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Examining the Educational Spillover Effects of Severe Natural Disasters: The Case of Hurricane Maria

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Abstract

This study examines the effects of internal migration driven by severe natural disasters on host communities, and the mechanisms behind these effects, using the large influx of migrants into Florida public schools after Hurricane Maria. I find adverse effects of the influx in the first year on existing student test scores, disciplinary problems, and student mobility among high-performing students in middle and high school that also persist in the second year. I also find evidence that compensatory resource allocation within schools is an important factor driving the adverse effects of large, unexpected migrant flows on incumbent students in the short-run. (*JEL* I20, I24, J15)

Keywords: peer effects; migration; climate change; severe natural disasters; Hurricane Maria

I. Introduction

Migration and its effects remain to be a contentious topic of debate in developed countries. While these debates typically relate to cross-border migration, there is growing concern about increasing rates of internal migration driven by climate change.[i] This study examines the spillover effects of internal migration due to severe natural disasters – one of the leading consequences of climate change - in the United States. Over the past four decades, the number of "super-severe" weather and climate disasters that cause more than a billion dollars in damage has increased dramatically in the United States, from 3 in 1980 to 16 in 2017 (NOAA 2018).[ii] Furthermore, many climate scientists predict that the quantity and severity of such disasters will increase as global greenhouse gas emissions increase. There is evidence in the literature suggesting that such severe disasters lead to significant increases in out-migration rates (Boustan et al. 2020). According to the Internal Displacement Monitoring Centre (IDMC), 6 million people were internally displaced due to severe weather and climate disasters in the United States between 2008 and 2017.[iii]

I address this question using the large influx of Puerto Rican migrants into Florida public schools following Hurricane Maria, which made landfall on Puerto Rico on September 20, 2017, resulting in thousands of deaths[iv] and destroying the island's infrastructure. As of December 2018, the estimated cost of the hurricane was $90 billion, placing Hurricane Maria as one of the costliest hurricanes in U.S. history (NOAA 2018). In the 12 months after the hurricane, an estimated 160,000 Puerto Ricans (roughly 5 percent of the island's population in 2017) relocated to the United States. Florida received the largest share of these migrants[v] with nearly 12,000 students from Puerto Rico enrolling in Florida public schools between October 2017 and May 2018.[vi] This study explores the effects and potential mechanisms of this large influx of migrant students on the educational outcomes of incumbent students in a large, anonymous district in Florida, which experienced roughly 4,000 Puerto Rican migrants following Hurricane Maria (Hinojosa, Román, and Meléndez 2018).

I find significant adverse effects of hurricane migrants on the educational outcomes of existing students in the first year, especially among high-performing middle and high school students. Specifically, the results indicate that a 5-percentage point increase in the share of hurricane migrants reduces averaged reading and math scores by roughly 4 percent of the standard deviation (0.04σ), increases the likelihood of being involved in a disciplinary incident by 15 percent (of the dependent variable mean) in middle and high school, and increases the likelihood of existing students leaving their schools before the start of 2018-19 school year by roughly 10 percent. These effects are significantly more pronounced among high-performing students in middle and high school: a 5-percentage point increase in migrant share decreases test scores of existing students who were deemed as proficient in both ELA and math (based on their prior year test scores) in middle school by 0.15σ, increases incident rates by 50 percent, and more than doubles student mobility. In contrast, I find statistically and economically insignificant effects of a similar-sized increase in migrant share on low-performing students who were not proficient in both ELA and math, and elementary school students.

To assess the magnitude of these effects, it is helpful to compare them to other estimates in the family and education literature. Using Florida data, Figlio et al. (2014) show that a 10 percent increase in birth weight increases test scores by 0.05σ; Breining et al. (2020) show birth order effects of 0.08σ on reading scores; Figlio, Holden, and Özek (2018) find that extending school day by an hour to provide literacy instruction increases reading scores by 0.05σ in elementary schools; Rouse et al. (2013) show that receiving a failing school grade ("F") under

Florida's school accountability system increases student test scores by 0.06σ to 0.14σ in math and by 0.06σ to 0.10σ in reading. More related to the research question addressed in this study, Imberman, Kugler, and Sacerdote (2012) find that an increase of 5-percentage points in Katrina/Irma migrant share decreases math scores by 0.045σ among existing elementary school students in Louisiana (outside of New Orleans). Therefore, the first-year effects presented in this study (especially the effects on higher-performing students in middle and high school) are not only statistically significant, but also economically meaningful and comparable to (and in many cases larger than) the effect sizes found in other contexts.

