{BDt} + \beta_2 lnGDP_{jt} + \beta_3 \ln Distance_{BDj} + \beta_4 lnMigS_{BDjt} + \beta_5 BER_{BDjt} + \beta_6 Covidt + \beta_7 CovidMortality_{BDt} + \beta_8 CovidMortality_{jt} + \varphi X_{BDjt}\Big)\eta_{BDjt} \ldots \quad (8)$$

$$Rem_{BDjt} = exp(\beta_0 + \beta_1 \ln GDP_{BDt} + \beta_2 lnGDP_{jt} + \beta_3 \ln Distance_{BDj} + \beta_4 lnMigS_{BDjt} + \beta_5 BER_{BDjt} + \beta_6 Covidt + \beta_7 Vaccination_{BDt} + \beta_8 CovidVaccination_{jt} + \varphi X_{BDjt}\Big)\ \eta_{BDjt} \quad (9)$$

5. Data and Variables

Monthly data on remittance inflow to Bangladesh from 12 partner countries were collected from January 2018 to September 2022 from Bangladesh Bank. Since monthly GDP data are unavailable, monthly industrial production index (IPI) data were used instead as a proxy for GDP (Bilgili 2015; Katrakilidis and Trachanas 2012). Monthly IPI data were collected from International Financial Statistics by the International Monetary Fund (IMF) for Bangladesh, Singapore, Malaysia, Japan, Italy, and the UK. However, monthly IPI data are unavailable for Middle Eastern countries and Libya. Therefore, we constructed an oil production index using a fixed-base Laspeyres quantity index approach. Strong correlation and causality were established between oil production and GDP in oil-producing countries. (Hafsi et al. 2021; Ratti and Vespignani 2015). The economies of Saudi Arabia, UAE, Qatar,

Oman, Kuwait, Qatar, Bahrain, and Libya primarily depend on oil production. Therefore, the oil production index can pick up variations in GDP in these countries. Hence, we use the oil production index as a proxy for GDP in this paper. The oil production index is constructed using monthly crude oil price data from the World Bank (World Bank n.d.) and monthly oil production data from the US Energy Information Administration (EIA).

Distance and standard gravity control variables, like population, contiguity, common language, common colonial origin, etc., are taken from the Dynamic Gravity dataset constructed by the United States International Trade Commission. Migration stock data are collected from the Bureau of Manpower Employment and Training (BMET), Bangladesh. Exchange rate data are collected from Bangladesh Bank, where bilateral currency values are given. To tackle the issue of diverse currency units, a bilateral exchange rate index (BERI) is constructed, in which the exchange rate of each month for each country is divided by the exchange rate of the base year of that particular country.

COVID cases, COVID mortality, and vaccination data are collected from the Our World in Data website. A COVID dummy is generated to identify the COVID-19 pandemic periods. Pre-COVID periods (January 2018–January 2020) are denoted by 0, signifying a reference dummy. COVID pandemic periods (February 2020 to September 2022) are denoted by 1. Table 1 presents a list of all variables used in econometric estimations.

Table 1. Variable definitions and sources of data.

Variables	Definitions	Sources
Remittance Inflow	Remittance inflow from partner countries of Bangladesh.	Bangladesh Bank (2022) https://www.bb.org.bd/en/index.php/econdata/econposition accessed on (15 April 2023)
Industrial Production Index (IPI) Home Country	The industrial production index (IPI) is a monthly economic indicator measuring real output in the manufacturing, mining, electric, and gas industries relative to a base year.	The International Monetary Fund (2022) https://data.imf.org/regular.aspx?key=61013712 accessed on (18 April 2023)
Industrial Production Index (IPI) Partner Country	The industrial production index (IPI) is a monthly economic indicator measuring real output in the manufacturing, mining, electric, and gas industries relative to a base year.	The International Monetary Fund (2022) https://data.imf.org/regular.aspx?key=61013712 accessed on (18 April 2023)
Migration Stock	Migrated people from Bangladesh to partner countries.	BMET (2022) http://www.old.bmet.gov.bd/BMET/stattisticalDataAction accessed on (18 April 2023)
Exchange Rate	Exchange rate of Bangladesh currency and partner countries' currencies.	Bangladesh Bank (2022) https://www.bb.org.bd/en/index.php/econdata/econposition accessed on (15 April 2023)
Distance	This is the geographical distance between home and partner country.	Gurevich and Herman (2018) https://www.usitc.gov/data/gravity/dgd.htm accessed on (17 April 2023)
Common Language	It is a dummy variable. If both the home and the partner country have a common official language, then the dummy = 1, otherwise 0.	Gurevich and Herman (2018) https://www.usitc.gov/data/gravity/dgd.htm accessed on (17 April 2023)
Contiguity	It is a dummy variable. If home and partner country share a common land border, the dummy is = 1, otherwise 0.	Gurevich and Herman (2018) https://www.usitc.gov/data/gravity/dgd.htm accessed on (17 April 2023)

