Migration, Externalities, and the Diffusion of COVID-19 in South Asia*

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Abstract

The initial spread of COVID-19 halted economic activity as countries around the world restricted the mobility of their citizens. As a result, many migrant workers returned home, spreading the virus across borders. We investigate the relationship between migrant movements and the spread of COVID-19 using district-day-level data from Bangladesh, India, and Pakistan (the 1st, 6th, and 7th largest sources of international migrant workers). We find that during the initial stage of the pandemic, a 1 SD increase in prior international out-migration relative to the district-wise average in India and Pakistan predicts a 48% increase in the number of cases per capita. In Bangladesh, however, the estimates are not statistically distinguishable from zero. Domestic out-migration predicts COVID-19 diffusion in India, but not in Bangladesh and Pakistan. In all three countries, the association of COVID-19 cases per capita and measures of international out-migration increases over time. The results show how migration data can be used to predict coronavirus hotspots. More broadly, the results are consistent with large cross-border negative externalities created by policies aimed at containing the spread of COVID-19 in migrant-receiving countries.

Keywords: Coronavirus, international migration, lockdown, Bangladesh, India, Pakistan.

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1 Introduction

As COVID-19 spread globally, governments faced one of the hardest choices in public economics: how to choose between saving lives or saving livelihoods (Viscusi, 2020)? Some argued that placing priority on public health is a moral imperative and would also be the best economic policy in the long run. In Spring 2020, most European countries accordingly sharply restricted mobility and ordered non-essential businesses closed, even though it carried steep short-run economic costs (Thomsen, 2020). Other countries (especially low- and middle-income economies) were pressed to put greater weight on immediate challenges, including poverty and hunger, caused by lost jobs and disappearing businesses (Abi-Habib and Yasir, 30 March, 2020; Dahir, April 22, 2020; Sen et al., 17 April, 2020). As a result, lockdowns in Spring 2020 were shorter and restrictions on mobility and commerce were generally less stringent—even if that risked raising rates of COVID-19 infection (International Monetary Fund, 2020; Malik et al., 2020).

The strict lockdowns in richer countries closed workplaces and curtailed infection by limiting negative externalities from personal interactions (Bethune and Korinek, 2020). Simultaneously, however, the policies created negative externalities elsewhere by pushing migrant workers from poorer countries to travel home (World Bank, 2020; Mitra et al., May 14, 2020). We quantify the spread of COVID-19 as migrants returned to Bangladesh, India, and Pakistan, bringing the risk of contagion from their former workplaces. We then document how patterns of prior international migration predict potential hotspots (see also Ahsan et al. 2020).

Globally in 2019, India was the leading country of origin for international migrants, Bangladesh was sixth, and Pakistan was seventh (United Nations DESA, 2019).[1] The countries were also the three most affected by the initial spread of the coronavirus in South Asia. In South Asia, the movement of migrants heading home in anticipation of lockdowns, both

[1]In 2019, India accounted for 17.5 million international migrants, Bangladesh for 7.8 million, and Pakistan for 6.3 million. (Source: United Nations DESA 2019.) Together, the three countries include 1.8 billion people or 28% of the world population outside of China.

internationally and within countries, was the largest mass migration since the 1947 partition of India, Pakistan, and what is now Bangladesh (Ellis-Petersen and Chaurasia, March 20, 2020).[2] The migration brought fear of COVID-19 contagion and the shunning of migrants as they spread through the sub-continent (Pandey, April 15, 2020; Bisht, March 27, 2020).

We use labor force surveys and household-level economic surveys from prior years to measure the extent of out-migration for each of 755 districts in the three countries and to distinguish between international and domestic migration. We then use data on migration patterns to predict the incidence and number of confirmed COVID-19 cases in each district using district-day data, beginning on the day of the 100th confirmed case in each country and, subject to data availability, continuing for the following 1.5 months.[3] Out-migration in earlier periods is used as an indicator of reverse migration in February, March, and April 2020. To capture broader patterns of diffusion, we flexibly control for trends over time with day-level fixed effects.

The data establish that international migration predicts the spread of the coronavirus across and within districts in India and Pakistan. In the 45 days following the first 100th case in each country, a 1 standard deviation (SD) increase in prior international out-migration from the district-wise average (measured as the number of out-migrants per capita and averaged over the cross-section) predicts a 48% higher number of cases per capita. In Bangladesh, however, where COVID-19 testing rates were substantially lower, the correlation of international out-migration and the number of confirmed cases is imprecisely measured and flips sign from positive to negative in some specifications.

Domestic migration is a weaker and less consistent predictor of contagion. While domestic migrants who returned to their home towns and villages were a focus of local fears and national policy debate (Ray and Subramanian, 2020), the detectable effects of domestic

[2]Bangladesh imposed a nationwide lockdown on March 26, 2020, India imposed a nationwide lockdown on March 25, and most provinces in Pakistan were under lockdown as of March 23, 2020.

[3]The 100th case of COVID-19 was confirmed on April 6, 2020 in Bangladesh, on March 15 in India, and on March 16 in Pakistan. The sample windows are thus April 6-May 20 for Bangladesh; March 15-April 28 for India; and March 16-April 27 for Pakistan.

migration are low in Bangladesh (a 3% increase in the probability of any COVID-19 cases is predicted by a 1 SD increase in domestic migration in the average district) and negative in Pakistan. In India, where fears of contagion from migrants were reported widely (Mitra et al., May 14, 2020), a 1 SD increase in domestic migration in a given district predicts a 11% increase in whether or not a district reports any cases of COVID-19 during the study period, but predictions of the number of cases are measured imprecisely.

The predictive power of international migration patterns is not driven mechanically by the COVID-19 experiences of the returning migrants themselves. Instead, the results are consistent with community spread seeded by migrants (and others) from abroad. First, Section 3.3 shows that plausible magnitudes of return-migration and infection are too small to match the scale of reported COVID-19 cases. Second, Section 2 and Appendix A describe policies that limited international air travel and dramatically slowed the influx of migrants near the start of our study windows. Third, section 5 shows that the predictive power of the measures of international migration to explain COVID-19 cases increased steadily over time, consistent with community spread and, given the policy time-line, inconsistent with COVID-19 infections suffered by international migrants directly.

Quarantines for migrants and other travelers were imposed in the three countries, but the findings, especially for international migrants, are consistent with worries that the policies were not implemented stringently. The evidence is equivocal with respect to the role of domestic migrants, showing an advantage of household-level and individual-level survey data which provides the ability to distinguish between international and domestic migrants—and thus to provide insight into health-related cross-border externalities.

The estimates are not causal parameters. The pattern of coronavirus cases is affected by demographics, climate, the stringency of the lockdown, the nature of the initial spread, and other factors. The results necessarily reflect complicated interactions of biology, policy, and human behavior, as well as omitted variables correlated with migration patterns. Yet the results are consistent with the nature of timing of COVID-related policy decisions and cross-border mobility, and they show that data on migration patterns, drawn from existing labor and household surveys, can help pinpoint patterns of diffusion and anticipate which districts are likely to face particularly acute healthcare needs.

2 Policy Responses to COVID-19 in South Asia

COVID-19 cases were first reported on January 30 in India, on February 26 in Pakistan, and on March 8 in Bangladesh. Cases then grew steadily. Our analysis continues through May 20, 2020, 45 days after the 100th case in Bangladesh. By then, there were 112,028 confirmed cases in India; 45,898 cases in Pakistan, and 26,738 cases in Bangladesh.[4]

The severity and infectiousness of the virus prompted governments to begin restricting mobility in March 2020 (International Monetary Fund, 2020). Facing job losses in host countries and movement restrictions in home countries, many migrants rushed to get home. Travel bans imposed in the three countries meant that their window to return home was short. About a week after the start of our samples, international borders had largely closed (a week before the day 1 in Bangladesh, on the day 8 in India and on the day 7 in Pakistan; see Appendix A). The growth of cases in the second part of the samples is thus almost entirely due to community spread rather than to cases brought by returning international migrants.[5]

In Bangladesh, international migrants returned while a tide of domestic migrants also returned to rural areas of the country from Dhaka, in part spurred by government promises that shelter and food would be provided in rural areas (UNB, Dhaka, March 26, 2020). On March 14, visa requirements were made stricter, and flights from Europe (except the United Kingdom) were halted (Daily Star, March 14, 2020). Travelers were requested to self-quarantine for 14 days.

[4]Data are for confirmed COVID-19 cases on May 20, 2020 from `https://www.worldometers.info/coronavirus/#countries`. By September 20, 2020, India had reported 5,485,612 cumulative cases, Pakistan 305,671 cases, and Bangladesh 348,916 cases.

[5]The incubation period of COVID-19 averages 5-6 days and can take up to 14 days (World Health Organization, 2020).

Government telecom administration data indicate that as many as 10 million subscribers initially left Dhaka in the days following the announcement of the government Independence Day holiday on March 26, 2020, which marked the start of a ten-day lockdown (Dhaka Tribune, March 28, 2020). Some of this was followed by re-migration back to Dhaka, as the Bangladesh Garment Manufacturers and Exporters Association reopened factories on April 4, 2020. Shonchoy (2020) partnered with epidemiologists from the International Centre for Diarrhoeal Disease Research, Bangladesh to show that the earliest outbreaks outside of Dhaka were predicted partly by migration patterns.

In India, similarly, reverse international migration was paired with the urban-to-rural movement of domestic migrant workers. The government first announced travel restrictions on March 11, 2020, mandating quarantines for international passengers arriving from China, South Korea, Iran, France, Germany, Italy, and Spain. By March 22, India closed its borders to all international commercial flights.[6] Domestically, a national government lockdown was announced on March 24, 2020, which restricted the movement of people throughout the entire country. Faced with loss of employment, migrant workers immediately left major urban centers for rural areas (e.g., Denis et al., April 21, 2020). While some migrants successfully reached home, others were stymied by the stoppage of transport services and journeyed hundreds of miles on foot. (In early May, special trains were arranged to take migrants home; Al Jazeera, May 4, 2020.)

In Pakistan, in addition to returning economic migrants who worked internationally and domestically in urban areas, the country received travellers who had attended large religious gatherings, including in Iran, a badly-hit neighbor (Emont and Shah, March 18, 2020). On March 21, the government suspended international flights for two weeks. The Government of Sindh announced a lockdown in the province for 14 days from March 23, 2020, ordering all public transport, markets, offices, shopping malls, restaurants, and public areas to be shut down (Arain, March 22, 2020). Punjab also was put on lockdown on March 24, 2020 (ARY

[6] For more details, see: `https://www.mohfw.gov.in/pdf/Traveladvisory.pdf`.

