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The impact of COVID-19 government responses on remittances in Latin American countries

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Abstract

Workers' remittances declined sharply as the COVID-19 pandemic spread in the first half of 2020, rebounding in the second half. This paper analyses the impact of containment and economic support measures on remittances sent to Latin America during 2019–2020 using a gravity model estimated with the Poisson pseudo-maximum likelihood estimator (PPML). Results show that containment measures in receiving countries mainly explain the fall in remittance flows, whereas the effect of economic support measures is not robust. Among the traditional explanatory factors, the business cycle and the real exchange rate in receiving countries explain the subsequent recovery of remittances.

KEYWORDS
COVID-19, Latin America, lockdown, PPML, remittances

JEL CLASSIFICATION
F10, O10

1 | INTRODUCTION

Remittances to Latin America and the Caribbean have significantly increased in the last two decades of the 21st century, hand in hand with sustained growth in migratory flows. Meanwhile, in the 2010s, remittances became the main source of foreign exchange for some countries, reaching a historical peak in 2019 and playing an important role in fostering economic growth and reducing poverty. After this glorious decade, remittances plunged in the second

quarter of 2020 as the COVID-19 pandemic expanded worldwide. However, contrary to forecasts made in the first half of 2020, remittances to Latin America recovered rapidly in the second half of 2020 and increased by 6.5% compared to 2019 (Ratha et al., 2021), showing to be very resilient to the economic and health crisis.

The fall in remittances in the first half of 2020 has been linked to the drop in economic activity that led not only to increased unemployment among migrants but also to the specific COVID-19 policy responses in sending and receiving countries. Confinement measures, social distance policies and sudden closure of the economy had an initial impact by hindering access to physical stores, which at least in the United States were the most prevalent way of sending money before the pandemic (see Martin et al., 2019).[1] Simultaneously, economic and debt relief measures, which compensated for the loss of income due to rising unemployment as the pandemic intensified, had a budgetary effect on migrants by allowing them to sustain a certain income and consumption level. Measures taken vary considerably between and within countries. While industrialized countries implemented a wide range of support measures, including, for instance, unemployment benefits, stimulus checks (economic impact payment), financial assistance to businesses, and financial assistance for food, housing, and debt repayment; economic support to citizens in developing countries was lower or even nonexistent, pushing many families into poverty. Moreover, the combination of confinement and economic support measures encouraged the reorganization of consumption towards activities involving less social contact and higher online retail.

This re-composition, along with a higher level of altruism due to the adverse effects of the pandemic, may have materialized in quick recovery of remittances after the initial uncertainty generated by confinement and containment measures.

This paper focuses on quantifying the effect of COVID-19 policy responses on remittances sent to 10 Latin American countries from all countries of origin by incorporating several policy responses that were put forward during the COVID-19 pandemic into a gravity model in both developed and developing countries, which to the best of our knowledge has not been done before. We use the Oxford COVID-19 response tracker (OxCGRT), which provides 19 indicators on worldwide government responses starting January 2020 (Hale et al., 2021). Since the analysis focuses on short-term changes, in the Poisson pseudo-maximum likelihood (PPML) estimation of the gravity model, we use control variables that have quarterly variation and are highly relevant in determining remittance flows while also reflecting short-run decisions. These include gross domestic products (GDPs), exchange rates and unemployment rates.

Considering that remittances occur within households, we argue that those whose income depends heavily on these transfers have been doubly affected by the pandemic. On the one hand, emigrants whose jobs were interrupted during lock-downs were less able to send remittances, and on the other hand, employment opportunities also decreased in the receiving economies due to lock-downs and economic contraction. Given the important role that remittances have played historically in fostering economic growth and reducing poverty in Latin America (Vacaflores, 2018a), it is crucial to quantify the magnitude of those effects and to ascertain whether they might have lasting consequences on well-being and on attenuating the effect of the COVID-19 crisis on poverty, which in 2020 has increased by 3.2 percentage points in Latin America (CEPAL, 2021).

Our main results point to the relevance of containment measures in the remittance receiving countries. Moreover, the business cycle and the exchange rate in these countries are also of utmost importance. According to the results, a recovery in the receiving country's economy and a depreciation of its currency against the dollar lead to an increase in remittances. Hence, economic growth and weak currencies in Latin American countries will give remittances a boost.

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[1] A technical report by Martin et al. (2019) shows that most migrants preferred to send remittance payments in cash, also consistent with the predominance of cash salary payments. The survey, which approaches migrants from Colombia, Dominican Republic, El Salvador and Mexico, shows that approximately 83% of remittances are sent for payout in cash, while 17% are credited to a bank account. An even higher percentage was also received in cash at a payout point at the destination. Compared to other modes of transfer, cash payment is quicker, easy to access and less expensive than other channels like mobile apps, internet browsers, debit cards or direct debit from bank accounts. However, the restricted physical access to money transfer operators during COVID-19 seems to have been compensated by a quick reaction from remittance services providers who offered non-face-to-face services (see Maldonado Gonzáles et al., 2021).

The rest of the paper is structured as follows. Section 2 summarizes the existent literature closely related to our research. Section 3 presents the data and the empirical strategy, and Section 4 outlines the main results. Finally, the conclusions and some suggestions for further research are presented in Section 5.

2 | LITERATURE REVIEW

In this section, we first focus on the related literature that analyses the main motivations that migrants have to send remittances. Next, we summarize the research that examines the factors that influence the decision to remit at the microlevel and macrolevel. Concerning the microfoundation of macroeconomic models and hence the migrants' motivations to remit, theoretical micromodels evaluate the extent to which altruism overrides self-interest as the main motive for sending remittances. Pure altruism reflects that migrants care about those left behind in the home country, regardless of their own economic condition, while self-interest reflects that migrants care about invest-ments in their home country for future benefits. The seminal study by Lucas and Stark (1985), which is the first to propose a theoretical framework in this area, indicates that altruism alone is not sufficient to explain the migrant's motivation to send remittances. For instance, remittances are assumed to mutually benefit the migrant and their family in inter-temporal arrangements, considering risk diversification strategies and self-interest. More recently, SeyedSoroosh (2017), Osili (2007) and Adams (2011) find that altruism is the main motivation to send remittances, whereas other authors find that the relationship between altruism and remittances is difficult to establish (Antoniades et al., 2017; Cox et al., 1998; Mahapatro, 2017). In particular, the authors find that altruism is intangible and interacts with many other factors. In this context, Antoniades et al. (2017) and Mohapatra et al. (2012) argue that altruism can either be measured indirectly using microeconomic or macroeconomic data or can be approximated using experimental approaches.[2] Current research in the area of experimental economics indicates that altruism is not static and that it varies strongly depending on the context. In the specific case of the COVID-19 crisis, Luo et al. (2021) suggest that the pandemic caused significant disruption in social cognition and behavior and find that participants in an experiment made more decisions that benefited others more than themselves when the severity of the pandemic intensified. These results are in line with pre-pandemic research, indicating that an individual's degree of altruism is dynamic and context-dependent, being higher when facing crisis and natural disasters (Luo et al., 2021). The microeconomic reasons to remit related to self-interest include investing in assets, paying for the cost of migra-tion, saving for retirement or purchasing administrative services, usually to maintain or expand assets in the home country. Self-interest motives may also relate to the migrant's intention to return home in the future (Rapoport & Docquier, 2006). An additional reason for remitting related to self-interest is insurance against unexpected shocks causing income fluctuations (Adams, 2011; Docquier & Salomone, 2012; Lucas & Stark, 1985; Yang & Choi, 2007).[3]