Table 1. *Cont.*

Variables	Definitions	Sources
Island Home Country	It is a dummy variable. If a country is surrounded by water, then the dummy is = 1; otherwise, 0 for home and partner country.	Gurevich and Herman (2018) https://www.usitc.gov/data/gravity/dgd.htm accessed on (17 April 2023)
Island Partner Country	It is a dummy variable. If a country is surrounded by water, then the dummy is = 1; otherwise, 0 for home and partner country.	Gurevich and Herman (2018) https://www.usitc.gov/data/gravity/dgd.htm accessed on (17 April 2023)
Landlock Home Country	Landlock is a dummy that indicates a country is almost or surrounded by land if a country is landlocked, the dummy is = 1, otherwise 0 for home and partner country.	Gurevich and Herman (2018) https://www.usitc.gov/data/gravity/dgd.htm accessed on (17 April 2023)
Landlock Partner Country	Landlock is a dummy that indicates a country almost or surrounded by land if a country is landlocked, the dummy is = 1, otherwise 0 for home and partner country.	Gurevich and Herman (2018) https://www.usitc.gov/data/gravity/dgd.htm accessed on (17 April 2023)
COVID Dummy	For COVID Period (2020M1–2022M8), the value is = 1; for 2018M1 to 2019M12, it is 0.	
COVID Cases Home Country	Total cumulative monthly confirmed cases per million per month.	Mathieu et al. (2020) https://ourworldindata.org/coronavirus accessed on (20 April 2023)
COVID Cases Partner Country	Total cumulative monthly confirmed cases per million per month.	Mathieu et al. (2020) https://ourworldindata.org/coronavirus accessed on (20 April 2023)
COVID Mortality Home Country	Total cumulative monthly confirmed deaths per million per month.	Mathieu et al. (2020) https://ourworldindata.org/coronavirus accessed on (20 April 2023)
COVID Mortality Partner Country	Total cumulative monthly confirmed deaths per million per month.	Mathieu et al. (2020) https://ourworldindata.org/coronavirus accessed on (20 April 2023)
COVID Vaccinations Home Country	Total cumulative number of people who took vaccination for COVID for each month for home country.	Mathieu et al. (2020) https://ourworldindata.org/coronavirus accessed on (20 April 2023)
COVID Vaccinations Partner Country	Total cumulative number of people who were vaccinated for COVID each month for partner country.	Mathieu et al. (2020) https://ourworldindata.org/coronavirus accessed on (20 April 2023)

Descriptive statistics provide a guideline about the nature of the data (Table 2).

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Remittance	684	936.354	864.756	1.08	5365.21
Migration Stock	684	187,339.7	379,308.7	1	2,339,854
GDP BD	684	289.705	36.886	194.632	348.449
GDP Partner	684	252.896	4007.588	1.576	104,907.35
Population BD	684	1.642×10^8	1,908,561.7	1.614×10^8	1.663×10^8
BERI	684	372.487	441.673	0	1395.79
Population Partner	684	29,655,025	36,419,098	1,569,440	1.268×10^8
Distance	684	4732.764	1750.85	2653.964	8082.075
Common Language	684	Dummy	Variable	0	1
Colony	684	Dummy	Variable	0	1