Web, March 23, 2020). Pakistan announced an extension of the lockdowns at the beginning of April, with further extensions after April 14 to May 31 (SNS Web, April 2, 2020).

The analysis focuses only on confirmed cases. This has at least two implications. First, actual cases are likely much higher (The Economist, September 30, 2020). Second, the nature of testing protocols, especially in Bangladesh and India, where contact with international travelers was an early screening criterion, can partly account for positive correlations with migration and confirmed cases. By the middle of the sample period, however, testing protocols in Bangladesh and India had expanded to include all hospitalized patients showing respiratory symptoms associated with COVID-19. In Section 5, we show results for the entire sample window and for the period after testing was expanded, documenting the robustness of correlations after testing protocols had broadened. We also note that the results for Pakistan and India are broadly similar, although in Pakistan international travel history was never a screen for testing (see Appendix A for policy details).

3 Data

3.1 Tracking COVID-19 cases by district

The analysis focuses on the initial stage of the pandemic, starting with the day that the 100th case was confirmed in each country: in Bangladesh, April 6; in India, March 15; and in Pakistan, March 16. Subject to data availability, we then analyze cases over the next 1.5 months. This covers 45 days in Bangladesh, 45 days in India, and 43 days in Pakistan.[7]

Indicators for daily COVID-19 cases by district for Bangladesh were obtained from the Institute of Epidemiology, Disease Control and Research (IEDCR) in Bangladesh.[8] Data on COVID-19 cases by district for India were taken from the CovIndia website, which provides daily updates on the number of cases by district and day.[9] Data on daily COVID-19 cases by

[7] For Bangladesh, district-day level data were not released for two of the 45 days. We impute missing data for May 14 using data on May 13 and missing data for May 18 using data on May 17.

[8] See `https://www.iedcr.gov.bd`.

[9] See `https://covindia.com`. These data are highly correlated with data released by the Ministry of

district for Pakistan were obtained from the Government of Pakistan COVID-19 dashboard.[10]

3.2 Using national surveys to measure migration

Data on international and domestic migration by district for Bangladesh were computed from the Household Income and Expenditure Survey (HIES) 2016, a large nationally representative household survey. The indicator is calculated as the number of migrants identified in the survey divided by the number of individuals in the survey (in hundreds), adjusted using survey weights. International migration is accounted for separately from domestic (within-country) migration. When estimating, the measures are normalized as z-scores calculated using country-specific distributions.

The migrants captured in the HIES 2016 surely did not all return to Bangladesh in response to the COVID-19 crisis, some may have returned earlier, and another group of migrants (those who left post-2016) are not captured at all. Still, migration patterns tend to be relatively stable, and recent evidence validates the use of the 2016 HIES data for Bangladesh to capture reverse-migration in 2020. Ahsan et al. (2020) show a significant correlation between the HIES 2016 district-level data on migration and coronavirus-related quarantines in districts in 2020 (correlation = 0.51, p-value < 0.01) and between the migration data and distress calls to a government coronavirus hotline (correlation = 0.54, p-value < 0.01). As Ahsan et al. (2020) note, this makes widely-available surveys like the HIES particularly valuable when contemporaneous data on population mobility is unavailable. Surveys like the HIES also have the advantage of distinguishing between international and domestic migration.

Measures of international and domestic migration for India were similarly calculated from the most recent migration module in the National Sample Survey (NSS), the 2007-2008 round. Respondents were asked to report the number of migrants who left the district for another country or another district within the past five years. The indicator is calculated as

Health and Family Welfare, but the government data are not available on a daily basis.

[10] See `http://covid.gov.pk/stats/pakistan`. District-level data were retrieved on April 27, 2020.

the number of migrants in the survey divided by the number of individuals in the survey (in hundreds), adjusting using survey weights.

Data on international migration for Pakistan were taken from the Pakistan Social and Living Standards (PSLM) 2014-2015 survey. Assuming one international migrant per surveyed household that receives international remittances, the indicator is the number of international migrants per 100 people in the households surveyed in the district, adjusted using survey weights. Data on domestic migration for Pakistan come from the Pakistan Labour Force Survey (LFS) 2007-2008.[11] The indicator for domestic migrants is calculated as the number of internal migrants from a district per 100 people surveyed from the district.

3.3 Summary statistics and analysis of relative magnitudes

Table 1 shows summary statistics for the sample. Over the full sample, the average share of districts with any COVID-19 cases was 0.84 in Bangladesh, 0.35 in India, and 0.60 in Pakistan. Cases per million people are much higher in Bangladesh and Pakistan, at 19.17 and 11.81 respectively, while the number of cases per million people is 2.56 in India. Data sources and definitions for control variables are reported in Appendix B.

Bangladesh and Pakistan also report much higher rates of international migration (2.41 and 1.32 people per 100, respectively) relative to India (0.24 people per 100 people). Conversely, rates of domestic migration are much higher in India data than in Bangladesh or Pakistan, with Pakistan having substantially lower rates of domestic migration than either Bangladesh or India.

Some of the estimates in Section 5 can be interpreted in terms of 1 standard deviation variations in district-wise out-migration rates. Table 1 shows that for Bangladesh, 1 SD corresponds to 2.38 migrants on a base of 2.41 migrants per 100 people (a 99% ratio). For India, 1 SD in international out-migration corresponds to a change of 0.67 migrants on a

[11] The 2007-2008 round was used because of the availability of information on the previous district of the migrant. In this dataset, about 10% of individuals aged 10 and above report having moved from a different district to their current district of residence. This rate (10%) is unchanged in the 2014-2015 round, which uses an identical question to identify migrants.

base of 0.24 migrants per 100 people (i.e., a 279% ratio). In Pakistan, 1 SD corresponds to a change of 1.83 migrants on a base of 1.32 migrants per 100 people (a 139% ratio).

The summary statistics also provide relative magnitudes of cases plausibly experienced by returning migrants versus those due to broader community spread. The magnitudes suggest the presence of substantial community spread beyond infections of migrants themselves.

For example, in India, the summary statistics show an average of 0.24 international migrants per hundred people in the survey data. The coronavirus tracker shows 2.56 cases per million people – or 0.000256 cases per hundred people – during the study window. If 3% of the migrants returned and 1% were infected with COVID-19 (a conservative assumption given that the window is early in the pandemic), then $0.24 * 3\% * 1\% = 0.000072$ infected migrants returned per hundred people.[12] Dividing 0.000072 infected migrants by 0.000256 cases yields that 28% of the reported cases could plausibly be accounted for by infected migrants.

In Pakistan, there are 1.32 international migrants per hundred people and 11.81 cases per million people – or 0.001181 cases per hundred people. If 3% of the migrants returned and 1% had COVID, then $1.32 * 0.03 * 0.01 = 0.000396$ infected migrants returned per hundred people. This would account for about 34% of cases in our study window. The calculation rests on conservative assumptions and shows that it is implausible that the correlations are solely due to infections of migrants themselves. By the final 2 week period in the sample window, the corresponding calculation suggests that international migrants could directly account for just 15% of cases in India and 18% of cases in Pakistan.

4 Empirical Strategy

To frame negative externalities from global and local coronavirus containment policies, we combine district-day level data on COVID-19 cases with district-level data on international

[12] For example, Mitra et al. (May 14, 2020) notes that out of 1.3 million migrants in the Gulf who were originally from the state of Telangana, around 40,000 (3%) returned home to India in March 2020.

and domestic out-migration and covariates. We start by predicting variation within a given day across districts using a day fixed-effects model that starts on the day of the 100th confirmed case in each country.

For district i and day t, where t is the number of days since the 100th case was confirmed in each country, we estimate the relationship between international out-migration and COVID-19 with a linear specification for each country:

$$Y_{it} = \beta_0 + \beta_1 InternationalOutmigration_i + \beta_2 DomesticOutmigration_i + \mathbf{X_i}\beta + \alpha_t + \varepsilon_{it} \quad (1)$$

where Y_{it} is either (a) an indicator term equal to 1 if the district had any COVID-19 cases on day t and 0 otherwise, or (b) the number of COVID-19 cases per million people in the district on day t. The main coefficient of interest is β_1, the predictor of COVID-19 cases related to international out-migration, conditional on the control variables and fixed effects. $InternationalOutmigration_i$ is the number of migrants who had previously left district i for another country per 100 people as calculated from the household and labor surveys for India, Pakistan, and Bangladesh. $DomesticOutmigration_i$ is the number of migrants who left district i for another district in the same country per 100 people as calculated from the survey data for the three countries. $\mathbf{X_i}$ is a set of district-level control variables comprising population, population density, the fraction of the population residing in urban areas of the district, the fraction of the population below the poverty line, and a measure of access to health facilities.[13] Country-wide trends are captured flexibly by day fixed-effects via the variable α_t. Standard errors are clustered two-way by district and day.

We also estimate equation (1) in successive 2-week windows to study the relationships between international out-migration and the spread of COVID-19 over time. These results

[13]For India, we use the number of primary health centers per capita to measure health access. For Pakistan, we use the percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling for Pakistan. For Bangladesh, we use the number of hospital beds per capita. We exclude the number of testing labs in district i on day t in the main set of control variables due to concerns with potential endogeneity, but we show robustness of the results to the inclusion of this control in appendix section C.1.

are shown in Section 5 and in Appendix Tables 6, 7, and 8. The final window provides results after international travel bans were in force and after testing protocols were broadened to include all symptomatic individuals with respiratory issues in the three countries.

The second specification flexibly accounts for changing relationships over time. We exploit the panel structure of the district-day level data, using day fixed effects to exploit variation within a given day across districts:

$$
\begin{aligned}
Y_{it} = \beta_0 &+ \sum_{t=1}^{T} \theta_t InternationalOutmigration_i * Day_t \\
&+ \sum_{t=1}^{T} \gamma_t DomesticOutmigration_i * Day_t + \mathbf{X_i}\beta + \alpha_t + \varepsilon_{it} \qquad (2)
\end{aligned}
$$

where Y_{it}, $InternationalOutmigration_i$, $DomesticOutmigration_i$, $\mathbf{X_i}$, and α_t are as defined earlier. $\{Day_t\}_{t=1}^{T}$ is a set of indicator variables equal to 1 if the day is equal to t, and 0 otherwise. $\{\theta_t\}_{t=1}^{T}$ is a set of coefficients of interest capturing the relationship between international out-migration and COVID-19 cases on day t, while $\{\gamma_t\}_{t=1}^{T}$ is an analogous set of coefficients for domestic out-migration. Again, all standard errors are clustered two-way by district and day.