As already mentioned, the determinants of altruism and self-interest motives to remit have been investigated using either microeconomic or macroeconomic data (Rapoport & Docquier, 2006). Microeconomic studies use data from household surveys, census or migrant surveys, which allow, for instance, estimating the household earnings elasticity of remittances (Simpson & Sparber, 2020), while controlling for specific characteristics of the households. In this framework, studies typically have either data on the migrant sending remittances or the household receiving them, but hardly both. On the one hand, authors focusing on the migrants typically analyze the effect of their skill composition, the time elapsed since emigration, their age and specific socio-economic characteristics of households receiving remittances (Adams, 2009; Docquier & Salomone, 2012).[4] On the other hand, authors focusing on the origin of migrants find that countries with high poverty rates and low levels of human capital have an even larger

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[2](Rapoport & Docquier, 2006) present a comprehensive review on the theoretical reasons for remitting.

[3]Insurance turns out to be an important determinant in rural areas exposed to natural disasters, such as rainfalls or draughts (Yang & Choi, 2007).

[4]Controversies particularly arise around the effect of the skill level of migrants. Whereas some authors argue that this effect is ambiguous and depends on the immigration policy of the country of destination (Docquier & Salomone, 2012), the human capital theory argues that people with higher levels of education are more likely to migrate and tend to send higher volumes of remittances.

number of people who intend to migrate and send remittances. A certain consensus exists on the fact that if altruism dominates self-interest, remittances increase when the emigrant's income is higher, as well as when adversities in the country of origin reduce the income of family members. Contrary to this, if self-interest prevails, remittances are positively related to family income at home (Adams, 2009).

Macroeconomic studies use cross-sectional or panel data at the country level and consider aggregate variables to explain remittances (Adams, 2009). Those factors include interest rate differentials, exchange rates, stock of migrants, cost of transferring remittances, political or economic risk in the receiving country, poverty and GDP differentials between sending and receiving country (Freund & Spatafora, 2008). The levels of GDP and unemployment in the remittance sending country can impact the individual income of the migrant. Therefore, an increase in GDP, as well as a decrease in unemployment, are expected to have a positive impact on remittances, both linked to the prevalence of altruism (Chami et al., 2005; Lin, 2011). Higher remittances sent after improvements in the investment environment in the remittance receiving country suggest that self-interest overrides altruism. The investment environment is usually proxied by interest rates, financial soundness and political risk indicators. In addition, GDP in the remittance receiving country could signal profit opportunities in the home country of the migrant. Finding that GDP in the receiving country has a positive impact on remittances when controlling for other factors points towards self-interest motives being prevalent (Adams & Cuecuecha, 2010; Cooray & Mallick, 2013; Lin, 2011; Yang, 2008).

The impact of the exchange rate could be twofold. On the one side, a depreciation of the domestic currency in the remittance receiving countries vis-a-vis currencies of the sending countries increases the purchasing power of remittances and could induce an increase in the flows sent. On the other side, high volumes of remittances, particularly those sent to small open economies, can impact the real exchange rate and cause a Dutch disease effect, with adverse effects on export competitiveness of the receiving country via an appreciation of the domestic currency. Amuedo-Dorantes and Pozo (2004), using a panel of 13 Latin American and Caribbean countries, find evidence of real exchange rate appreciation caused by increasing remittances, suggesting a shift of resources from the traded to the non-trade sectors of the economy. Mandelman and Zlate (2012) find that remittance flows are responsive to business cycles in the remittance sending and receiving countries, while Lueth and Ruiz-Arranz (2008) find that remittances are not as much motivated by altruism but are mostly profit-driven and governed by portfolio considerations. They do not find evidence of remittances increasing following a natural disaster in the home country. Using data for the five largest recipients of remittances sent by US residents Vargas and Huang (2006) find that factors in the remittance-sending country are crucial, as migrants consider the economic situation of this country relative to the remittance receiving country when deciding how much to remit. In Latin America, Vacaflores (2018b) shows that the economic activity of the migrants' host countries has a positive and statistically significant effect on the number of remittances the region receives. They also find that remittances are related to the interest rates of the home countries, as suggested by the self-interest hypothesis. Consumption-smoothing models and macroeconomic empirical research argue that remittances increase during economic downturns and after natural disasters, like draughts or unexpected losses in harvests, acting as a buffer in times of crisis (Ahmed & Martínez-Zarzoso, 2016; Bettin et al., 2017; Mohapatra et al., 2012). Further literature on the counter-cyclical effect of remittances shows, at best, mixed results, depending on whether altruism or self-interest is believed to dominate, as suggested by Simpson and Sparber (2020).

Although remittances are not only sent by migrants but also by NGOs or charitable institutions, the largest part of them depends on the stock of migrants, which is thus an obvious determinant of remittances. Vacaflores (2018b) argues that remittances are endogenous, given that the level of economic development in the country that hosts them does at the same time cause migration and subsequent remittances. In a cross-country panel study, Freund and Spatafora (2008) find that remittances depend positively on the stock of migrants and negatively on transfer costs and exchange rate restrictions. Concerning the expected effects of interest rates, Adams (2009) finds that the real interest rate in the receiving country has a positive and significant impact on per capita remittances, indicating that they are positively related to investment returns at home. However, McCracken et al. (2017) point to an ambiguous effect of the interest rate of the remittance receiving country, which could reflect a higher risk for assets. Instead,

other authors find no significant relationship between domestic interest rates and remittances. For example, Buch and Kuckulenz (2010), using data for 87 countries for the years 1970–2000, find that the spread of the domestic lending rate over the London Inter-bank Offered Rate (Libor) is not statistically significant when considered as a factor explaining remittances. Given that our study focuses on changes in remittances due to an unexpected worldwide crisis, the COVID-19 pandemic, our target variables are the confinement and economic support measures, which we will incorporate into a gravity model, as will be explained in the next sections. In the model, we will include as control variables the above-mentioned macroeconomic aggregates with variation in the short-run, namely, GDP, unemployment and exchange rates.