Using detailed data on student course enrollments that are linked to individual teachers, I examine some of the mechanisms that could explain these findings in middle and high school. I show that an increase in migrant share leads to a much larger increase in the likelihood that lower-performing students in middle schools share classrooms with the migrants compared to higher-performing students. Further, the results provide evidence of schools reallocating resources (teachers in particular) moving more effective teachers from advanced courses to remedial courses to accommodate the needs of entering migrants. In particular, I find that an increase in migrant share significantly reduces teacher quality (as proxied by leave-out-year value-added scores) for high-performing students. In contrast, an increase in migrant share significantly increases the likelihood that a low-performing student is assigned to a highly effective teacher as classified under the district's teacher evaluation system.

I also examine the extent to which these adverse effects persist in the second year. This is an important question because approximately half of the Hurricane Maria migrants left the school district at the end of the first year. Overall, I find precisely estimated zero effects of migrant share on the test scores, disciplinary problems, and attendance of existing students in the second year; however, there is evidence suggesting that the first year effects slightly decline, yet persist in the second year among high-performing students in middle and high school.

II. Prior Literature and Contributions

There is an extensive literature looking at the effects of cross-border migrants (immigrants or refugees) on existing students yielding mixed results. For example, using the large influx of Russian Jews into Israel after the collapse of the Soviet Union, Gould, Lavy, and Paserman (2009) study the effects of immigrants and find a large adverse effect on the high school dropout rates and high school matriculation test passing rates among native Israeli students. Similarly, Jensen and Würtz-Rasmussen (2011) find negative effects of immigrant concentration on both native and immigrant secondary school students in Denmark. On the other hand, Hunt (2017) finds that an increase in the immigrant share in the population increases the likelihood of high school graduation among native-born black students in the United States. Similarly, Brunello and Rocco (2013) and Geay, McNally, and Telhaj (2012) find small or no negative spillover effects of immigrants on natives, and Ohinata and Van Ours (2013) and Schneeweis (2015) find large negative effects of immigrant concentration on the educational outcomes of immigrant students, yet no significant effect on natives. Finally, a number of recent studies examine the effects of refugees on the educational outcomes of native students. For example, Figlio and Özek (2019) examine the effects of Haitian refugees who entered Florida public schools in the aftermath of the Haitian earthquake of 2010, and find precisely estimated zero effects on existing students, regardless of their socioeconomic status, race/ethnicity, and nativity. Similarly, van der Werf (2019) studies how the Indochinese refugees at the end of the Vietnam War affected U.S. children, and find little effects on academic achievement and educational attainment among native students.

There are several important reasons why the effects of internal disaster migrants could be different from the effects of cross-border migrants. First, internal disaster migrants, similar to refugees, are forced to leave their homes due to an imminent threat to their lives. In contrast, immigrants typically make conscious choices to leave their countries of origin seeking “a better life” elsewhere (Figlio and Özek 2019). Internal migrants also face fewer barriers of entry into the host community compared to cross-border migrants. As such, these migrants could be less likely to be positively selected from, and more likely to be representative of, their communities of origin.[vii]

Further, severe natural disasters induce much larger influxes of internal migrants compared to cross-border migrants due to differences in barriers to entry, which could lead to more severe adverse effects on host communities. For example, the migrant influx in the aftermath of Hurricane Maria into Florida public schools had been significantly larger than the Haitian refugee influx following the Haitian earthquake of 2010: Roughly 4,000 Haitian students entered Florida public schools in the four months after the earthquake compared to 11,000 Puerto Rican students in the four months after the hurricane (Rayer 2018). On the other hand, internal migration could be less detrimental than cross-border migration as the migrants are expected to be more similar to the host community culturally/linguistically and, unlike cross-border migrants, are eligible for social assistance programs. Finally, there is evidence in the literature suggesting that disaster migrants are more likely to be transitory and more likely to leave the host communities in the long-run (Figlio and Özek 2019): As such, these students could have different long-term effects on incumbent students compared to economic migrants.[viii]