The pattern of the coefficients θ_t and γ_t show the shifting predictive power of migration pattern on the spread of COVID-19. If the return of migrants to districts seeded cases of COVID-19 that led to increases in cases through community transmission over time, we would expect the coefficients θ_t and γ_t to increase during the period, even after accounting for day fixed effects.

To capture the effect of domestic migration outward from large cities, we restrict attention to districts without state, provincial, and country capitals. For consistency, we do the same when analyzing associations of international migration. We assess robustness of the results to the inclusion of these districts in appendix section C.2. Including the full set of districts strengthens the results on international migration in Pakistan, very slightly weakens them in India, and leaves a mixed picture in Bangladesh.

5 Results

The results connect patterns of migration by district to cases of COVID-19 in the first 1.5 months after the first 100th case in each country. First, we predict whether or not a district reports any cases. Next, we predict the number of cases per million people.

5.1 Predicting the Incidence of COVID-19

In all three countries, an increase in international out-migration predicts diffusion of COVID-19 on the extensive margin—i.e., they predict a higher probability that a district reports any cases—but the results are sensitive to the addition of controls. Table 2 presents the relationship between international out-migration and COVID-19 cases using empirical specification (1). The results for Bangladesh, India, and Pakistan are reported in panels A, B, and C, respectively.

In Bangladesh, COVID-19 had spread widely across districts during the period, and on average during the period 84% of districts had confirmed cases. Even with the high average, column (1) shows that a 1 SD increase in international out-migration is associated with a relatively large 5% (0.045/0.84) increase in the probability of any district-wise COVID-19 cases. In India, the association is 32%, and it is 23% in Pakistan. These results are without controls and $p < 0.05$ for each coefficient.

The prevalence of international migration is in part a proxy for other attributes of districts, however, and Column (2) shows that adding controls for district size, demography, health facilities and poverty levels diminishes net associations. In Bangladesh, the association falls to 3% (0.027/0.84). In India, the association falls to 25% (0.087/0.35) and remains statistically significant at the 1% level, and in Pakistan the association is now essentially zero (coefficient = 0.013 with a standard error of 0.033).

The pattern is robust to adding the rate of domestic migration to the specification following equation (1). The coefficients on the international migration variables in columns (3) and (4) are of a similar order but slightly smaller than in columns (1) and (2), and levels of statistical significance are unchanged. The results also show that international and domestic migration differ in their associations with COVID diffusion. In India, the coefficient on domestic migration is one third to half as large as the coefficient on international migration. In Pakistan, the coefficients are similarly-sized in Column (3) and flip signs in column (4).[14]

As noted in Section 2, part of the positive correlations can be explained by testing protocols and the lack of travel restrictions in the beginning of the samples. Columns (5) and (6) thus present results restricted to two-week periods at the end of the sample window, after international travel restrictions had been in force and testing protocols had broadened.[15]

In Bangladesh, 99% of districts had reported cases by this point, and there is so little variation in the dependent variable that coefficients on the migration measures are close to zero. In India, however, the coefficients increase in size, with and without controls (Panel B, columns 5 and 6). In Pakistan the coefficients also increase before controls are added (Panel C, column 5), but, as in columns (2) and (4), adding controls in column (6) eliminates the predictive power of the migration variables in explaining the extensive margin of COVID-19 diffusion. The column (5) results for India and Pakistan are consistent with community spread seeded by returning migrants.

Figure 1 summarizes these patterns, presenting the development of the relationship between out-migration and the probability that a district reports any cases of COVID-19. Coefficients plotted in red depict the relationship between international out-migration and an indicator for any cases over time. Coefficients plotted in blue illustrate the relationship for domestic out-migration; 95% confidence intervals are shown.

The three panels are broadly consistent with the coefficients in column (4) of Table 2. For India, the domestic out-migration coefficients are positive but smaller than the international out-migration coefficients. For Bangladesh and Pakistan, the coefficients are generally sta-

[14] Demographers note that the mobility of migrants in Pakistan in early 2020 was considerably lower than in India (The Economist, September 30, 2020).

[15] Appendix D presents the relationships between out-migration and cases separately for each of the first, second, and third 14-day periods since the 100th case was reported in each country.

tistically indistinguishable from zero, although they are positive and statistically significant between days 7 and 17 in Bangladesh, and negative and statistically significant before day 8 in Pakistan.

Taking everything together on the extensive margin: The results for India are strong and robust. But the non-results for Bangladesh, and the sensitivity to specification of the results for Pakistan, suggest that migration may more reliably predict COVID-19 on the intensive margin than the extensive margin.

5.2 Predicting COVID-19 Cases

The results in India and Pakistan are clearer and stronger on the intensive margin. Table 3 presents predictions of COVID-19 cases per million people in each district estimated using equation (1).

Panel A shows that the relationship between international out-migration and cases per capita in Bangladesh is measured imprecisely with or without controls. The number of cases per capita was relatively high in the sample window (more than seven times India's rate), however, and the coefficients are large. The coefficient in column (1) of Panel A implies that a 1 SD increase in international out-migration in Bangladesh is associated with a 23% increase in the district-wise average number of cases per million. The coefficient flips from positive to negative when controls are added in column (2), although with a relatively large standard error. A similar pattern is repeated in columns (3) and (4) and in columns (5) and (6).

In India and Pakistan, in contrast, the predictions are far more precisely estimated and are robust across specifications.[16] Column (1) shows that, without controls, a 1 SD increase in international out-migration in India is associated with a 62% (1.592/2.56) increase in the district-wise average of cases per capita. In Pakistan, the association is 56% ($p < 0.01$ for each coefficient). The results fall only slightly when adding controls for other district

[16] The results are also robust to controlling for the number of testing labs in the country and the inclusion of state, provincial, and country capitals (Appendix C).

characteristics. Column (2) shows that the association falls to 49% (1.253/2.56) in India, and it decreases to 51% (6.023/11.81) in Pakistan. The estimates remain statistically significant at the 1% level. Columns (3) and (4) show that the results are also robust to the inclusion of measures of domestic migration.[17] The estimates in column (4) are the most conservative—with controls and the inclusion of measures of domestic mirgation—but the predictions remain large: 1 SD increase in international out-migration in India is associated with a 48% (1.235/2.56) increase in the district-wise average of cases per capita. In Pakistan, the corresponding figure is also 48% (5.659/11.81).

As in Section 5.1, in columns (5) and (6) we restrict attention to the final two-week subsample (days 29-42) after international travel restrictions were in place and testing protocols were broadened. Column (5) shows that, without controls, a 1 SD increase in international out-migration in India is associated with a 44% (2.264/5.11) increase in the district-wise average of cases per capita. With the inclusion of controls in Column (6), this association falls to 31%. In Pakistan, the associations are 66% and 53%, without and with controls, respectively.

The relatively large size of these predictions in India and Pakistan is echoed in Figure 2. The figure presents the development of the relationship between out-migration and COVID-19 cases per million people using equation (2). Again, coefficients plotted in red depict the relationship between international out-migration and cases per million people over time. Similarly, coefficients plotted in blue illustrate the relationship between domestic out-migration and cases per million people over time. 95% confidence intervals are shown.

The figure shows that the predictive power of domestic out-migration changes only minimally. The point estimates are small and slightly negative by the last day for which we have data for the three countries (and statistically indistinguishable from zero).

In contrast, the relationship between international out-migration and cases per capita

[17] While domestic migration rates are not very predictive of increases in cases per capita in India, column (4) shows that a 1 SD increase in the rate of domestic out-migration in Pakistan is associated with a 23% (-2.744/11.81) decrease in the district-wise average number of cases per capita.

grows over time in each country. For India, the coefficients are positive and statistically different from zero by day 17, and they continue to increase over time. For Pakistan, the coefficients are positive and statistically different from zero by day 25. For Bangladesh, the coefficients are positive but less precisely estimated, becoming statistically different from zero after day 40.

A back-of-the-envelope calculation helps to frame the magnitudes. For Pakistan, we begin with the change in the point estimates for international out-migration (23.72) relative to the change in cases per capita (31.56 cases) between day 1 and T (the last day for which we have data for each country). That difference implies that for a district that starts with the average level of out-migration, a one standard deviation increase in out-migration predicts an increase in COVID-19 cases per capita equivalent to 75% of the actual increase that was experienced on average across the sample. For India, the change in the point estimates for international out-migration (2.29) relative to the change in cases per capita (7.17) implies a result of 32% in a parallel comparison. For Bangladesh, the change in the point estimates for international out-migration (16.36) relative to the change in cases per capita (52.14) implies a figure of 31%. The estimates are large but most of the spread of COVID-19 comes from other sources.

6 Conclusion

The coronavirus outbreak started in China and soon spread, including to the Gulf, Europe and North America, countries in which migrants from South Asia were concentrated. Migrants returned home as the migrant-employing countries shut down their economies to protect their citizens. We show evidence consistent with important negative externalities for migrants' countries of origin as the COVID-19 virus spread to South Asia in early 2020.

International migration has been an important source of growth and opportunity in South Asia, and we expect that it will continue to be. But the data suggest that in early 2020 the movement of migrants back to their homes substantially increased health risks in the region. We find that 1 standard deviation increases in prior international out-migration in India and Pakistan (relative to the cross-sectional average across districts in each country) predicts increases of 48% in cases per capita.

The evidence shows that survey data on migration in previous years systematically predicts patterns of confirmed COVID-19 cases in 2020, especially in India and Pakistan. The evidence allows us to distinguish between domestic and international migration, making it complementary to real-time geo-coded data from mobile telephones and other sources that document contemporaneous population movements but lack detail on movers' identities (e.g., Milusheva, 2020).

The predictive power of the survey data should be helpful for health officials allocating resources to prepare for future global pandemics. The estimates are not causal, and could reflect other factors beyond migration rates, but they are consistent with the established epidemiological shape of infectious disease (Sattenspiel and Lloyd, 2009).

Bangladesh, India, and Pakistan share common elements of history and culture, and their governments have taken broadly similar policy decisions to contain the virus. Each imposed systematic quarantines of migrants as an important tool to slow the growth of the pandemic, but quarantines were largely voluntary. Our ability to predict COVID-19 incidence with migration data suggests that quarantines for migrants were not followed systematically, especially in the critical early months of the pandemic.