3 | DATA AND EMPIRICAL STRATEGY

3.1 | Remittances during COVID-19: An V-shaped curve

International financial flows plunged in the second quarter of 2020 after the COVID pandemic expanded worldwide, and containment measures restricted work, travel and economic activity. Preliminary estimates of the World Bank expected a drop of 20% in remittances to Latin America in 2020 (Ratha et al., 2020a), which in the end did not materialize. More recent estimates indicate that the interannual fall in remittances in 2020 for 2019 is around −0.2% (Ratha et al., 2020b).

Figure 1 shows that the quarterly year-on-year variation of remittances in 2019 and 2020 presents a V-shaped pattern for the countries examined. The selected 10 countries are very relevant in terms of remittance flows in Latin America. Four of them are located in Central America, namely, El Salvador, Guatemala, Nicaragua and the Dominican Republic. They are highly dollarized economies, small in economic terms, and for which remittances
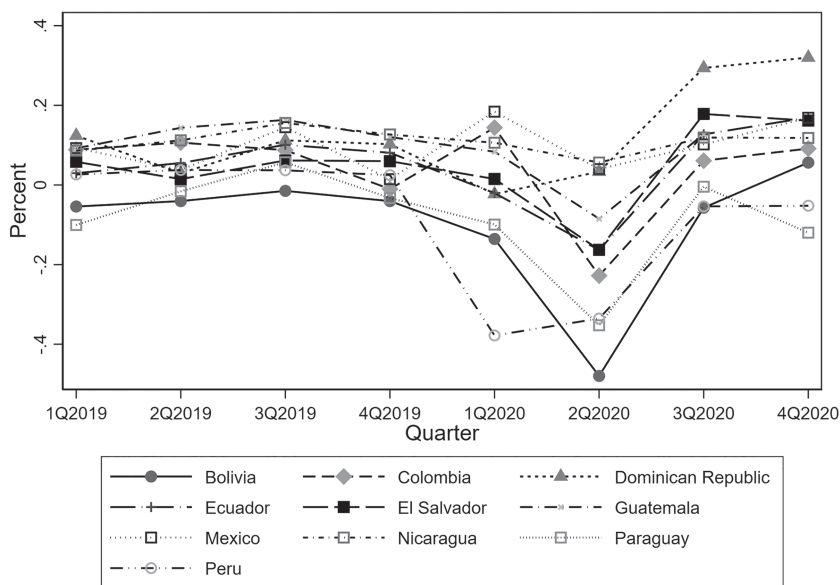
Source: Authors' elaboration using data from Central Banks.

FIGURE 1 Year-on-year variation of quarterly remittances in 2019 and 2020 (%)

represent a high share of GDP (greater than 10% in all cases). Two other countries, Mexico and Colombia, are large economies with a high volume of remittances but representing a low share of GDP (below 3%). Finally, Bolivia and Paraguay present the special feature of largely receiving remittances from other Southern Cone countries, reflecting the existence of large south-south migrant flows.[5]

3.2 | Governmental measures during the COVID-19 crisis

The extent to which confinement and economic support policies affected remittances could vary depending on the strictness of the measures. The wide range of policies, their intensity and duration is captured by The OxCGRT, which provides 19 indicators on government responses to contain the pandemic starting on the first of January of 2020 (Hale et al., 2021). These governmental measures, some of which used in the empirical analysis, are grouped into four indices: (1) the government response index (GRI), which is a simple average of all ordinal indicators, (2) the stringency index (SI) that includes only indicators on containment and closure policies (sometimes named lock-down policies), (3) the CHI subindex which adds health policies to the containment and closure policies, and, finally, (4) the economic support index (ESI) that exclusively accounts for economic support measures. Most indicators are on an ordinal scale and measure the severity of the policy. As determinants of remittances, we mainly use Indices (2) and (4) and some of the subindices that each group contains.

As shown in Figure 2, the SI shows its highest level in the second quarter of 2020, in both remittance-sending and remittance-receiving countries. Whereas the figure on the left-hand side shows small differences between the SIs in the main remitting countries, Nicaragua's SI is extremely low compared to the other nine Latin American countries (left-hand side). The ESI shown in Figure 2 also shows a high level in the second quarter of 2020 for receiving and sending countries and remained around similar levels in the following two quarters, with few exceptions. Those are Chile, among the sending countries, which increased its ESI in the third and fourth quarters of 2020, and Bolivia and Mexico among the receiving countries, the former decreasing its economic support in the third quarter and the latter only presenting positive values of the index in the last quarter. The economic measures included in this index are mainly income support and debt relief for households. Fiscal measures and giving international support are recorded by the project in numerical values but are not included when calculating the aggregated index (Hale et al., 2021).

3.3 | Bilateral remittances and explanatory variables: Construction and sources

To analyze the effect of the COVID-19 pandemic on remittances in Latin America, we have selected a sample of countries for which total quarterly remittances were available from each country's Central Bank. The final sample includes remittances in Million US dollars for El Salvador, Guatemala, Dominican Republic, Bolivia, México, Colombia, Paraguay, Nicaragua, Peru and Ecuador. The sample period starts on the first quarter of 2019 and ends on the fourth quarter of 2020, with complete information for all countries except for Guatemala, for which remittances are not available for the last quarter of 2020.

Bilateral remittances are computed by multiplying total remittances received by each country in our sample by annual bilateral weights obtained from the bilateral remittance matrix of the World Bank of 2018, obtained according to the methodology suggested by Ratha and Shaw (2007). These weights are a proxy for the share of remittances coming from a specific sending country over the total remittances received by the destination country. Since these are the most updated remittance flows, we extrapolate them to 2019 and 2020. In order to check the accuracy of