Table 2. *Cont.*

Variable	Obs	Mean	Std. Dev.	Min	Max
Contiguity	684	Dummy	Variable	0	0
Island	684	Dummy	Variable	0	1
COVID Cases BD	684	35,517.351	66,592.447	0	336,226
COVID cases Partner	684	113,593.86	461,704.39	0	6,170,622
COVID Mortality BD	684	515.123	1146.308	0	6182
COVID Mortality Partner	684	721.289	2875.081	0	36,570
COVID Vaccination BD	672	2,203,306.6	5,705,661.9	0	30,821,308
Vaccination Partner	579	1,357,291.5	4,593,217.6	0	46,294,329
COVID Dummy	684	Dummy	Variable	0	1

Source: Authors' calculation.

6. Result and Interpretation

PPML estimations of Equations (7)–(9) are presented in Table 3: We estimate three different versions of the extended gravity model. The first estimation includes the number of COVID cases at home and partner countries as the independent variable, the second one comprises COVID mortality at home and partner countries, and the third one includes COVID vaccination rollout at home and in partner countries.

Table 3. Results of PPML estimation.

	(1)	(2)	(3)
	Rem	**Rem**	**Rem**
lnGDPBD	−0.238 (0.189)	−0.177 (0.194)	−0.0858 (0.266)
lnGDPP	0.0825 (0.0441)	0.0795 (0.0433)	0.190 *** (0.0370)
lnDist	−0.695 *** (0.131)	−0.691 *** (0.132)	−0.597 *** (0.135)
BERI	0.000103 * (0.0000405)	0.000101 * (0.0000405)	0.000239 *** (0.0000420)
lnMigS	0.0831 *** (0.00931)	0.0838 *** (0.00933)	0.0800 *** (0.00967)
lnTPopBD	0.422 (3.081)	−0.118 (3.074)	8.723 * (4.005)
lnTPopP	0.515 *** (0.0215)	0.513 *** (0.0215)	0.477 *** (0.0208)
Colony	1.011 *** (0.106)	0.991 *** (0.105)	0.997 *** (0.0998)
CommonLang	1.384 *** (0.0798)	1.379 *** (0.0802)	1.326 *** (0.0807)
Island	−1.164 *** (0.103)	−1.152 *** (0.102)	−1.202 *** (0.0940)
CovDummy	0.221 *** (0.0571)	0.209 *** (0.0576)	0.0948 (0.0695)
CovCasesBD	-6.49×10^{-8} (0.000000224)		

Table 3. *Cont.*

	(1)	(2)	(3)
	Rem	**Rem**	**Rem**
CovcasesP	5.44×10^{-8} (3.81×10^{-8})		
CovMortBD		0.00000641 (0.0000117)	
CovmortP		0.00000992 * (0.00000416)	
CovVaccBD			-1.09×10^{-8} ** (3.63×10^{-9})
VaccP			-4.60×10^{-9} (5.33×10^{-9})
_cons	−4.700 (57.46)	5.167 (57.31)	−163.1 * (74.86)
N	684	684	573
R-sq	0.814	0.814	0.823

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

All three models generate expected signs of the traditional gravity model. As the distance between home and partner countries increases by 1%, remittance inflow to Bangladesh falls by approximately 0.69%. This result is consistent with standard gravity model findings (Silva et al. 2022; Lueth and Ruiz-Arranz 2006). In addition, as expected, migration stock is a significant determinant of remittance inflow to Bangladesh. The home country receives more remittance earnings when more people find work opportunities abroad. The results show that a 1% increase in migration stock results in an approximately 0.83% increase in remittance inflow. The bilateral exchange rate also positively and significantly impacts remittance inflow. As the bilateral exchange rate increases by 1%, remittance inflow increases by 0.00010%, and the estimations are statistically significant at a 5% significance level. Our results are consistent with the findings of Silva et al. (2022) and Ahmed and Martinez-Zarzoso (2014). In addition, traditional gravity variables like common language and common colonial roots have a positive and significant impact on remittance inflow because knowledge of local language and culture makes it easier for migrants to find jobs in foreign countries.