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Tables & Figures

Table 1: Summary Statistics

	Mean	Standard Deviation	N
Panel A: Bangladesh (April 6 - May 20)			
Any Cases	0.84	0.37	2,835
Cases per Million People	19.17	42.23	2,835
Domestic Migrants per 100 People	1.18	1.03	63
International Migrants per 100 People	2.41	2.38	63
Population (millions)	2.10	1.23	63
Population Density (thousands per sq km)	1.01	0.55	63
Fraction Urban Population	0.17	0.07	63
Fraction Below Poverty Line	0.33	0.12	63
Hospital Beds (per million)	0.03	0.02	63
Number of Testing Labs	0.33	0.62	63
Panel B: India (March 15 - April 28)			
Any Cases	0.35	0.48	26,145
Cases per Million People	2.56	7.72	26,145
Domestic Migrants per 100 People	4.88	3.10	581
International Migrants per 100 People	0.24	0.67	581
Population (millions)	2.17	1.65	581
Population Density (thousands per sq km)	1.32	5.70	581
Fraction Urban Population	0.24	0.18	581
Fraction Below Poverty Line	0.52	0.24	581
Primary Health Centers per Million People	28.07	22.27	581
Number of Testing Labs	0.42	1.34	581
Panel C: Pakistan (March 16 - April 27)			
Any Cases	0.60	0.49	4,773
Cases per Million People	11.81	21.74	4,773
Domestic Migrants per 100 People	0.57	0.82	111
International Migrants per 100 People	1.32	1.83	111
Population (millions)	1.49	1.34	111
Population Density (thousands per sq km)	0.44	0.54	111
Fraction Urban Population	0.21	0.14	111
Fraction Below Poverty Line	0.38	0.15	111
Fraction Health Access	0.41	0.24	111
Number of Testing Labs	0.12	0.53	111

Notes: State/Provincial/Country capitals have been omitted. The sample includes all days for which we have available data since the 100th COVID-19 case was reported in each country.

Table 2: Any COVID-19 Cases in District

	All Days				Days 29-42	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Bangladesh (April 6 - May 20)						
International Migrants	0.045**	0.027	0.041**	0.012	0.005	0.002
per 100 People (z-score)	(0.018)	(0.017)	(0.018)	(0.016)	(0.004)	(0.003)
Domestic Migrants			0.017	0.022	-0.008	-0.009
per 100 People (z-score)			(0.014)	(0.014)	(0.008)	(0.008)
R^2	0.389	0.427	0.391	0.430	0.026	0.044
Dependent Variable Mean	0.84	0.84	0.84	0.84	0.99	0.99
Observations	2,835	2,835	2,835	2,835	882	882
Panel B: India (March 15 - April 28)						
International Migrants	0.112***	0.087***	0.108***	0.081***	0.112***	0.084***
per 100 People (z-score)	(0.010)	(0.009)	(0.010)	(0.010)	(0.011)	(0.012)
Domestic Migrants			0.034**	0.040***	0.046**	0.053**
per 100 People (z-score)			(0.014)	(0.013)	(0.019)	(0.019)
R^2	0.217	0.328	0.222	0.334	0.069	0.209
Dependent Variable Mean	0.35	0.35	0.35	0.35	0.54	0.54
Observations	26,145	26,145	26,145	26,145	8,134	8,134
Panel C: Pakistan (March 16 - April 27)						
International Migrants	0.137***	0.013	0.117***	0.005	0.133***	-0.021
per 100 People (z-score)	(0.026)	(0.033)	(0.024)	(0.033)	(0.026)	(0.028)
Domestic Migrants			0.081***	-0.058*	0.150***	-0.024
per 100 People (z-score)			(0.028)	(0.029)	(0.028)	(0.024)
R^2	0.175	0.417	0.202	0.426	0.240	0.598
Dependent Variable Mean	0.6	0.6	0.6	0.6	0.68	0.68
Observations	4,773	4,773	4,773	4,773	1,554	1,554
Controls		✓		✓		✓
Day Fixed Effects	✓	✓	✓	✓	✓	✓

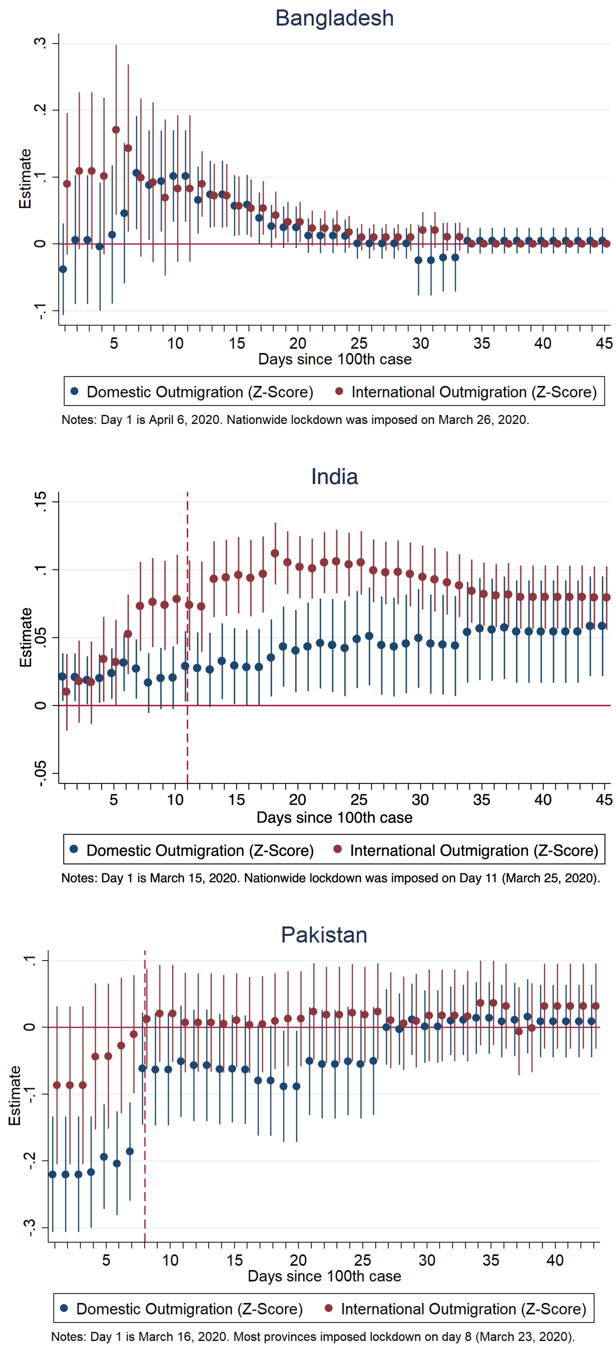
Notes: State/Provincial/Country capitals are omitted. The sample for columns (1)-(4) includes all days for which data are available since the 100th COVID-19 case was reported in each country. The sample for columns (5)-(6) includes days 29-42 since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects, while columns (2), (4), and (6) additionally include the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 3: Cases per Million People in District

	All Days				Days 29-42	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Bangladesh (April 6 - May 20)						
International Migrants	4.492	-4.122	5.621*	-4.319	9.734	-6.082
per 100 People (z-score)	(2.777)	(2.968)	(3.285)	(3.238)	(5.548)	(5.794)
Domestic Migrants			-5.276	0.629	-9.019	0.126
per 100 People (z-score)			(4.508)	(2.147)	(7.344)	(3.578)
R^2	0.133	0.569	0.148	0.569	0.060	0.719
Dependent Variable Mean	19.17	19.17	19.17	19.17	32.14	32.14
Observations	2,835	2,835	2,835	2,835	882	882
Panel B: India (March 15 - April 28)						
International Migrants	1.592***	1.253***	1.604***	1.235***	2.264***	1.565**
per 100 People (z-score)	(0.452)	(0.460)	(0.450)	(0.458)	(0.627)	(0.662)
Domestic Migrants			-0.100	0.119	-0.239	0.138
per 100 People (z-score)			(0.198)	(0.212)	(0.405)	(0.426)
R^2	0.138	0.188	0.138	0.188	0.059	0.167
Dependent Variable Mean	2.56	2.56	2.56	2.56	5.11	5.11
Observations	26,145	26,145	26,145	26,145	8,134	8,134
Panel C: Pakistan (March 16 - April 27)						
International Migrants	6.657***	6.023***	6.816***	5.659**	14.584***	11.678**
per 100 People (z-score)	(1.800)	(2.174)	(1.838)	(2.130)	(3.299)	(3.972)
Domestic Migrants			-0.616	-2.744**	-0.673	-4.653**
per 100 People (z-score)			(0.915)	(1.255)	(1.698)	(2.120)
R^2	0.280	0.323	0.281	0.333	0.301	0.390
Dependent Variable Mean	11.81	11.81	11.81	11.81	22.00	22.00
Observations	4,773	4,773	4,773	4,773	1,554	1,554
Controls		✓		✓		✓
Day Fixed Effects	✓	✓	✓	✓	✓	✓

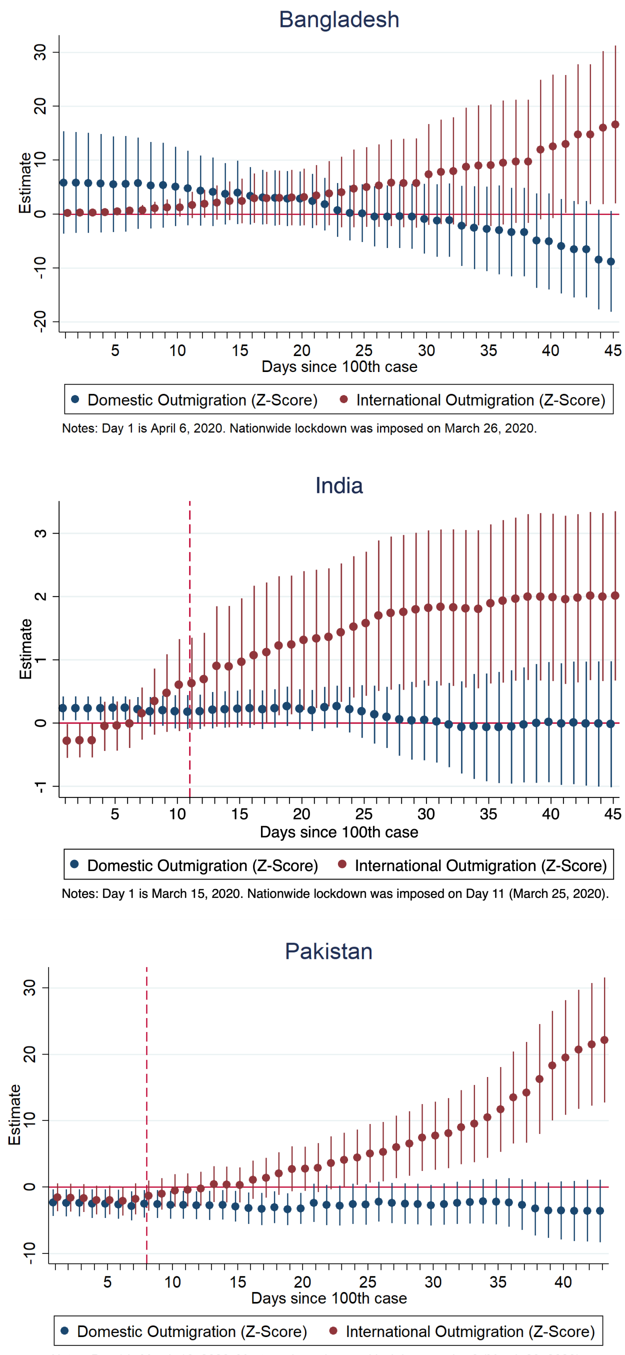
Notes: State/Provincial/Country capitals are omitted. The sample for columns (1)-(4) includes all days for which data are available since the 100th COVID-19 case was reported in each country. The sample for columns (5)-(6) includes days 29-42 since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects, while columns (2), (4), and (6) additionally include the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figure 1: Relationship between Out-migration & Probability District Reports Any Cases