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[5]Brazil was not included as a receiving country since remittances are not a significant financial flow for this country in terms of both remittances/GDP and remittances per capita.
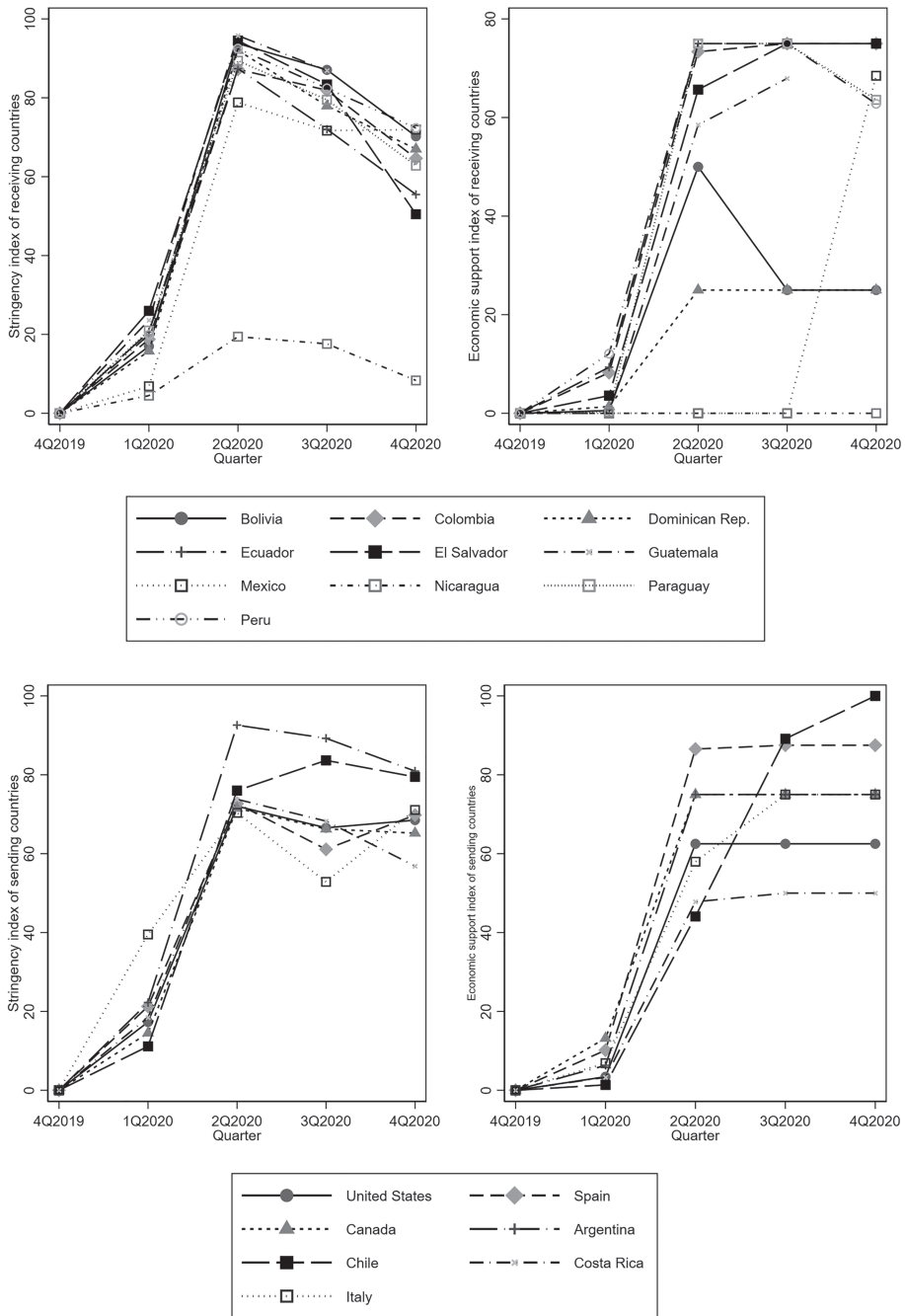
Source: Authors' elaboration using data from The Oxford COVID-19 response tracker (OxCGRT).

FIGURE 2 Evolution of stringency and economic support indices of receiving and sending countries

our variable, we calculated simple correlations between the constructed bilateral weights and the official bilateral weights reported by the central banks of Ecuador, Colombia, Dominican Republic and Mexico for their top five sending countries. The obtained correlation coefficient of 0.98 gives us confidence in favor of the validity of our bilateral
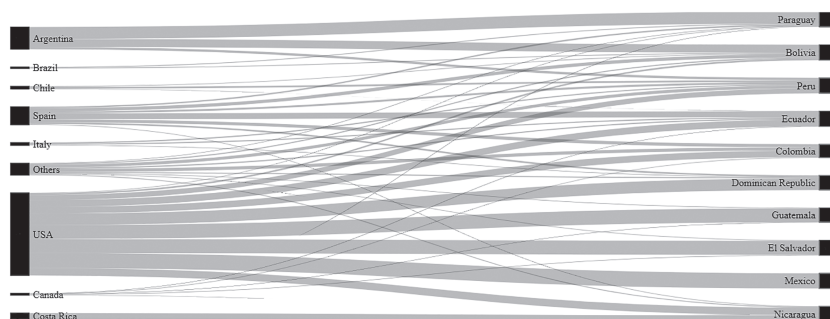
Source: Authors' elaboration using data from CEntral Banks.

FIGURE 3 Sankey diagram of bilateral remittances received by Latin American countries from each sending country in 2020

remittances variable.[6] Given the data available, we finally have a panel data set of bilateral remittances for 10 receiving countries and more than 100 sending countries over eight quarters.

An illustration of the geographical origin of remittances is shown in the Sankey diagram, which shows the bilateral remittances received by the 10 Latin American countries analyzed from each sending country in 2020 (Figure 3). Mexico, El Salvador and Guatemala predominantly receive remittances from the United States, while for the Dominican Republic, the origin of remittances is somewhat more diversified, Spain being the second most important source. In Colombia, diversification is greater since it receives a significant proportion of remittances from countries other than the United States and Spain. On the other hand, remittance flows to Paraguay and Bolivia come mainly from Argentina.

We use nominal exchange rates and GDPs as control variables. The quarterly real GDP series of the countries sending remittances and the nominal exchange rate of both receiving and sending countries were extracted from the IFS data of the IMF. In contrast, the GDP for the Latin American countries in the sample comes from the CEPALSTAT database of the Economic Commission for Latin America and the Caribbean since this database has up-to-date GDP data of Latin American countries. The GDP of both sending and receiving countries was converted to international dollars using the nominal exchange rate data.

The GDP variables are introduced in the empirical model lagged one quarter to avoid multicollinearity with the policy indexes (e.g., GDP variables containing the impacts of policy responses) and mitigate reverse causality issues. We capture those impacts uniquely by our policy response variables; therefore, we control for the supply and demand conditions of the previous quarter.

The policy response variables are quarterly averages of the original daily measures published by OxCGRT, which provides daily data on government responses to contain the pandemic using 19 indicators that go back to January 2020 (Hale et al., 2021). As explained in the previous subsection, the GRI is a simple average of all four categories reported, of which we have selected two for empirical analysis: the SI, including indicators on containment and closure policies (sometimes named lock-down policies), and the ESI, exclusively accounting for economic support measures.

For our estimations, we use the SI and the ESI and selected subcomponents of them. The aggregated indices vary from 0 to 100, while the subindices are expressed in logs since their range of values is not homogeneous (e.g., some vary from 0 to 2, whereas others from 0 to 3). Since every index takes the value of 0 for the year 2019

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[6]The table with the official bilateral weights is available upon request

(before COVID started), we express the subindices as log(1+ index). It is worth noting that these indices allow for cross-country comparisons of measures taken by governments but do not say much about the degree of implementation.