Our primary variable of interest, the COVID dummy, is positive and significant in Estimations (1) and (2), which implies that remittance inflow increased by 0.258% during the pandemic compared to pre-COVID years. This finding seems to strongly support the "altruistic" motive for remittance inflow because during the pandemic, migrant workers remitted higher amounts of money to their family members to keep them safe and comfortable. During a turbulent time, when there was no job security and a steady source of income, migrant workers still sent more remittances to bear family members' medical expenses or cushion the economic shock dealt with by COVID-19 containment measures. Another possible explanation for this increase in remittance inflow is "self-interest"-driven. During strict lockdown and containment measures, migrant workers were worried that they might lose their jobs or even face forced deportation. Therefore, out of fear, they remitted more money home in advance to have a safety net in case they were forced to return to Bangladesh.

The special remittance incentive introduced by the Government of Bangladesh may be another reason for increased remittance inflow during COVID-19. Starting from July 2019, a cash incentive of 2% was given when inward foreign remittances were transmitted to Bangladesh through the official channels, i.e., banks, non-bank financial institutions, and money transfer services. Bangladesh government later increased the remittance incentive

rate to 2.5% effective January 2022. During the COVID-19 pandemic, unofficial Hundi channels were hard to access due to international travel bans and containment measures. In this circumstance, the remittance incentive further motivated expatriate workers to send money via official channels.

From column (1) estimations, we found that the number of COVID cases in Bangladesh did not significantly impact remittance inflow, implying that migrant workers did not abandon their families in times of crisis. They continued to remit money to their family members even when facing salary cuts and fewer job opportunities in their workplace. Therefore, the initial apprehension that remittance inflow would fall drastically due to the COVID-19 pandemic did not hold in the case of Bangladesh. The number of COVID cases in partner countries is also insignificant.

In Column (2), we replace the number of COVID cases with COVID mortality and find different results. COVID mortality in Bangladesh is an insignificant determinant of remittance inflow. However, COVID mortality in partner countries was a positive and significant determinant supporting altruistic and self-interest-driven motives. As COVID mortality in partner countries increased by 1%, remittance inflow to Bangladesh increased by 0.00000992%. As the COVID situation worsened in partner countries, migrant workers did not keep their earnings to themselves for better treatment or other facilities; instead, they sent more money back home. However, this decision can also be driven by fear of deportation and future uncertainty.

Lastly, the estimation in Column (3) attempts to measure the impact of wide-scale vaccine rollout in home and partner countries. As vaccine rollout increased by 1% in Bangladesh, the remittance inflow significantly reduced by -1.09×10^{-8}%. However, the magnitude of the coefficient is so small that we can consider the effect to be approximately zero. Therefore, the result implies that mass vaccination only marginally eradicated the impact and uncertainty of the COVID-19 pandemic. As more people were vaccinated, migrant workers realized that the pandemic would eventually be under control and that economies would gradually recover.

Sensitivity Analysis

We conducted a pooled OLS and two-way fixed-effect OLS regression to conduct a sensitivity analysis using Equations (4)–(6). The results reported in Table 4 shows that the gravity variables generate consistent results, and the partner's and home country's GDPs are identified as significant determinants of remittance, unlike the PPML model. Interestingly, both pooled OLS and two-way fixed-effect results show the COVID dummy as insignificant, unlike our PPML estimation. However, the COVID situation in partner countries quantified with COVID cases and COVID mortality in partner countries were still important determinants of remittance inflow. These results imply that migrant workers responded more to the COVID situation in partner countries than in Bangladesh. COVID vaccination in Bangladesh was also a significant determinant in the two-way FE estimation.

Table 4. Results from pooled OLS and two-way fixed-effect estimation.

	Pooled OLS Two-Way Fixed-Effect					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	lnRem	**lnRem**	**lnRem**	**lnRem**	**lnRem**	**lnRem**
lnGDPBD	−0.0938 (0.621)	0.175 (0.615)	0.0817 (0.702)	0.138 (0.168)	0.168 (0.170)	0.0941 (0.191)
lnGDPP	−0.122 (0.0986)	−0.126 (0.0975)	0.217 (0.125)	−0.169 *** (0.0266)	−0.174 *** (0.0267)	−0.0777 * (0.0391)
lnDist	−0.698 * (0.323)	−0.772 * (0.319)	0.0169 (0.350)	0 (.)	0 (.)	0 (.)