Notes: Dependent variable: Indicator variable equal to 1 if the district had any COVID-19 cases on day t and 0 otherwise. Coefficients plotted in red (θ_t in equation (2)) illustrate the relationship between international out-migration and an indicator for any cases in the district on day t. Coefficients plotted in blue (γ_t in equation (2)) illustrate the relationship between domestic out-migration and an indicator for any cases in the district on day t. State/Provincial/Country capitals have been omitted. The regressions include district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling) and day fixed effects. Standard errors are double-clustered by day and district. 95% confidence intervals shown.

Figure 2: Relationship between Out-migration & Cases per Million People



Notes: Dependent variable: COVID-19 cases per million people on day t. Coefficients plotted in red (θ_t in equation (2)) illustrate the relationship between international out-migration and cases per million people on day t. Coefficients plotted in blue (γ_t in equation (2)) illustrate the relationship between domestic out-migration and cases per million people on day t. State/Provincial/Country capitals have been omitted. The regressions include district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling) and day fixed effects. Standard errors are double-clustered by day and district. 95% confidence intervals shown.

Online Appendix

A Policy Timeline and Econometric Interpretation

The main results use data on migration patterns to predict patterns of confirmed COVID-19 cases near the start of its spread in Bangladesh, India, and Pakistan. A potential concern is that correlations between migration and confirmed COVID-19 cases could be a mechanical result of testing policy—since confirming a case requires a test and not everyone was eligible for testing. A mechanical bias could arise through at least three sources.

First, especially at the start of the pandemic, countries were selective in who could be tested. Asymptomatic people were generally not tested, nor were all people with symptoms tested. Instead, at least early on in Bangladesh and India, people with symptoms were more likely to be tested if they were a migrant or had been in close contact with a migrant. These screening criteria could mechanically create a strong correlation between migration and confirmed COVID-19 cases.

To address the concern, we describe shifts in policy below. Robustness checks in Appendix D show that as testing criteria became more inclusive (dropping the early screening criteria that had been based on migration status), correlations between migration and contagion in fact strengthened.

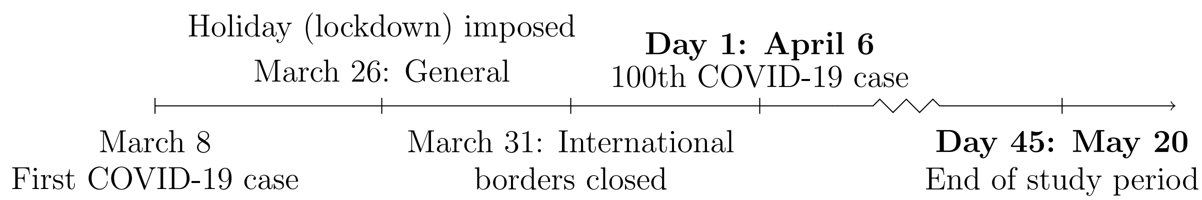
Second, testing centers might be more likely to be placed in areas with higher migrant populations. This again could drive a mechanical correlation between the incidence of migration and the incidence of COVID-19. Again, robustness checks show that this does not drive the results. In regressions reported in Appendix section C.1, we control for the number of testing centers in each district, and the main results are unchanged. This suggests that neither testing criteria nor testing availability drive the correlation between migration and contagion.

Third, the correlations could be created by a steady and growing influx of international migrants (rather than through community spread to non-migrants). However, this was not the case. All three countries restricted their international borders early in the sample periods, and international flights had not resumed by the end of the sample periods.

For example, the sample in India begins on March 15 with the 100th COVID case, and India closed its international borders by March 22 (8 days later). Similarly, the Pakistan sample starts on March 16 and the last international flight to Pakistan was on March 21 (5 days later). In Bangladesh, the sample starts on April 6 and flights from continental Europe, North America, and the Gulf had already ended on March 14.

Borders were not entirely tight after these restrictions. There were still some flights from China to Bangladesh and some from the UK, and there were a few charter flights that arrived in India and Pakistan after the travel ban. But the numbers of people coming in at that point were relatively small—and much smaller than can explain COVID incidence. Again, in India and Pakistan, the correlations in Appendix section C.1 continued to grow during the sample period, which is consistent with community spread.

A.1 Policy timeline in Bangladesh (Sample: April 6-May 20)



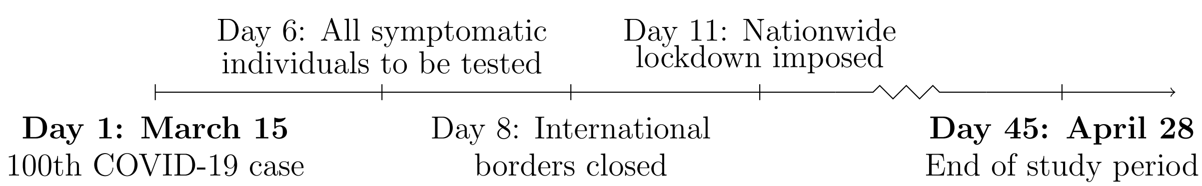
In Bangladesh, testing requirements were such that all "suspect cases" were to be tested, defined as all symptomatic individuals with travel history or contact with confirmed cases, as well as all symptomatic individuals with respiratory issues that required hospitalization. Specifically: (a) the patient had acute respiratory illness (fever and at least one sign or symptom of respiratory disease, e.g., cough, shortness of breath) and (b) either had very recently (i) lived in or traveled to a region reporting community transmission of COVID-19 or (ii) had been in contact with someone who had been abroad who had a confirmed or probable COVID-19 case. Alternatively, they could be showing clear symptoms of COVID-19 infection and requiring hospitalization. People with less severe symptoms were told to stay home and were not tested.

The criteria exclude symptomatic individuals who were (a) not sick enough to go to the hospital and (b) who had not been in clear contact with a confirmed case or international traveler. To confirm what was happening on the ground (rather than just in documents), we spoke with a first-responder in charge of COVID patients in a government hospital in Dhaka. His response was that by the start of our sample period, they were testing everyone who was symptomatic, irrespective of whether they had been in contact with travelers.

A second problem for analysis in Bangladesh is that the overall testing rate was very low relative to India and Pakistan. On a population-adjusted basis, India's testing rate is about 3 times that in Bangladesh. See, for example, the data on testing and cases at Our World in Data ("COVID-19: Daily tests vs. Daily new confirmed cases per million"), https://ourworldindata.org/grapher/covid-19-daily-tests-vs-daily-new-confirmed-cases- per-million?country=BGD IND PAK (accessed September 7, 2020).

The results from Bangladesh are thus noisy and we do not in fact find strong evidence of an international-migration-COVID link in Bangladesh.

A.2 Policy timeline in India (Sample: March 15-April 28)



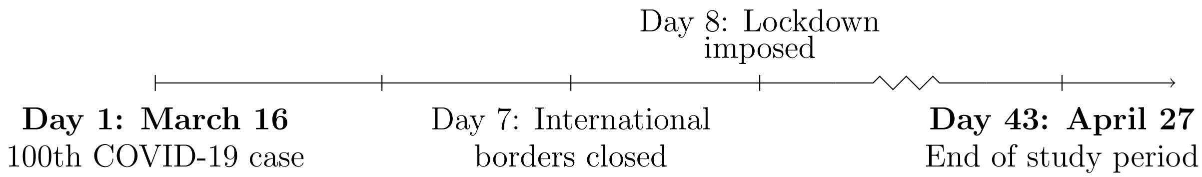
The sample in India begins on March 15 with the 100th COVID case. At the start of the sample (i.e., March 15), testing protocols had travel history as a criterion, but testing was not exclusive to international travelers or their contacts.

The Indian Council of Medical Research expanded its criteria for testing over time. At the start of the sample (i.e., March 15, 2020), travel history was a criterion used to determine whether or not to administer COVID tests. On March 17, guidance was issued recommending testing for (i) all asymptomatic individuals who had undertaken international travel, (ii) all symptomatic contacts of laboratory confirmed positive cases, and (iii) healthcare workers managing respiratory distress and/or severe acute respiratory illness (fever, cough and/or shortness of breath). On March 20 (day 6 of our sample), this was expanded to include all hospitalized patients with severe acute respiratory illness, as well as asymptomatic direct and high-risk contacts of confirmed cases. On April 9, this was further revised to include all symptomatic individuals in hot spots or clusters (as defined by the Ministry of Health and Family Welfare) and large migration gatherings and evacuee centers.

Thus, by the middle of the sample window, testing had substantially widened, although people who were not sick enough to be hospitalized were generally not tested unless they met the travel or contact criteria.

After the study period ended on April 28, 2020, the government launched a program to repatriate migrants in other countries, beginning on May 7, 2020 with flights from Abu Dhabi and Dubai (`https://mea.gov.in/vande-bharat-mission-list-of-flights.htm`). The repatriation does not affect the results here.

A.3 Policy timeline in Pakistan (Sample: March 16-April 27)



The 100th case in Pakistan was confirmed on March 16. In Pakistan, all patients showing symptoms were tested, and contact with someone who had traveled internationally was not a screen for testing.

The initial official protocol was that all patients showing symptoms are tested, but Pakistan had only 15 testing labs at the start of April and only 60 by the start of May.[18] Random testing started in Lahore and then extended to Karachi (DP Web, April 17, 2020).[19]

The tables in Appendix section D show that correlations are stronger at the end of the period, consistent with community-spread.