We select the SI and the ESI as target variables since they are the ones that are more likely to affect remittances. The former includes eight components: school closing, workplace closing, cancel public events, restrictions on gathering size, close public transport, stay-at-home requirements, restrictions on internal movement and restrictions on international travel. These policies limit the ability to work and access remittance sending agencies and banks when formal channels are used. If migrants use informal channels to send remittances, those could be affected by restrictions to international travel and internal movement, which were also imposed during the pandemic. The ESI includes four subcomponents: income support, debt relief for households, fiscal measures and international support measures. The first two are ordinal, and the third and fourth are numerical. Income support for households and debt relief directly affect disposable income and can influence remittances depending on the household income elasticity of remittances. The summary statistics of the variables are presented in Table 1.

TABLE 1 Summary statistics

	Obs	Mean	SD	Min	Max
Bilateral remittances	1322	95	754	0	10 419
Log of nominal GDP i	1167	10	2	8	14
Log of nominal GDP j	1202	12	2	8	17
Log of exchange rate USD i	1322	3	3	0	9
Log of exchange rate USD j	1322	3	2	0	8
COVID cases pc i	1322	97	248	0	1433
COVID cases pc j	1322	119	318	0	2455
Stringency index i	1322	25	35	0	96
Stringency index j	1322	24	32	0	99
Economic support index i	1322	17	30	0	75
Log distance	1322	9	1	5	10
Contiguity	1322	0	0	0	1
Economic support index j	1322	22	33	0	100
Income support index i	1322	0	0	0	1
Income support index j	1322	0	1	0	2
Debt relief i	1322	0	1	0	2
Debt relief j	1322	0	1	0	2
Stay at home i	1322	1	1	0	3
Stay at home j	1322	0	1	0	3
Movement restrictions i	1322	1	1	0	2
Movement restrictions j	1322	0	1	0	2
International restrictions i	1322	1	2	0	4
International travel j	1322	1	1	0	4

Note: 'i' denote the remittances receiving countries, and 'j' the remittance sending countries. Bilateral remittances are expressed in millions of US dollars.

3.4 | Model specification and empirical strategy

The main modeling framework for the empirical application is the gravity model, which has been widely used to estimate the determinants of bilateral trade flows. It has also been extensively used to explain other international flows such as FDI (Wu et al., 2005), international migration (Mayda, 2010) and equity holding and cross border banking (Portes & Rey, 2005). In general terms, the gravity model predicts that the bilateral flows are directly proportional to the economic masses of the countries involved in the flow and inversely proportional to the cost incurred. Although empirical applications to study the determinants of international remittances using the gravity model have been less common, these flows can also be explained by the economic mass of the countries involved in the financial transfer and the frictions that limit the transfer volume (Adams, 2006; Lueth & Ruiz-Arranz, 2008; Nnyanzi, 2016). We employ a gravity model of bilateral remittances, in which its variability is explained by the GDPs of both the sending and receiving countries and other factors that might hinder or help deliver the transfer. Given that our focus is on explaining the effects of the COVID-19 government responses on bilateral remittances, we extend the model with proxies for the containment measures applied in sending and receiving countries.

The baseline empirical specification builds on the literature that uses country-level data and panel data techniques to explore the drivers of bilateral remittances using the gravity model. We build on the approach proposed by Lueth and Ruiz-Arranz (2008), Ahmed and Martínez-Zarzoso (2016) and Ahmed et al. (2021). We differ from these three papers in that we do not use a log–log specification but instead use a generalized linear model (GLM), the PPML, as has been suggested in the most up-to-date econometric literature (Head & Mayer, 2014; Yotov et al., 2017).[7]

Our main specification is, therefore, a gravity model of remittances with the dependent variable in levels estimated by PPML that includes country-pair fixed effects (FEs) to account for unobserved heterogeneity, quarter dummies to account for common shocks, as well as a bilateral trend to account for transaction costs and interest rate differentials. The addition of a bilateral trend has been suggested in the trade literature by Baier et al. (2014) and Bergstrand et al. (2016).[8]

The PPML estimator also accounts for zero values in bilateral remittances. That is, if we censor the data to keep only positive observations (as were the case in a log-log gravity specification), we might have a selection bias problem if the chance of having zero bilateral remittances increases when the potential for remitting between two countries is low, as Mnasri and Nechi (2019) and Head and Mayer (2014), among others, explained in the case of trade flows. Furthermore, considering the dependent variable in the form $log(1 + x)$ is also not a good option since there could be a misspecification in the estimated model since it interprets zero bilateral remittances flows as an absence of potential for remitting from one country to another. This interpretation may not match the expectations of the altruistic/self-interest remittances theory of McCracken et al. (2017), which predicts remittances based on income differentials and remittances costs. In addition, as argued in the literature (see, e.g., Mnasri & Nechi, 2019), using the log-linearized model could lead to biased results related to Jensen's inequality, which implies that the expected value of the logarithm of a random variable is not the same as the logarithm of the expected value of the same variable.

The dependent variable corresponds to remittances sent to remittance receiving county 'i' from sending country 'j' at quarter 't'. The independent variables vary either by receiving 'i' or origin 'j' country and quarter 't'. Therefore, the baseline model specification takes the following form:

$$
\begin{aligned}
BilRem_{ijt} = Exp(&\beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{jt} + \beta_3 NEER_{it} + \beta_4 NEER_{jt} + \\
&\beta_5 Stringency_{it} + \beta_6 Stringency_{jt} + \beta_6 EconResp_{it} + \beta_6 EconResp_{jt} + \gamma_t + \delta_{ij} + \sigma_{ijt}) * \epsilon_{ijt},
\end{aligned}
\tag{1}
$$

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[7]The PPML is preferred to alternative GLM models such as the Gamma PPML or the non-linear least squared (Yotov et al., 2017).

[8]Standard errors are clustered at the country-pair level to account for heteroskedasticity and autocorrelation.

TABLE 2 Manning and Mullahy test

	MAMU test b/se
ln_fitted_model	1.065***
	(0.010)
Observations	1692

Notes: Dependent variable: Bilateral remittances. *** stands for significant at the 0.01 level. Clustered standard errors(se) at the country pair level in parenthesis.

where GDP denotes GDP, $Stringency_{it}$, $Stringency_{jt}$, $EconResp_{it}$ and $EconResp_{jt}$ measure the SI and ESI of receiving and sending countries, respectively. NEER denotes quarterly nominal exchange rate,[9] and two sets of FEs are also included, namely, quarterly (γ_t) and pair FE (δ_{ij}). Finally, σ_{ijt} represents the bilateral trend.