In contrast to the extensive literature about the effects of cross-border migrants on host communities, relatively little is known about the effects of internal migration due to severe natural disasters. One study that is worth highlighting is Imberman, Kugler, and Sacerdote (2012), which investigates the effects of Hurricane Katrina (and Irma) evacuees on incumbent students in Louisiana and Houston. They find a moderate negative effect of the influx only on math scores in Louisiana (outside of New Orleans) elementary schools, with students in schools that received higher-achieving evacuees faring better than students in schools that received evacuees that were low-performing before the hurricane. This study complements Imberman, Kugler, and Sacerdote (2012) in two ways. First, I examine the effects of a migrant influx that is similar in size, yet very distinct in terms of the educational needs (English skills in particular) of the migrants, compared to Katrina evacuees. Indeed, I find significantly larger spillover effects in the aftermath of Hurricane Maria.

Second, to the best of my knowledge, this study is the first to shed light on the mechanisms behind these migrant effects, particularly about the effects of a large, unexpected influx of migrants with high educational needs on the resources available for existing students. I find evidence suggesting that unexpected migrant influxes do not only alter the peer input in education production function (EPF) for existing students, but they also lead to schools reallocating instructional resources across classrooms (thereby affecting the teacher input in EPF), which makes it difficult to attribute the observed effects of migrants on existing students to classroom externalities alone.

III. Data and Descriptive Statistics

In this study, I use student-level administrative data from a large, urban school district (LUSD) in Florida that provide detailed information about all students in grades K-12 between 2014-15 and 2018-19 school years. These school records contain Florida Standards Assessment (FSA) scores in ELA and math of all students in tested grades (between grades three and ten for

ELA, and grades 3 through 8 for math)[ix] along with a wealth of student characteristics including student demographics (e.g., race/ethnicity, gender), whether the student receives subsidized meals, measures of English proficiency (limited English proficiency indicator and language spoken at home), detailed information about disciplinary incidents, attendance, and special education status. The administrative records also provide information about student courses that are linked to individual teachers. More importantly for the purposes of this study, the data contain the country and state of birth, and the entry and withdrawal dates of all students to/from the schools they attended in a given school year, which allow me to identify Puerto Rican migrants who entered the district for the first time after the hurricane.

Figure 1 presents the number of Puerto Rican migrant students who entered LUSD in the aftermath of Hurricane Maria (between September 20, 2017 and the end of 2017-18 school year).[x] As a comparison, the figure also presents the number of students born in Puerto Rico who entered the district for the first time during the same time frame in the prior two school years. Clearly, LUSD experienced a significant migrant student influx after the hurricane. In particular, 3,089 Puerto Rican migrants entered the district in the three months following the hurricane. This is in stark contrast to the 687 Puerto Rican students entering the district in the previous two years. The hurricane migrant influx decelerated, yet continued, after the winter break, reaching a grand total of 3,991 Puerto Rican students until the end of 2017-18 school year.[xi] To put this in context, the Puerto Rican influx in LUSD was slightly smaller than the volume of Hurricane Katrina evacuees who entered Houston Independent School District (4,986 students/2.9 percent of the student body) in the aftermath of Hurricane Katrina, (Imberman, Kugler, and Sacerdote 2012). Yet, the Puerto Rican influx was much larger than the volume of Haitian refugees in

Spring 2010 when 3,743 Haitian students entered Florida public schools, which represents 0.14 percent of the total enrollment in the entire state in Fall 2009 (Figlio and Özek 2019).

The three panels in Figure 2 examine the distribution of Puerto Rican migrants across schools in LUSD. In particular, the cumulative distribution function (CDF) of the number of entering hurricane migrants by school is given in Panel A; the CDF of the share of entering hurricane migrants in the entire student body by school is given in Panel B; and the CDF of the share of entering hurricane migrants among English learners by school is given in Panel C. Panel A shows 33 schools (14 percent) received no migrants in 2017-18. Of the schools that received at least one hurricane migrant, 40 percent received fewer than 10 migrant students, 70 percent received fewer than 25 migrant students, and 94 percent received fewer than 50 students. Looking at the share of migrants in each school in Panel B, in 64 percent of schools, migrants constitute less than 2 percent of the existing student body whereas the migrant share exceeds 5 percent of the student body in 10 percent of all schools. Results in Panel C show that entering migrants substantially increased the number of English learners within schools, with entering migrants representing more than 10 percent of the existing English learners in nearly half of all schools.