B Data Appendix

B.1 Bangladesh

Bangladesh COVID-19 Cases:

- **Any Cases:** Indicator variable equal to 1 if a district has at least 1 case of COVID-19, and 0 otherwise. Source: `www.iedcr.gov.bd`, May 20, 2020.
- **Cases per 1 Million People:** Cumulative number of COVID-19 cases in the district as of date t divided by the district population in 2011 (see population below). Source: `www.iedcr.gov.bd`, May 20, 2020 and Population and Household Census, 2011.

Bangladesh Outmigration Variables:

- **International Outmigration:** We used nationally representative household survey that asked specific questions about having a migrating member in the household and the location of the migrating member. We calculated the number of international migrants within the district per 100 people. Source: Household Income and Expenditure Survey (HIES 2016). Calculated district-wise as the number of migrants surveyed divided by the number of individuals surveyed (in hundreds). Out-migration rates adjusted using survey weights.

[18]Sources include: https://www.dawn.com/news/1538338, http://covid.gov.pk/facilities/List of Province-wise COVID-19 Testing Facilities Pakistan.pdf, http://covid.gov.pk/facilities/30 Apr Current Laboratory Testing Capacity for COVID.pdf.

[19]At the end of May 2020, the testing capacity was about 14,000 tests a day with an aim to reach 20,000 a day (`https://www.dawn.com/news/1538338`).

- **Domestic Outmigration:** Number of international migrants within the district per 100 people. Source: Household Income and Expenditure Survey (HIES 2016). Calculated district-wise as the number of migrants surveyed divided by the number of individuals surveyed (in hundreds). Out-migration rates adjusted using survey weights.

Bangladesh Controls:

- **Population:** District level population, in millions, based on Population Census of 2011, reported by the Bangladesh Bureau of Statistics (BBS). Source: Population and Household Census, 2011, BBS.

- **Population Density:** Number of individuals per square kilo-meter. Source: Bangladesh Bureau of Statistics, Population Census report, 2011. Calculated as the total population of the district divided by the district area (measured in squared kilometer).

- **Fraction Urban Population:** Number of individuals residing in urban areas of the district divided by the total number of individuals surveyed from that district. Source: Household Income and Expenditure Survey (HIES 2016). Fraction below urbanization adjusted using survey weights.

- **Fraction Below Poverty Line:** Number of households below the poverty line in the district reported in the interactive poverty map of Bangladesh. Source: `www.worldbank.org/en/data/interactive/2016/11/10/bangladesh-poverty-maps`

- **Number of Testing Labs:** Total number of government laboratories, private laboratories, and collection sites in the district. Source: compiled from various newspaper articles, as of May 20, 2020.

- **Number of Hospital Beds:** Total number of hospital beds at public hospitals within the district, as reported in 2016 - 2017. Source: Management Information System (MIS) of DGHS (Directorate General of Health Services) of Ministry of Health & Family Welfare of Bangladesh. `https://dghs.gov.bd/index.php/en/home`

Bangladesh Data Cleaning Notes:

- The capital city of Bangladesh (Dhaka) has been dropped from the analysis.
- The top 1% of each variable (except the number of testing labs) has been winsorized to remove outliers.
- In the IEDCR daily reports, Dhaka is reported twice: Dhaka City and Dhaka (District). We aggregate both this under Dhaka district. We noticed discrepancy between what is reported as a total of the day (T) and district-wise aggregation (D), where T is always greater than D. As a rule of thumb, T-D is added with Dhaka for consistency with the daily new reported cases. Also, we notice discrepancy at the district level reporting, which sometimes goes down than the past reported numbers. In such cases, we kept the higher numbers.

B.2 India

India COVID-19 Cases:

- **Any Cases:** Indicator variable equal to 1 if a district has at least 1 case of COVID-19, and 0 otherwise. Source: `www.covindia.com`, April 28, 2020.
- **Cases per 1 Million People:** Cumulative number of COVID-19 cases in the district as of date t divided by the projected district population in 2020 (see population below). Source: `www.covindia.com`, April 28, 2020 and Primary Census Abstract, 2001 - 2011.
- Note: High correlation between data from `www.covindia.com` on April 28, 2020 and data from the Ministry of Health and Family Welfare on April 28, 2020: Correlation = 0.901. Using data from `www.covindia.com` as the government data is not available at the district-day level.

India Outmigration Variables:

- **International Outmigration:** Number of migrants who left the district within the past 5 years for another country, per 100 people. Source: National Sample Survey, 2007-08. Calculated district-wise as the number of migrants surveyed divided by the number of individuals surveyed (in hundreds). Out-migration rates adjusted using survey weights.

- **Domestic Outmigration:** Number of migrants who left the district within the past 5 years for another district in India, per 100 people. Source: National Sample Survey, 2007-08. Calculated district-wise as the number of migrants surveyed divided by the number of individuals surveyed (in hundreds). Out-migration rates adjusted using survey weights.

India Controls:

- **Population:** Projected number of individuals in 2020, in millions. Source: Primary Census Abstract, 2001 - 2011. Calculated as a projection based on district-wise population growth rates between 2001 and 2011.

- **Population Density:** Number of individuals (thousands) per square kilometer. Source: Primary Census Abstract, 2001 - 2011 and 2011 district shapefiles from the World Bank. Calculated as the projected number of individuals in 2020 divided by the land area of the district.

- **Fraction Urban Population:** Number of individuals residing in urban areas of the district in 2011 divided by the total number of individuals residing in the district in 2011. Source: Primary Census Abstract, 2011.

- **Fraction Below Poverty Line:** Number of households below the poverty line in the district divided by the total number of households in the district. Source: National Sample Survey, 2007-08. A household in a rural area is defined to be below the rural poverty line if the daily per capita household expenditure was less than 22.42 rupees

(2012 rural poverty line). A household in an urban area is defined to be below the urban poverty line if the daily per capita household expenditure was less than 28.65 rupees (2012 urban poverty line). Poverty rates adjusted using survey weights.

- **Primary Health Centers per Capita:** The number of Primary Health Centers (PHCs) in the district divided by projected population (millions) in the district in 2017. Source: "District-wise availability of health centres in India as on 31st March, 2017": Open Government Data (OGD) Platform India and Primary Census Abstract, 2001 - 2011.

- **Number of Testing Labs:** Total number of government laboratories, private laboratories, and collection sites in the district. Source: Indian Council of Medical Research, April 28, 2020.

India Data Cleaning Notes:

- All districts with state capitals have been dropped for the analysis (for example, Delhi, Mumbai, Chennai, Kolkata, etc.)

- The top 1% of each variable (except the number of testing labs) has been winsorized to remove outliers.

B.3 Pakistan

Pakistan has a total of 154 districts at present. Of these due to survey difficulties and data issues we do not include the 14 in Gilgit–Baltistan, 7 which were formerly in Federally Administered Tribal Areas (FATA)[20] and 10 in Azad Jammu and Kashmir. We do not separately consider Karachi East, West, Malir, Central and Korangi but rather only Karachi as a whole and also do not separately consider upper and lower Kohistan but rather only

[20] On 28 May, 2018 an amendment was passed that merged all seven agencies of Federally Administered Tribal Areas (FATA) into Khyber Pakhtunkhwa province. May 2018. https://tribune.com.pk/story/1762047/1-notification-issued-composition-new-administrative-divisions-mohmand-khyber/

Kohistan as a whole. Additionally, for two districts in Balochistan, Kech and Pangaur, we do not have data for international migration rates and district controls so these have been dropped for all analysis reported.

1. **Internal Migration:** From the Labour Force Survey 2007-08.

    - **Domestic migrants per 100 people:** number of internal migrants from a district per 100 people surveyed from the district.

    - **Rural-urban migrants per 100 people:** number of internal migrants from a rural area who are currently in an urban area per 100 people surveyed from the sending district.

2. **International migrants per 100 people:** From the Pakistan Social and Living Standards Measurement (PSLM) 2014-15 survey. Total number of international migrants (assuming 1 international migrant in every household reporting receiving foreign remittances) in a district per 100 people surveyed in the district.

3. **Shapefiles:** These data were extracted from the GADM database (www.gadm.org), version 2.5, July 2015.

4. **Covid cases:** Data obtained from the Pakistan Institute of Development Economics Covid-19 dashboard https://pide.org.pk/index.php?option=com_content&view=article&id=695 OR data obtained from the Government of Pakistan Covid-19 Dashboard http://covid.gov.pk/stats/pakistan. The first recorded cases in Pakistan are on 10th March 2020 (cases jumped from 53 on 15th March to 187 on 16th March)

5. **District level controls** obtained from: http://www.data4pakistan.com/. Glossary of indicators: http://www.data4pakistan.com/download/Glossary-of-Indicators.pdf

    - **Poverty rate:** The percentage of population living below the official national poverty line. The district poverty headcount rate is calculated using a small area estimation approach based on successive pairs of HIES and PSLM survey rounds. The HIES and PSLM are fielded in alternate years, and the following HIES–PSLM pairs were used to construct district poverty rates 2014/15: HIES 2013/14 and PSLM 2014/15. The software used for the small area estimation is the sae command in Stata. sae is a user-written program that is freely distributed to the research community. [Source: World Bank. (2017). "Small Area Estimation: An extended ELL approach."]

- **Accessibility:** Percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling.
- **Urban pop share:** Percentage of population in the district who lives in urban areas. This is obtained from the PSLM.
- **Population:** District population figures based on the provisional results of the 2017 Population Census.
- **Population density:** Population density is the population from the census divided by the area of the district. fieldarea, a user-written Stata program is used to calculate the area of each district.

6. **Number of Testing Labs:** Total number of government laboratories, private laboratories, and collection sites in the district. Source: National Institute of Health. April 28, 2020.

C Robustness Checks

In this section, we assess robustness of our results to controlling for the number of testing labs in section C.1 and the inclusion of state, provincial, and country capitals in section C.2.

C.1 Control for Testing Capacity

A potential concern with the analysis could be that the number of cases reported is constrained by the testing capacity of each district. To assess robustness of our results to testing capacity constraints, we additionally control for the number of COVID-19 testing labs in each district, thereby comparing the relationship between rates of out-migration and COVID-19 cases across districts with the same testing capacity.

Table 4 presents these results. Columns (1) - (2) present the relationship between domestic out-migration and cases per capita, unconditional of the rate of international out-migration. Columns (3) - (4) present the relationship between international out-migration and cases per capita, unconditional of the rate of domestic out-migration. Columns (5) - (6) present the relationship between domestic and international out-migration and cases per capita. The odd numbered columns control for the set of five control variables (population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access). The even numbered columns additionally control for the number of testing labs in the district.