Even if the literature suggested PPML as a superior alternative to GPML or NLS, the choice could be data-driven (Martínez-Zarzoso, 2013). In order to validate our PPML estimation strategy, we test the functional form of the model by using the extension of the Park's test performed by Manning and Mullahy (2001), popularly known as the 'MaMu' test. Specifically, this test consists of estimating the data's heteroskedasticity pattern to differentiate if the data follow a Poisson, gamma or inverse-Gaussian distribution. This is done by regressing the log of the squared residuals of Equation (1) on the log of the fitted model of the same estimation. If the coefficient of this regression is close to 1, then the data would follow a Poisson distribution, and the PPML specification would be preferred. The coefficient of this regression results in 1.065, as can be observed in Table 2 with a 1% significance level. Therefore, there is evidence supporting the use of the PPML functional form in our data.

As a preliminary exploratory exercise, we estimate conditional correlations of bilateral remittances and the corresponding subindices of receiving and sending countries. In particular, we regress the logged bilateral remittances on the subindices and the above-mentioned control variables together with country-pair, quarter FE and bilateral trends. The results are presented in Figure 4 for the indices of receiving countries.[10] The correlations show a potential negative effect of three policy response subindices of receiving countries on bilateral remittances, these indices being 'stay at home restrictions', 'international travel restrictions' and 'income support'. On the other hand, there is no clear evidence of correlations between policy responses of sending countries and bilateral remittances.

4 | MAIN RESULTS

The main results obtained by utilizing the PPML estimator are presented in Table 3.[11] We estimate five different versions of the baseline model specified in Equation (1). The first includes gravity control variables instead of country-pair FE for comparative purposes. The second includes country-pair and quarter FE together with a bilateral trend, and the third–fifth complements the second by including selected subcomponents of the policy response indices introduced sequentially. In Specifications (3)–(5), the ESI is disaggregated into the 'income support' subindex,[12] while the SI is disaggregated into the 'stay at home restrictions', 'movement restrictions' and 'international travel restrictions' subcomponents, each of them is included individually to avoid multi-collinearity given the high correlation between them.

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[9]This is defined as the value of the domestic currency used to buy 1 dollar.

[10]Confident bands are shown in discontinuous lines.

[11]As stated in the previous section, this technique offers several advantages and is preferred in our case.

[12]The other subcomponent of the ESI is 'debt relief', but is not included in the estimations given its high multicollinearity with 'income support'.
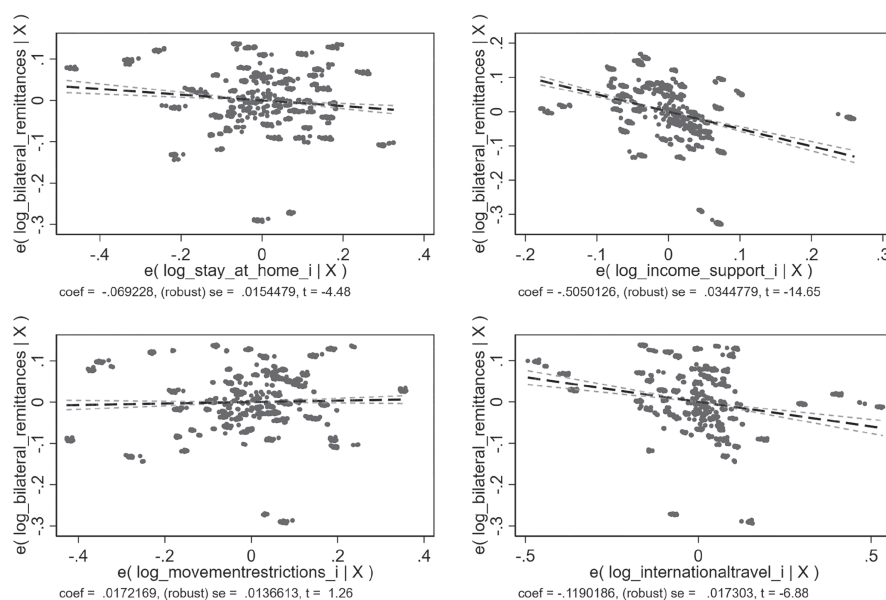
Notes: Scatter plot and predicted fit resulting from a Fixed Effect (FE) regression (with country pair as the unit of the panel) of the logged bilateral remittances on different policy response indices of receiving countries, including the mentioned control variables and quarter dummies.

FIGURE 4   Correlations between policy responses of receiving countries and bilateral remittances

In Column (1) of Table 3, a traditional gravity model is presented, with typical gravity controls, including bilateral dummy variables for contiguity, common language, previous colonial relationship and distance between sending and receiving countries. The coefficients of these gravity variables are statistically significant and have the expected sign; specifically, remittances are 113% larger between countries that share a border and 206% times larger between countries speaking the same language. The coefficient of distance shows an expected coefficient: A 1% increase in the distance reduces remittances by around 2%. Given that the four included bilateral variables cannot account for all time-invariant factors relevant to explain remittance flows (for example, the existence of long-term treaties), we do not interpret the results for the target variables and other time-variant controls in Column (1).

The results we rely on and discuss are the ones obtained with the preferred specification shown in Columns (2)–(5) containing dyadic (country-pair) FE and bilateral trends. They show that GDP, an indicator of the business cycle, is not significant for sending countries but positive and significant for receiving countries. The impact of a 1% increase in receiving country's GDP on remittances goes from 0.69% to 0.83% in these specifications. A 1% increase—depreciation—in the nominal exchange rate of the receiving country increases remittances by about 1.53%–1.97%. Changes in the nominal exchange rate of the sending country are not shown to be significant drivers of remittances. In Column (2), we see that increases in levels of containment and closures in receiving countries reduce remittances to a small extent. Economic support measures for households in sending countries are not significant. Looking at Columns (3)–(5), we find that containment measures, restrictions on free movement and restrictions on international travel only negatively affect remittances if they take place in the receiving country. Specifically, a 1% increase in those indices leads ceteris paribus to a decrease of remittances by 0.25%, 0.18% and 0.08%, respectively.

We perform several robustness checks to validate the results, which are estimated separately for the specification with 'stay at home' and 'movement restriction' indexes (given their high collinearity), which can be found in

TABLE 3 PPML estimations of the impact of COVID-19 government responses on bilateral remittances