Table 1 compares the characteristics and outcomes of Puerto Rican hurricane migrants in the first and second year (column (I)) with Puerto Rican migrants in previous two years (column (II)) and existing students who were enrolled in the district at the beginning of 2017-18 school year (column (III)). Compared to Puerto Rican migrants in prior years, hurricane migrants were more likely to receive subsidized meals (95 percent versus 82) [xii], less likely to be identified as special education students (16 percent versus 20), more likely to report Spanish as the primary language spoken at home (94 percent versus 89), and more likely to be classified as an English learner (84 percent versus 79) when they first entered the district. Hurricane migrants had similar test scores in the first year as the Puerto Rican migrants in prior two years, yet they had significantly lower absence rates (8 percent versus 10), and were less likely to be involved in a disciplinary incident (5 percent versus 7). Importantly, 68 percent of hurricane migrants left their schools and 46 percent of the migrants left the school district before the start of the following school year. Both of these numbers are considerably larger than the first-year attrition rates of the Puerto Rican migrants in the prior two years (57 percent and 28 percent respectively). The differences in test scores, absences, and disciplinary incidents between the two groups widened in favor of the hurricane migrants in the second year after they entered the school district: Hurricane migrants outscored other Puerto Rican migrants by 0.18σ and 0.13σ in math and ELA respectively, had fewer absences, and were less likely to be involved in a disciplinary incident.[xiii]

Compared to existing students in the district, Puerto Rican hurricane migrants were more disadvantaged both socioeconomically and academically. Hurricane migrants were significantly more likely to receive subsidized meals, nearly six times more likely to be classified as English learners, and 50 percent more likely to be identified as special education students. Existing students also outperformed these migrants considerably on standardized tests in the first year (by 1.25 standard deviations in ELA and by one standard deviation in math), and had lower absence rates, yet were almost two times more likely to be involved in a disciplinary incident.[xiv] These gaps shrunk considerably, yet persisted, in the second year.

A number of studies have shown that recent immigrants are more likely to settle in neighborhoods with larger shares of immigrants, typically from their countries of origin (e.g., Card 2001; Figlio and Özek 2019). While Puerto Rican migrants are not technically immigrants, this is also what was observed in the aftermath of Hurricane Maria in LUSD.[xv] Table 2 presents the estimated coefficient on the school migrant share in regressions where the outcome of interest is the existing student attribute provided in the table.[xvi] The estimates suggest that schools with higher hurricane migrant shares also had students with significantly lower prior year achievement in both ELA and math, had higher shares of students born in Puerto Rico, Hispanic students, English learners, and students receiving subsidized meals. As such, simple comparisons between the educational outcomes of existing students in schools that received Puerto Rican hurricane migrants and those that did not would likely yield biased estimates of the causal effects of the migrant influx.

IV. Empirical Strategy

To deal with this selection issue, following the empirical approach employed in a number of studies on peer effects in education[xvii], I rely on within-school, across-grade variation in migrant concentration to study the effects of the student influx on host students.[xviii] Using students who were enrolled in a public school in the district at the time of the hurricane I estimate:

(1) $$Y_{itsg} = \alpha + \beta M_{sg} + \delta_s + \theta_g + \varepsilon_{it}$$

where Y_{itsg} is the year *t* educational outcome (test scores standardized to zero mean and unit variance at the year-grade level[xix], an indicator for being involved in a disciplinary incident, % absent days multiplied by 100, and an indicator for leaving the school in Fall 2017 before the start of 2018-19[xx]) of student *i* who attended school *s* and grade *g* at the beginning of 2017-18 school year, M_{sg} is the percentage of Puerto Rican hurricane migrants in grade *g* and school *s* in 2017-18 school year, and δ_s and θ_g are school and grade fixed-effects of the school and the grade that student *i* attended in Fall 2017 respectively. In some specifications, I also include a vector of student characteristics (X_{it}) to check the robustness of the findings and cluster standard errors at the school-by-grade level.