Across the three countries, an increase in the number of testing labs is associated with an increase in the number of cases per capita. In India, an additional testing lab in the district is associated with an increase of 1.12 - 1.14 cases per capita in the district. The relationship between the number of testing labs and cases per capita is positive but not statistically significant at conventional levels for Bangladesh and Pakistan.

Overall, the relationships between out-migration and cases per capita are robust to controlling for the number of COVID-19 testing labs in each district. For India, the international out-migration coefficient unconditional of domestic out-migration increases slightly from 1.253 in column (3) to 1.283 in column (4). The international out-migration coefficient conditional on the rate of domestic out-migration increases slightly from 1.235 in column (5) to 1.266 in column (6). These results are statistically significant at the 1% level.

For Pakistan, the international out-migration coefficient unconditional of domestic out-migration decreases slightly from 5.902 in column (3) to 5.771 in column (4) ($p < 0.05$). The international out-migration coefficient conditional on the rate of domestic out-migration decreases slightly from 5.392 in column (5) to 5.300 in column (6) ($p < 0.05$).

Table 4: COVID-19 and Out-migration - Control for Number of Testing Labs

	Dependent Variable: Cases per 1 Million People					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Bangladesh (April 6 - May 20)						
Number of Domestic Migrants	-0.622	-0.846			0.629	0.386
per 100 People (z-score)	(1.770)	(1.839)			(2.147)	(2.179)
Number of International Migrants			-4.122	-4.102	-4.319	-4.222
per 100 People (z-score)			(2.968)	(2.768)	(3.238)	(3.067)
Number of Testing Labs		7.510		7.296		7.225
		(5.454)		(4.831)		(4.864)
R^2	0.561	0.566	0.569	0.573	0.569	0.573
Dependent Variable Mean	19.17	19.17	19.17	19.17	19.17	19.17
Observations	2,835	2,835	2,835	2,835	2,835	2,835
Panel B: India (March 15 - April 28)						
Number of Domestic Migrants	0.316	0.310			0.119	0.108
per 100 People (z-score)	(0.240)	(0.237)			(0.212)	(0.211)
Number of International Migrants			1.253***	1.283***	1.235***	1.266***
per 100 People (z-score)			(0.460)	(0.446)	(0.458)	(0.446)
Number of Testing Labs		1.120**		1.143**		1.142**
		(0.424)		(0.441)		(0.438)
R^2	0.164	0.196	0.188	0.221	0.188	0.221
Dependent Variable Mean	2.56	2.56	2.56	2.56	2.56	2.56
Observations	26,145	26,145	26,145	26,145	26,145	26,145
Panel C: Pakistan (March 16 - April 27)						
Number of Domestic Migrants	-3.316**	-3.470**			-2.635**	-2.744**
per 100 People (Z-score)	(1.396)	(1.378)			(1.268)	(1.255)
Number of International Migrants			5.895***	6.023***	5.561**	5.659**
per 100 People (Z-score)			(2.173)	(2.174)	(2.127)	(2.130)
Number of Testing Labs	3.098		2.809		2.462	
	(2.226)		(2.154)			
R^2	0.297	0.293	0.327	0.323	0.336	0.333
Dependent Variable Mean	11.81	11.81	11.81	11.81	11.81	11.81
Observations	4,773	4,773	4,773	4,773	4,773	4,773
Controls	✓	✓	✓	✓	✓	✓
Day Fixed Effects	✓	✓	✓	✓	✓	✓

Notes: State/Provincial/Country capitals have been omitted. The sample includes all days for which we have available data since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects and the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

C.2 Inclusion of State Capitals

Table 5 presents the relationships between domestic and international out-migration and COVID-19 cases per capita, including in the sample all state, provincial, and country capitals for which data is available for all dependent and independent variables. Columns (1) - (2) present the relationship between domestic out-migration and cases per capita, unconditional of the rate of international out-migration. Similarly, columns (3) - (4) present the relationship between international out-migration and cases per capita, unconditional of the rate of domestic out-migration. Columns (5) - (6) present the relationship between domestic and international out-migration and cases per capita.

Overall, the results on the relationship between international out-migration and cases per capita are robust to the inclusion of the state, provincial, and country capitals. For India, the international out-migration coefficient unconditional of domestic out-migration decreases slightly from 1.253 in column (2) of table 3 to 1.211 in column (4) of table 5. The international out-migration coefficient conditional on the rate of domestic out-migration decreases slightly from 1.235 in column (4) of table 3 to 1.190 in column (6) of table 5. These results are statistically significant at the 5% level.

For Pakistan, the international out-migration coefficient unconditional of domestic out-migration increases slightly from 6.023 in column (2) of table 3 to 6.317 in column (4) of table 5. The international out-migration coefficient conditional on the rate of domestic out-migration increases slightly from 5.659 in column (4) of table 3 to 5.934 in column (6) of table 5. These results are statistically significant at the 1% level.

Table 5: COVID-19 and Out-migration - Including Capitals

	Dependent Variable: Cases per 1 Million People					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Bangladesh (April 6 - May 20)						
Number of Domestic Migrants	-8.149	-0.686			-9.009	0.320
per 100 People (z-score)	(5.742)	(1.776)			(5.866)	(2.119)
Number of International Migrants			1.814	-3.405	3.835	-3.502
per 100 People (z-score)			(3.736)	(2.903)	(3.698)	(3.166)
R^2	0.114	0.629	0.093	0.632	0.118	0.632
Dependent Variable Mean	22.96	22.96	22.96	22.96	22.96	22.96
Observations	2,880	2,880	2,880	2,880	2,880	2,880
Panel B: India (March 15 - April 28)						
Number of Domestic Migrants	-0.0744	0.328			-0.257	0.141
per 100 People (z-score)	(0.232)	(0.244)			(0.215)	(0.224)
Number of International Migrants			1.666***	1.211**	1.694***	1.190**
per 100 People (z-score)			(0.453)	(0.456)	(0.452)	(0.457)
R^2	0.093	0.187	0.132	0.204	0.133	0.205
Dependent Variable Mean	3.18	3.18	3.18	3.18	3.18	3.18
Observations	27,540	27,540	27,540	27,540	27,540	27,540
Panel C: Pakistan (March 16 - April 27)						
Number of Domestic Migrants	0.563	-4.046***			-1.162	-3.381***
per 100 People (Z-score)	(1.192)	(1.359)			(0.952)	(1.248)
Number of International Migrants			6.356***	6.317***	6.660***	5.934***
per 100 People (Z-score)			(1.798)	(2.070)	(1.852)	(2.004)
R^2	0.187	0.342	0.250	0.365	0.252	0.376
Dependent Variable Mean	13.29	13.29	13.29	13.29	13.29	13.29
Observations	4,988	4,988	4,988	4,988	4,988	4,988
Controls		✓		✓		✓
Day Fixed Effects	✓	✓	✓	✓	✓	✓

Notes: State/Provincial/Country capitals have been included. The sample includes all days for which we have available data since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects and the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

D Out-migration and COVID-19: Results by 14-Day Periods

D.1 International Out-migration & COVID-19

Table 6: COVID-19 Cases and International Out-migration: Day 1 to 14 since 100$^{\text{th}}$ Case

	Any Cases		Cases per Million People	
	(1)	(2)	(3)	(4)
Panel A: Bangladesh (April 6 - 19)				
Number of International Migrants	0.109**	0.0750	0.879	-0.999
per 100 People (z-score)	(0.0469)	(0.0475)	(0.560)	(0.608)
R^2	0.194	0.294	0.067	0.506
Dependent Variable Mean	0.55	0.55	2.84	2.84
Observations	882	882	882	882
Panel B: India (March 15 - 28)				
Number of International Migrants	0.0856***	0.0672***	0.634**	0.607**
per 100 People (z-score)	(0.0161)	(0.0146)	(0.233)	(0.227)
R^2	0.111	0.223	0.167	0.173
Dependent Variable Mean	0.11	0.11	0.21	0.21
Observations	8,134	8,134	8,134	8,134
Panel C: Pakistan (March 16 - 29)				
Number of International Migrants	0.0909**	0.0560	-0.0461	0.160
per 100 People (z-score)	(0.0318)	(0.0416)	(0.479)	(0.661)
R^2	0.170	0.267	0.030	0.076
Dependent Variable Mean	0.45	0.45	2.66	2.66
Observations	1,554	1,554	1,554	1,554
Controls		✓		✓
Day Fixed Effects	✓	✓	✓	✓

Notes: State/Provincial/Country capitals have been omitted. The sample includes the first 14 days since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects, while columns (2) and (4) additionally include the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 7: COVID-19 Cases and International Out-migration: Day 15 to 28 since 100^{th} Case

	Any Cases		Cases per Million People	
	(1)	(2)	(3)	(4)
Panel A: Bangladesh (April 20 - May 3)				
Number of International Migrants	0.0319**	0.0105	3.020	-5.799*
per 100 People (z-score)	(0.0144)	(0.0137)	(2.529)	(2.756)
R^2	0.053	0.200	0.025	0.690
Dependent Variable Mean	0.94	0.94	16.17	16.17
Observations	882	882	882	882
Panel B: India (March 29 - April 11)				
Number of International Migrants	0.132***	0.102***	1.745***	1.520**
per 100 People (z-score)	(0.0109)	(0.0105)	(0.541)	(0.553)
R^2	0.116	0.272	0.152	0.191
Dependent Variable Mean	0.36	0.36	1.71	1.71
Observations	8,134	8,134	8,134	8,134
Panel C: Pakistan (March 30 - April 12)				
Number of International Migrants	0.147***	0.003	4.447***	4.664**
per 100 People (z-score)	(0.031)	(0.039)	(1.451)	(1.867)
R^2	0.102	0.428	0.113	0.205
Dependent Variable Mean	0.68	0.68	9.30	9.30
Observations	1,554	1,554	1,554	1,554
Controls		✓		✓
Day Fixed Effects	✓	✓	✓	✓

Notes: State/Provincial/Country capitals have been omitted. The sample includes days 15 - 28 since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects, while columns (2) and (4) additionally include the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 8: COVID-19 Cases and International Out-migration: Day 29 to 42 since 100$^{\text{th}}$ Case