	(1) PPML b/se	(2) PPML-FE b/se	(3) PPML-FE b/se	(4) PPML-FE b/se	(5) PPML-FE b/se
Log GDP i$[t-1]$	0.330***	0.837***	0.788***	0.694***	0.863***
	(0.035)	(0.147)	(0.150)	(0.166)	(0.144)
Log GDP j$[t-1]$	1.125***	−0.174	−0.241	−0.266	−0.406
	(0.037)	(0.317)	(0.359)	(0.383)	(0.372)
Log Exchange Rate USD i	−0.059***	1.715***	1.970***	1.768***	1.539***
	(0.014)	(0.309)	(0.271)	(0.374)	(0.336)
Log Exchange Rate USD j	−0.089**	−0.246	0.059	0.049	−0.066
	(0.045)	(0.323)	(0.292)	(0.280)	(0.280)
Contiguity	0.757***				
	(0.193)				
Common language	1.117***				
	(0.303)				
Log distance	−1.975***				
	(0.201)				
Stringency index i	0.013***	−0.003***			
	(0.005)	(0.001)			
Stringency index j	−0.003	−0.003*			
	(0.016)	(0.002)			
Economic support index i	−0.003	0.001			
	(0.003)	(0.001)			
Economic support index j	0.014***	−0.000			
	(0.004)	(0.001)			
Log income support i			0.085	0.055	−0.051
			(0.060)	(0.075)	(0.059)
Log income support j			0.139	0.113	0.138
			(0.089)	(0.079)	(0.088)
Log stay at home i			−0.248***		
			(0.066)		
Log stay at homej			0.053		
			(0.053)		
Logmovement restrictions i				−0.180***	
				(0.036)	
Log movement restrictions j				0.020	
				(0.072)	
Log international travel i					−0.081**
					(0.041)
Log international travel j					0.106
					(0.071)

(Continues)

TABLE 3 (Continued)

	(1) PPML b/se	(2) PPML-FE b/se	(3) PPML-FE b/se	(4) PPML-FE b/se	(5) PPML-FE b/se
Constant	14.640***	9.675*	10.360	12.520*	13.321*
	(1.354)	(5.781)	(6.591)	(7.361)	(6.807)
Country pair FE	No	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes
Bilateral trend	No	Yes	Yes	Yes	Yes
Observations	1322	1322	1322	1322	1322

Note: Dependent variable: Bilateral remittances. Clustered standard errors (se) at the country pair level in parenthesis.
***Significant at 0.01 level.
**Significant at 0.05 level.
*Significant at the 0.1 level.

Tables 4 and 5, respectively.[13] The first robustness check (Column 1) includes the unemployment rate of sending countries instead of GDP to account for the migrant's ability to remit since migrants could be overrepresented in the sectors more heavily affected by the pandemic.[14] The second robustness check (Column 2) consists in controlling for COVID cases per capita in both sending and receiving countries since it could be correlated with both the policy indexes and remittances.[15] The third robustness check (Column 3) estimates the model for a sub-sample without Mexico, given this country's importance as a receiving country due to the substantial flow of remittances received from the United States. The fourth robustness check (Column 4) uses remittances per capita[16] as the dependent variable, as has been done in other studies. Finally, in the last robustness check (Column 5), we use remittances as a share of GDP as a dependent variable to differentiate the total effects of this financial flow in the receiving countries' economies.

With respect to the policy variables, as shown in Tables 4 and 5, the effect of 'stay at home' on receiving countries is robust to all the specifications except for the one without Mexico, while the effect of 'movement restriction' of the same group of countries is robust to all the specifications. These results indicate that the effect of the 'stay at home' restriction was driven by Mexico, while the 'movement restriction' is statistically significant for the whole sample.

Regarding the robustness of the macroeconomic variables, it can be observed in Tables 4 and 5 that the positive effect (depreciation) of the exchange rate on remittances is also driven by Mexico since its coefficient is no longer significant in the model that excludes this country from the sample (Column 3). In addition, economic activity measured by the GDP is not significant in the specifications using as dependent variable remittances per capita (Column 4) and remittances/GDP (Column 5), which implies that GDP of receiving countries only influence the total nominal value of remittances but not their relative importance for the economic activity or the quantity assigned to each individual.

The main implication of these results—concerning the discussed theoretical framework—is that both altruistic and self-interest-related factors have influenced remittances toward Latin American countries during the COVID-19

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[13]In both Tables 3 and 4, the first column has fewer observations because the quarterly unemployment rate was only available for OECD remittance-sending countries. The fifth column has fewer observations because the contemporaneous GDP of remittances-receiving countries was not available for the whole period in some countries.
[14]Unemployment rates were obtained from the OECD macroeconomic databases
[15]COVID-19 cases were calculated by aggregating at the quarterly level the new daily COVID cases obtained from the Our World in Data (OWID) database.
[16]Obtaining the population data from the United Nations Population Database.

TABLE 4 Robustness checks: Specification including stay at home index

	(1) PPML-FE b/se	(2) With COVID-19 cases b/se	(3) Without Mexico b/se	(4) Using remittances per capita b/se	(5) Using remittances/ GDP b/se
Log GDP i[t − 1]	0.853***	0.788***	0.451**	0.331	0.445
	(0.148)	(0.160)	(0.195)	(0.222)	(0.420)
Unemployment rate j [t − 1]	−0.006				
	(0.005)				
Log Exchange Rate USD i	2.007***	1.587***	−0.164	1.738***	2.097**
	(0.250)	(0.321)	(0.292)	(0.515)	(0.891)
Log Exchange Rate USD j	−0.381	0.140	0.118	0.078	0.133
	(0.277)	(0.266)	(0.256)	(0.350)	(0.416)
Log income support i	0.085	0.014	−0.104	0.132	0.349***
	(0.060)	(0.077)	(0.241)	(0.093)	(0.114)
Log income support j	0.032	0.162*	0.110	0.160	0.188
	(0.062)	(0.086)	(0.088)	(0.104)	(0.115)
Log stay at home i	−0.226***	−0.236***	−0.073	−0.186***	−0.240***
	(0.064)	(0.041)	(0.063)	(0.059)	(0.084)
Log stay at home j	0.036	0.025	0.037	−0.038	−0.114
	(0.067)	(0.048)	(0.054)	(0.091)	(0.091)
Log GDP j[t − 1]		−0.158	−0.108	−0.292	−0.043
		(0.360)	(0.338)	(0.431)	(0.460)
Log COVID cases pc i		0.049***			
		(0.013)			
Log COVID cases pc j		0.012			
		(0.010)			
Constant	5.963***	10.106	17.850***	2.242	3.687
	(1.905)	(6.759)	(6.126)	(7.507)	(8.403)
Country pair FE	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes
Bilateral trend FE	Yes	Yes	Yes	Yes	Yes
Observations	1040	1322	1154	1322	1167

Note: Dependent variable: Bilateral remittances in (1), (2) and (3), per capita in (4) and divided by gross domestic product (GDP) in (5). Clustered standard errors (se) at the country pair level in parenthesis.
***Significant at 0.01 level.
**Significant at 0.05 level.
*Significant at the 0.1 level.

pandemic. Some of the factors are relevant for the 10 Latin American countries included in our study, whereas others seem to be driven by Mexico, which receives around 92% of its remittances from the United States. More specifically, the positive effect of GDP of receiving countries on remittances might be triggered by the self-interest channel, by which migrants send more remittances due to improved investment conditions in the home country. On the other hand, the positive effect of a depreciation of the Mexican currency vis-a-vis the dollar on remittances