The critical assumption behind identification here is that M_{sg} is uncorrelated with unobserved characteristics of existing students as well as cohort attributes, controlling for schools attended. While it is not feasible to validate this assumption directly, Table 3 presents indirect evidence and provides the estimated associations between M_{sg} and observed characteristics of existing students and cohort size, with and without school fixed-effects. The estimates presented in column (I) show that, similar to Table 2, migrant share is significantly correlated with existing student attributes (sample means given in the third column of Table 1). However, once school fixed-effects are introduced, these associations vanish in almost all cases (only 1 out of 16 estimates is statistically different than zero at conventional levels). This approach also requires significant cross-grade variation in M_{sg} within schools. Appendix Figure 1 presents the CDF of the cross-grade range in M_{sg} by school and shows that the range exceeds 2.5 percentage points in half, and exceeds 5 percentage points in 30 percent of all migrant-receiving schools.

An important concern with this empirical strategy is the possibility that school administrators strategically place migrants in grades based on unobservable factors. For this, using the exact birth date of each student, I utilize the variation in the naturally occurring age distribution of entering migrants in each school as an instrument for M_{sg}, and assume that this within-school, across-grade age distribution is orthogonal to existing student and school-by-grade characteristics. In particular, using 2SLS, I estimate:

$$M_{sg} = \phi + \gamma A_{sg} + \delta_s + \theta_g + \nu_{sg}$$

$$Y_{itsg} = \rho + \theta \widehat{M}_{sg} + \delta_s + \theta_g + \vartheta_{itsg} \quad (2)$$

where A_{sg} is the number of migrants who entered school s and were age-appropriate for grade g multiplied by 100 and divided by the number of existing students enrolled in the same school-grade. Appendix Table 1 repeats the same analysis in Table 3 replacing M_{sg} with A_{sg}, and shows that once school fixed-effects are introduced, the instrument is uncorrelated with existing student and school-by-grade characteristics. To further investigate the strategic placement of migrants across grades within schools, I also present a falsification exercise where I estimate (1) using student outcomes in the year prior to the hurricane, assigning M_{sg} to the students in school s and grade g in 2016-17 school year. If the cross-grade, within-school differences in student outcomes are indeed driven by differences in migrant concentration (instead of unobserved school-by-grade level attributes such as teacher effectiveness), one would expect to find no significant correlation between this 'pseudo' migrant concentration and the outcomes in 2016-17.

V. First Year Effects

Table 4 presents the effects of hurricane migrant share on existing student test scores (averaged reading and math scores) in the first year (i.e., 2017-18 school year) estimated using OLS for all elementary and middle school students in grades 4 through 8. Because low-performing students could have higher levels of exposure to migrants in their classrooms due to tracking, and this type of achievement tracking is more pronounced in middle schools[xxi], I also present the differential effects by grade level (elementary versus middle school) and student prior achievement (above or below the proficient level on prior year ELA and math tests). [xxii] Each coefficient in this table presents the estimated effect of a 1-percentage point increase in migrant share on student outcomes in the first year. Regressions in column (I) control only for grade fixed-effects; column (II) introduces school fixed-effects and prior year test scores; and column (III) introduces the other student characteristics listed in the second panel of Table 2.

The findings reveal significant adverse effects of the migrant influx in the short-term, especially for high-performing students in middle schools. For all subgroups, the estimated coefficients decline considerably in magnitude once school fixed-effects are introduced (as one would expect given the migrant selection issue described in Table 2), yet the effects of migrant share using the preferred specification in column (III) are still statistically and economically meaningful in several cases. It is also worth noting that the estimated effects remain virtually unchanged when I introduce student baseline attributes in column (III), which provides further evidence about the validity of the empirical approach.

Figure 3 presents a graphical depiction of the main findings in Table 4 and provides further evidence on the validity of the research design. In particular, similar to Carrell, Hoekstra, and Kuka (2018), I graph the predicted test scores (after controlling for all covariates in the third column of Table 4 other than the school-by-grade migrant share) and the actual test scores against the percent change in residual school-by-grade migrant share relative to the migrant share at the school level. Consistent with the baseline equivalency results presented in Table 3, the findings presented in the 9 panels of Figure 3 reveal that predicted test scores do not vary with the school-by-grade migrant share. In contrast, actual test scores decline significantly as the migrant share increases in several cases, especially among high-performing students in middle school.