Table 4. *Cont.*

	Pooled OLS Two-Way Fixed-Effect					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	lnRem	**lnRem**	**lnRem**	**lnRem**	**lnRem**	**lnRem**
BERI	0.00120 *** (0.000150)	0.00117 *** (0.000149)	0.00153 *** (0.000181)	0.000275 * (0.000126)	0.000282 * (0.000127)	0.000493 ** (0.000172)
lnMigS	0.263 *** (0.0250)	0.265 *** (0.0246)	0.277 *** (0.0273)	0.0336 * (0.0150)	0.0449 ** (0.0146)	0.0794 *** (0.0147)
lnTPopBD	−6.385 (11.22)	−8.919 (11.14)	2.129 (12.49)	5.330 (3.215)	4.884 (3.280)	5.281 (3.513)
lnTPopP	0.583 *** (0.0633)	0.577 *** (0.0628)	0.547 *** (0.0678)	−0.483 (0.778)	−0.658 (0.791)	0.809 (0.805)
Colony	2.699 *** (0.257)	2.550 *** (0.259)	2.359 *** (0.275)	3.281 (2.835)	4.023 (2.879)	0 (.)
CommonLang	0.253 (0.185)	0.303 (0.182)	0.176 (0.197)	−0.354 (3.332)	−1.189 (3.382)	4.826 (3.441)
Island	−1.204 *** (0.142)	−1.163 *** (0.140)	−1.325 *** (0.148)	−0.308 (2.395)	0.328 (2.430)	0.307 (2.443)
CovDummy	0.0517 (0.210)	−0.0222 (0.209)	0.0723 (0.237)	0.0703 (0.0518)	0.0595 (0.0520)	0.0643 (0.0571)
CovCasesBD	-8.87×10^{-8} (0.000000825)			−0.000000507 * (0.000000207)		
CovcasesP	0.000000120 (0.000000116)			7.52×10^{-8} ** (2.88×10^{-8})		
CovMortBD		0.0000194 (0.0000457)			−0.0000114 (0.0000119)	
CovmortP		0.0000651 *** (0.0000187)			0.00000155 * (0.00000456)	
CovVaccBD			-1.26×10^{-8} (1.10×10^{-8})			-1.33×10^{-8} *** (2.68×10^{-9})
VaccP			-1.07×10^{-8} (1.31×10^{-8})			9.45×10^{-10} (3.08×10^{-9})
Month Dummy	No	No	No	Yes	Yes	Yes
Country Dummy	No	No	No	Yes	Yes	Yes
Constant	121.3 (209.6)	168.4 (208.1)	−47.73 (233.6)	−87.98 (56.36)	−77.17 (57.31)	−112.2 (61.14)
N	684	684	573	684	684	573
R-sq	0.554	0.561	0.549	0.977	0.976	0.978
adj. R-sq	0.545	0.552	0.539	0.976	0.975	0.976

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

7. Conclusions and Policy Recommendations

Bangladesh will remain a labor export powerhouse due to its economic condition and massive, always "ready to fly" surplus labor force. Therefore, if outmigration persists, remittances should continue to have a role in the nation's socioeconomic development. This, however, makes Bangladesh's economy vulnerable to financial shocks due to external economic contingency. Considering the overall importance of the issue to Bangladesh,

this study has examined the quantitative impact of COVID-19 on remittance inflow in Bangladesh based on the gravity model.

The paper looks at the immense importance of remittance, as it ensures the overall macroeconomic stability of Bangladesh. Remittances have helped Bangladesh enhance its international credit rating by balancing its trade deficits. In addition, the importance of remittances to Bangladesh's socioeconomic growth increased due to the substantial contribution of remittances to the formation of GDP. Even though the quasi-Dutch Disease impacts of remittances may have influenced certain areas of the economy, Bangladesh has prevented the "Dutch Disease" consequences on the actual exchange rate. The continual decline of the Bangladeshi currency over time has mitigated any export trade repercussions. Nonetheless, the depreciation may have been far more significant with a smaller remittance inflow.