TABLE 5 Robustness checks: Specification including movement restriction index

	(1) PPML-FE b/se	(2) With COVID-19 cases b/se	(3) Without Mexico b/se	(4) Using remittances pc b/se	(5) Using remittances/ GDP b/se
Log GDP i$[t-1]$	0.743***	0.765***	0.330*	0.202	0.215
	(0.180)	(0.190)	(0.176)	(0.246)	(0.417)
Unemployment rate j $[t-1]$	−0.006	−0.006			
	(0.005)	(0.005)			
Log Exchange Rate USD i	1.809***	1.516***	−0.529	1.284**	2.435***
	(0.346)	(0.402)	(0.391)	(0.606)	(0.902)
Log Exchange Rate USD j	−0.449*	−0.412*	0.119	0.207	0.328
	(0.245)	(0.225)	(0.199)	(0.266)	(0.243)
Log Income support i	0.056	-0.002	-0.121	0.064	0.423***
	(0.075)	(0.094)	(0.203)	(0.099)	(0.087)
Log income support j	0.012	0.025	0.115	0.156*	0.199**
	(0.053)	(0.045)	(0.085)	(0.090)	(0.091)
Log movement restrictions i	−0.177***	−0.156***	−0.095**	−0.150***	−0.385***
	(0.036)	(0.022)	(0.048)	(0.050)	(0.051)
Log movement restrictions j	0.012	0.078	0.116*	0.187	0.400***
	(0.029)	(0.051)	(0.064)	(0.155)	(0.155)
Log COVID cases pc i		0.036**			
		(0.014)			
Log COVID cases pc j		0.006			
		(0.010)			
Log GDP j$[t-1]$			−0.179	−0.270	0.008
			(0.348)	(0.447)	(0.412)
Constant	7.891***	8.397***	21.110***	3.795	3.939
	(2.611)	(2.743)	(6.348)	(7.761)	(9.215)
Country pair FE	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes
Bilateral trend FE	Yes	Yes	Yes	Yes	Yes
Observations	1040	1040	1154	1322	1167

Note: Dependent variable: Bilateral remittances in (1), (2) and (3), per capita in (4) and divided by gross domestic product (GDP) in (5). Clustered standard errors (se) at the country pair level in parenthesis.
***Significant at 0.01 level.
**Significant at 0.05 level.
*Significant at the 0.1 level.

reflects that both altruistic and self-interest channels might be operating via the reduction of the relative cost of consumption and investment in Mexico with respect to the United States, the former considering that altruistic migrants include the consumption of their family at home on their utility function. Regarding the policy indexes, 'movement restrictions' in receiving countries might reduce remittances demand by increasing citizens' available income due to the forced saving generated by the impossibility to spend on travel and the leisure activities. Finally, 'stay at home' restrictions only have a negative effect on remittances in Mexico which could be associated with the severity of these measures in this country. The effect is similar to the one of 'movement restrictions' increasing available

income due to the reduction of leisure expenses but complemented by the difficulty to collect remittances in the physical agencies.

These results show that there are factors influencing remittances in both sending and receiving countries. However, and as can be seen in Figure 1, the negative effects prevailed during the first and second quarter of 2020, but the positive effects dominated after the second quarter of 2020 and in the period as a whole. Therefore, this study implies that the recovery of the receiving countries' economies, the depreciation of their currency and the decrease in the restriction policies after the second quarter of 2020 (as can be seen in Figure 2) had been the determinants of the great recovery of remittances towards Latin American countries. Finally, an increase in the altruistic parameters of migrants during the pandemic could be another factor, moreover, in the context of increased health costs during the pandemic.

5 | CONCLUSIONS

Remittances are an important source of support in developing countries that help low-income families to escape poverty. For this reason, it is crucial to investigate the determinants of remittance flows in sending and receiving countries. This paper analyzes how the government measures implemented during the COVID-19 pandemic have affected bilateral remittances sent to ten countries in the Latin American region. The countries considered are important receivers of remittances and present specific characteristics concerning location, economic size and development level that allow us to infer whether the different economic support measures, containment measures and other mobility restrictions have influenced the dynamic of sending and receiving remittances over the period covering from January 2019 to December 2020.

We first show that the quarterly evolution of remittances for the selected countries presents a V-shaped pattern driven by the first wave of the pandemic, indicating a recovery of the flows starting in June 2020. We then proceed to estimate a gravity model of bilateral remittances augmented with several proxies for governmental measures taken during the pandemic in remittance receiving and sending countries. The model is estimated using PPML to include zero remittance flows and obtain consistent estimates of the target variables.

The main results indicate that containment measures are particularly relevant in the remittance receiving countries. However, the business cycle and the nominal exchange rate in receiving countries are also of utmost importance. Nevertheless, the latter result seems to be driven by Mexico. Results imply that a recovery in the receiving country's economy, depreciation of its currency (particularly for Mexico) and the relaxation of confinement and internal movement restrictions lead to increases in remittances. Hence, economic growth in the sending countries, weak currencies in Latin American countries and the smoothing of restrictions were determinants of the great recovery of remittances sent to Latin American countries after the second quarter of 2020.

Surely, a slow vaccination roll-out, the surge and spread of new mutants of the COVID-19 virus that require new vaccines, and the subsequent necessary measures of containment and closures will be detrimental for remittances. The latest figures show that the share of people vaccinated against COVID-19 as of August 2021 vary greatly in the countries of analysis (Oxford University, 2021).[17] Vaccination forecasts predict that the first round of vaccinations in Latin America should be completed by mid-2022, much slower than in the United States and Europe, where the population is expected to be fully vaccinated by late 2021 (EIU, 2021).

If progress in research in biotechnology continues to be faster than mutant variants, production of vaccines and medical equipment picks up, and vaccination roll-out works better than in the past, then an economic recovery of the remittance receiving economies could be expected and likely to be paralleled by a recovery of remittances, in line with econometric evidence shown in this paper. Moreover, global economic GDP growth, forecasted to reach over 5.8% in 2021 (OECD, 2021), will further boost remittances.

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[17]Nicagua has the lowest share of people fully vaccinated against COVID-19, reaching only 3,03%. This same share reaches 42% in the Dominican Republic.

In order to secure that the households left behind can benefit from remittances and that COVID-19 and its dangerous variants do not spread from poorer countries to richer countries, it will be crucial to deliver vaccines in sufficient quantities in the 'Global South' and support a more efficient vaccination roll-out there. In this line, and given that the overall poverty rate in Latin America increased by 3.2 percentage points in 2020 compared to 2019 (CEPAL, 2021), which corresponds to 22 million more people in poverty, it would be interesting for further research to investigate how remittances prevented poverty from rising even more. Moreover, further research is needed on the altruistic motives of migrants during crisis and extending the model to other regions, particularly Africa and Asia, where there are several countries for which remittances play a crucial role as support for poor households.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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