To assess the magnitude of these effects, consider an increase of 5-percentage points in migrant share at the school-by-grade level (roughly 30 percent of all LUSD schools had at least one grade that received an influx larger than 5 percent of the student body in that grade). The effects presented in the first panel imply that a 5-percentage point increase in migrant share leads to a decline of 0.04σ overall, 0.075σ for middle school students, and 0.15σ for high-performing middle school students who were proficient in both ELA and math on prior year tests. In contrast, I find small and statistically insignificant declines of 0.015σ for elementary school students and 0.005σ for low-performing students who were not proficient in both ELA and math on prior year tests.

Table 5 presents the effects of migrant share on non-test outcomes in the first year including the likelihood of being involved in a disciplinary incident, absence rate, and the likelihood that the student leaves the school before the start of 2018-19 school year using the preferred specification in column (III) of Table 4. The results suggest that a 5-percentage point increase in migrant share increases the disciplinary incident rate in middle and high school where disciplinary incidents are more common[xxiii] by about 2 percentage points, which correspond to roughly 15 percent of the dependent variable mean, yet the estimated effects are only marginally significant. These adverse effects are once again more pronounced for high-performing middle school students with an increase of 4 percentage points (or nearly 50 percent of the dependent variable mean) in incident rates as a result of a 5-percentage point increase in migrant share. I find no significant effect on disciplinary incidents for students in elementary school and/or low-performing students.[xxiv]

The results in Table 5 also indicate that a 5-percentage point increase in migrant share increases the likelihood of leaving the school before the start of 2018-19 school year by 2 percentage points, which roughly correspond to 10 percent of the dependent variable mean. This is similar to the evidence in the previous literature suggesting that that native students are likely to leave their schools when facing a major immigrant influx (Schindler-Rangvid 2010; Gerdes 2010). Once again, this effect is more prevalent among high-performing students (the effect size is roughly equivalent to 70 percent of the dependent variable mean for this group), yet I also find a significant, positive effect on student mobility on low-performing students in middle and high school. Finally, Table 5 reveals no economically or statistically significant effects on existing student absences.

A. Robustness Checks

Appendix Table 2 presents the effects of migrant share on test scores and non-test outcomes estimated using the 2SLS approach described in Section 4. Results are very much in line with the OLS estimates presented in Tables 4 and 5. For example, the 2SLS estimates indicate that a 5-percentage point increase in migrant share reduces test scores among high-performers in middle school by 0.20σ, disciplinary incidents by 60 percent, and more than doubles the likelihood of leaving the school in a year. Among low-performers, I find no significant (statistically or economically) effect on test scores or disciplinary problems, but significant effects on student mobility.

The top panel in Appendix Table 3 provides the results of the falsification exercise, looking at the 'pseudo' effects of migrant share on the outcomes of students in the same school and grade in 2016-17 broken down by student prior achievement. If the results in Tables 4 and 5 are indeed driven by the migrant influx instead of some unobserved, time-invariant heterogeneity across grades within schools (e.g., teacher quality), one would expect no significant effects of the migrant influx during the school year before the hurricane. This is indeed the case. The estimated 'pseudo' effects are statistically insignificant (only 1 out of 36 estimates is statistically different than zero at 5 percent level or higher), and the magnitudes are considerably smaller in almost all cases than the true effect sizes presented in Tables 4 and 5.[xxv]

Appendix Figure 2 breaks down the effect of migrant share on student mobility further and examines the timing of student departure from their schools in the first year. This is an important exercise for the validity of the estimates presented in Tables 4 and 5 because if the migrant influx leads to differential attrition from the sample during the 2017-18 school year among existing students (e.g., an increase in migrant influx leads to higher-performing students leaving the sample), the adverse effects observed in the first year could be driven by changes in the composition of existing students for whom we observe outcomes rather than changes in their educational outcomes.

In particular, using exact withdrawal dates, each bar on Panel A of Appendix Figure 2 graph presents the estimated coefficient (along with the 95% confidence interval) on the migrant share variable in regressions where the dependent variable is an indicator that equals 1 if the student left their school (the school they attended at the beginning of 2017-18 school year) by the date given on the x-axis (the last entry on the x-axis represents the end of school year). The results indicate that the mobility results presented in Table 5 are primarily driven by the effect of the migrant influx on student mobility at the end of the school year rather than during the school year. Panel B in Appendix Figure 2 repeats the same analysis replacing the mobility indicator with a sample attrition indicator that equals 1 if the student left the district by the date given on the x-axis. The results reveal small and statistically insignificant effects of migrant share on existing student attrition from the sample during the school year, but a significant and much larger effect on student attrition from the sample at the end of the year.