	Any Cases		Cases per Million People	
	(1)	(2)	(3)	(4)
Panel A: Bangladesh (May 4 - May 17)				
Number of International Migrants	0.00347	-0.000498	7.806	-6.043
per 100 People (z-score)	(0.002)	(0.0015)	(4.678)	(5.258)
R^2	0.019	0.036	0.033	0.719
Dependent Variable Mean	0.99	0.99	32.14	32.14
Observations	882	882	882	882
Panel B: India (April 12 - 25)				
Number of International Migrants	0.117***	0.0916***	2.236***	1.587**
per 100 People (z-score)	(0.0112)	(0.0117)	(0.628)	(0.658)
R^2	0.060	0.199	0.058	0.167
Dependent Variable Mean	0.54	0.54	5.11	5.11
Observations	8,134	8,134	8,134	8,134
Panel C: Pakistan (April 13 - 26)				
Number of International Migrants	0.172***	-0.018	14.41***	12.29***
per 100 People (z-score)	(0.031)	(0.028)	(3.155)	(4.043)
R^2	0.140	0.596	0.301	0.374
Dependent Variable Mean	0.68	0.68	22	22
Observations	1,554	1,554	1,554	1,554
Controls		✓		✓
Day Fixed Effects	✓	✓	✓	✓

Notes: State/Provincial/Country capitals have been omitted. The sample includes days 29 - 42 since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects, while columns (2) and (4) additionally include the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

D.2 Domestic Out-migration & COVID-19

Table 9: COVID-19 Cases and Domestic Out-migration: Day 1 to 14 since 100th Case

	Any Cases				Cases per Million People			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Bangladesh (April 6 - 19)								
Number of Domestic Migrants	0.0694	0.0836**	0.0480	0.0680*	-0.487	0.257	-0.710	0.601
per 100 People (z-score)	(0.0395)	(0.0359)	(0.0379)	(0.0369)	(0.881)	(0.321)	(0.972)	(0.392)
Number of International Migrants			0.0986*	0.0538			1.031	-1.187*
per 100 People (z-score)			(0.0469)	(0.0472)			(0.667)	(0.631)
R^2	0.166	0.300	0.203	0.309	0.061	0.497	0.072	0.510
Dependent Variable Mean	0.55	0.55	0.55	0.55	2.84	2.84	2.84	2.84
Observations	882	882	882	882	882	882	882	882
Panel B: India (March 15 - 28)								
Number of Domestic Migrants	0.0280**	0.0329***	0.0182*	0.0227**	0.0657	0.123	-0.00889	0.0266
per 100 People (z-score)	(0.0108)	(0.0104)	(0.00958)	(0.00919)	(0.0475)	(0.0791)	(0.0361)	(0.0530)
Number of International Migrants			0.0834***	0.0638***			0.635**	0.603**
per 100 People (z-score)			(0.0159)	(0.0145)			(0.234)	(0.226)
R^2	0.040	0.188	0.115	0.228	0.010	0.044	0.167	0.174
Dependent Variable Mean	0.11	0.11	0.11	0.11	0.21	0.21	0.21	0.21
Observations	8,134	8,134	8,134	8,134	8,134	8,134	8,134	8,134
Panel C: Pakistan (March 16 - 29)								
Number of Domestic Migrants	0.0286	-0.085**	0.006	-0.079**	-0.434	-1.057	-0.452	-1.055
per 100 People (z-score)	(0.038)	(0.036)	(0.034)	(0.036)	(0.360)	(0.633)	(0.346)	(0.668)
Number of International Migrants			0.0895***	0.0456			0.0705	0.0196
per 100 People (z-score)			(0.029)	(0.041)			(0.477)	(0.682)
R^2	0.139	0.277	0.170	0.282	0.034	0.091	0.034	0.091
Dependent Variable Mean	0.45	0.45	0.45	0.45	2.66	2.66	2.66	2.66
Observations	1,554	1,554	1,554	1,554	1,554	1,554	1,554	1,554
Controls		✓		✓		✓		✓
Day Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓

Notes: State/Provincial/Country capitals have been omitted. The sample includes the first 14 days since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects, while columns (2), (4), (6) and (8) additionally include the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 10: COVID-19 Cases and Domestic Out-migration: Day 15 to 28 since 100$^{\text{th}}$ Case

	Any Cases				Cases per Million People			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Bangladesh (April 20 - May 3)								
Number of Domestic Migrants per 100 People (z-score)	0.0216 (0.0128)	0.0134 (0.0145)	0.0155 (0.0119)	0.0114 (0.0143)	-3.411 (4.158)	0.0250 (2.035)	-4.262 (4.540)	1.874 (2.345)
Number of International Migrants per 100 People (z-score)			0.0286* (0.0136)	0.00699 (0.0132)			3.932 (2.987)	-6.383** (2.923)
R^2	0.043	0.201	0.057	0.201	0.027	0.666	0.040	0.692
Dependent Variable Mean	0.94	0.94	0.94	0.94	16.17	16.17	16.17	16.17
Observations	882	882	882	882	882	882	882	882
Panel B: India (March 29 - April 11)								
Number of Domestic Migrants per 100 People (z-score)	0.0498** (0.0172)	0.0561*** (0.0158)	0.0347* (0.0163)	0.0408** (0.0156)	0.183 (0.184)	0.401* (0.223)	-0.0224 (0.141)	0.162 (0.162)
Number of International Migrants per 100 People (z-score)			0.128*** (0.0109)	0.0957*** (0.0111)			1.748*** (0.537)	1.495** (0.547)
R^2	0.049	0.241	0.121	0.279	0.027	0.108	0.152	0.192
Dependent Variable Mean	0.36	0.36	0.36	0.36	1.71	1.71	1.71	1.71
Observations	8,134	8,134	8,134	8,134	8,134	8,134	8,134	8,134
Panel C: Pakistan (March 30 - April 12)								
Number of Domestic Migrants per 100 People (z-score)	0.116** (0.0391)	-0.0741* (0.0376)	0.0839** (0.0360)	-0.0750* (0.0390)	0.516 (1.081)	-2.745* (1.304)	-0.663 (0.912)	-2.184* (1.225)
Number of International Migrants per 100 People (z-score)			0.125*** (0.0297)	-0.00714 (0.0398)			4.618*** (1.455)	4.375** (1.826)
R^2	0.064	0.444	0.134	0.444	0.032	0.170	0.115	0.217
Dependent Variable Mean	0.68	0.68	0.68	0.68	9.30	9.30	9.30	9.30
Observations	1,554	1,554	1,554	1,554	1,554	1,554	1,554	1,554
Controls		✓		✓		✓		✓
Day Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓

Notes: State/Provincial/Country capitals have been omitted. The sample includes days 15 - 28 since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects, while columns (2), (4), (6) and (8) additionally include the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 11: COVID-19 Cases and Domestic Out-migration: Day 29 to 42 since 100th Case

	Any Cases				Cases per Million People			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Bangladesh (May 4 - May 17)								
Number of Domestic Migrants	-0.00691	-0.00805	-0.00803	-0.00869	-6.912	-1.636	-9.019	0.126
per 100 People (z-score)	(0.00678)	(0.00714)	(0.00756)	(0.00784)	(6.625)	(2.887)	(7.344)	(3.578)
Number of International Migrants			0.00519	0.00221			9.734	-6.082
per 100 People (z-score)			(0.00398)	(0.00278)			(5.548)	(5.794)
R^2	0.023	0.044	0.026	0.044	0.029	0.709	0.060	0.719
Dependent Variable Mean	0.99	0.99	0.99	0.99	32.14	32.14	32.14	32.14
Observations	882	882	882	882	882	882	882	882
Panel B: India (April 12 - 25)								
Number of Domestic Migrants	0.0592**	0.0659***	0.0461**	0.0525**	0.0271	0.388	-0.239	0.138
per 100 People (z-score)	(0.0198)	(0.0193)	(0.0193)	(0.0194)	(0.422)	(0.439)	(0.405)	(0.426)
Number of International Migrants			0.112***	0.0835***			2.264***	1.565**
per 100 People (z-score)			(0.0112)	(0.0123)			(0.627)	(0.662)
R^2	0.018	0.182	0.069	0.209	0.011	0.146	0.059	0.167
Dependent Variable Mean	0.54	0.54	0.54	0.54	5.11	5.11	5.11	5.11
Observations	8,134	8,134	8,134	8,134	8,134	8,134	8,134	8,134
Panel C: Pakistan (April 13 - 26)								
Number of Domestic Migrants	0.183***	-0.0215	0.150***	-0.0243	3.052	-6.149**	-0.673	-4.653**
per 100 People (z-score)	(0.0338)	(0.0231)	(0.0281)	(0.0243)	(2.232)	(2.433)	(1.698)	(2.120)
Number of International Migrants			0.133***	-0.0215			14.58***	11.68**
per 100 People (z-score)			(0.0263)	(0.0282)			(3.299)	(3.972)
R^2	0.161	0.596	0.240	0.597	0.051	0.290	0.301	0.390
Dependent Variable Mean	0.68	0.68	0.68	0.68	22	22	22	22
Observations	1,554	1,554	1,554	1,554	1,554	1,554	1,554	1,554
Controls		✓		✓		✓		✓
Day Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓

Notes: State/Provincial/Country capitals have been omitted. The sample includes days 29 - 42 since the 100th COVID-19 case was reported in each country. All regressions include day fixed effects, while columns (2), (4), (6) and (8) additionally include the following district-level controls: population, population density, the fraction of urban population, the fraction of population below the poverty line, and a measure of health access (Bangladesh: number of hospital beds per capita, India: number of primary health centers per capita, Pakistan: percentage of population which has access to a health clinic or hospital within 15 minutes of their dwelling). Standard errors in parentheses and double-clustered by day and district. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

E Heatmaps

Figure 3 shows heatmaps of COVID-19 cases per million people and international and domestic migration per 100 people in Bangladesh, India and Pakistan. Visual inspection shows a broad similarity of patterns.

In India, the raw data show a correlation of 0.14 between international out-migration from each district and cases per capita (as of April 28, 2020). The raw correlation between domestic out-migration and cases per capita is small and negative (-0.02). In Pakistan, the raw correlation between international out-migration and cases per capita is 0.24 (as of April 27, 2020), and again the correlation between domestic out-migration and cases per capita (= -0.04) is small and negative. In Bangladesh, the data show a positive, low correlation between international out-migration and cases per capita (= 0.03) as of May 20, 2020. The correlation between domestic out-migration and cases per 1 million people is larger and negative (= -0.14).

Analysis in the main text corroborates these broad patterns: consistent, relatively large correlations between international migration and COVID-19 cases in India and Pakistan, and weaker correlations with domestic migration. In Bangladesh, the results are sensitive to the context and comparison.

Figure 3: COVID-19 and Out-migration - Heatmaps