The study's significant findings may be summarized as follows: The gravity variables used in the paper have generated consistent results per the model. Distance between home and partner countries, migration stock, and the bilateral exchange rate were significant determinants of remittance inflow in Bangladesh. Most importantly, the COVID dummy has been found to be positive and significant in the paper using PPML estimation. The paper reasons that expatriate workers sent home a higher amount of remittance during COVID compared to pre-COVID periods mainly for four reasons: (i) altruistic motive to help families in their home country, (ii) self-interest-driven motive to transfer money home in case of forced deportation, (iii) lack of access to hundi channels, and (iv) remittance incentive given by the Bangladeshi government during the COVID-19 pandemic. The paper also finds that remittance inflow was more responsive to the COVID-19 situation in partner countries than in the home country. In addition, COVID-19 vaccination in Bangladesh was also a significant determinant in the PPML and two-way FE estimations.

Based on the discussions and findings, this paper makes the following policy recommendations for meeting future contingencies that may impact the flow of remittances to Bangladesh. First, remittance has become an important source of net resource inflow to Bangladesh. Looking at the workforce scenarios of the global north, Bangladesh should try to diversify the export of its human resources to those destinations, too. This may enhance the "demographic dividends" of the many Bangladeshi youths willing to temporarily and permanently work abroad. However, this will require creating a more skilled and disciplined workforce to cater to their demands.

Second, in recent decades, sources of external economic shocks have substantially increased due to globalization and financial integration. COVID-19 and the Russo–Ukrainian War are the most recent examples of such external shocks. The uncertainty related to the US banking sector is also increasing, potentially affecting the global financial industry. The flow of remittance in Bangladesh was seen to have been affected in the past by most of the abovementioned reasons. This should make Bangladesh Bank and the policymakers cautious about better managing remittances by the recipients in Bangladesh. Considering the issue's importance, Bangladesh may constitute a panel of advisors for finding and innovating areas for better utilization of remittances.

Third, despite government incentives to encourage remittance transmission through official channels, the hundis are extensively used in transferring remittance, especially from Middle Eastern countries. Hundi syndicates mostly use mobile financial services (MFS) to remit money through unofficial channels. As a result, the remittance inflow growth through the official channel is gradually falling in Bangladesh post-COVID. Expat workers choose the hundi channel over the official channel mainly for two reasons: (i) The higher rate of exchange in the hundi market compared to the official rate, and (ii) MFS transaction makes the transmission process much faster.

The government must take prompt measures to discourage remittance transfers via hundis and other unofficial channels. It may adopt policies to include mobile financial services and online banking services for an official remittance transfer. Adopting quicker and friendlier remittance-receiving systems will improve the situation so that more and

more senders feel encouraged to use more of them, even during local, regional, or global contingencies.

Finally, offering financial incentives to the senders of remittances during COVID-19 was a timely measure to encourage the flow through proper channels. However, this measure financially burdens the government's exchequer and cannot be considered a permanent solution. Instead, monetary policies must be employed to make the exchange rate more competitive in the foreign currency market. Though using irregular means or hundis for sending money back home by remitters is not possible to stop completely, these policies may reduce the uncertainty during the financial or otherwise testing time. Remittance flow during COVID-19, in a sense, is a ray of hope here.

Author Contributions: G.G.G.: conceptualization, methodology, supervision; M.K.B.: resource, writing, reviewing, and editing; M.A.A.: writing—original draft preparation, investigation, formal analysis; M.R.: investigation, formal analysis, data curation. All authors have read and agreed to the published version of the manuscript.

Funding: This paper has received financial support from Kakenhi and APU Research Dissemination Subsidy for publication.

Informed Consent Statement: Not Applicable.

Data Availability Statement: All the data sources are cited in the text and references. The compiled dataset will be made available upon request.

Conflicts of Interest: The authors have no competing interests to declare relevant to this article's content. No human subjects or animals participated in this research.

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