Panels (C) and (D) repeat the same analysis for high-performing students in middle school (for whom the adverse effects of migrants are more pronounced), and examine the extent to which an increase in migrant share leads to high-performing students leaving their schools (and the district) before the end of 2017-18 school year. The findings reveal that an increase in migrant share significantly increases student mobility among high-performing students at the end of the school year, yet no significant effect on mobility during the school year. Further, I find no significant effect of migrant share on high-performing student attrition from the sample neither during the school year nor at the end of 2017-18. Appendix Table 4 provides further evidence on differential attrition from the sample, repeating the analysis in Table 3 for students who enrolled in a LUSD school at the beginning of 2018-19 school year. If there is indeed differential attrition from the district during the school year, one would expect significant correlations between the migrant share variable and existing student baseline characteristics (conditional on remaining in the district in 2018-19). However, I find no such associations.

Finally, the top panel in Appendix Table 5 presents the results of an exercise where I impute test scores for middle school students who left the sample after the migrant influx based on their test score history. In particular, I assign these students their test scores in the previous year (2016-17), or their average, maximum, and minimum test scores in the prior three years. The results are almost identical to the estimates presented in Table 4, once again providing evidence against differential attrition being a major factor in the first year.

B. Mechanisms Behind the Migrant Effects

There are a number of mechanisms that could drive the observed adverse effects of the migrant influx on existing students. First, the migrant influx could have a direct adverse effect on existing students through negative classroom spillovers. For example, large numbers of migrants entering classrooms could lead to disruptions in instruction or reduced instructional quality due to overcrowded classrooms. Further, an influx of migrants with high educational needs could lead to declines in classroom peer quality. Second, the influx could affect other students in the school indirectly (even if they do not share classrooms with migrants) if school administrators reallocate resources (e.g., teachers) within-grades, across classrooms or across grades to accommodate the needs of migrants. While it is not feasible to quantify the contribution of these alternative explanations to the observed adverse effects due to data limitations, in this section I present the results of several exploratory exercises investigating these mechanisms in middle schools where the adverse effects are more pronounced.

It is difficult to directly test for classroom externalities using administrative data for a number of reasons. For example, administrative data typically do not contain measures of classroom disruptions or resource reallocation within classrooms. Further, while the administrative data used in this analysis contain teacher-student links at the course level (e.g., I observe the 6^{th} grade math teacher of each student), I am unable to identify individual classrooms (middle school teachers typically teach several "sections" of the same course) and thus unable to examine student exposure to migrants in their classrooms or the effects of the migrant influx on class size.

That said, to assess differential exposure to migrants by existing student prior achievement, I first calculate the number of migrants taking the same course from the same teacher for each existing student. I then average this number over all ELA and math courses taken by the student, and estimate the effect of migrant share on this measure, which serves as a proxy for actual exposure to migrants in classrooms, using the same specification in column (III) of Table 4. Ex-ante, one would expect low-performing middle school students to be more likely to share classrooms with migrants due to Florida's middle school remediation policy. This policy requires students who score below the proficient level on prior year ELA and math tests to take an additional remedial course in that subject, and has been shown to lead to considerable classroom segregation along student prior achievement not only in the remediation subject, but also in other core subjects (Özek 2020, Figlio and Özek 2020b).[xxvi] Therefore, an influx of low-performing migrants is expected to increase migrant exposure to a larger extent for existing students who were not proficient in ELA or math on prior year tests as these migrants are more likely to be placed in their classrooms.

Indeed, I find that an increase in migrant share increases the number of migrants enrolled in the same course-teacher to a much larger extent for low-performing students compared to high-performing students. In particular, a 5 percentage point increase in migrant share increases the average number of migrants in the same course-teacher by 3 students for the former group (p-value<0.0001) compared to an increase of 0.25 students for the latter with a p-value of 0.717 (the estimated coefficients are statistically different at 5 percent level).[xxvii] While this finding does not rule out classroom disruptions as a potential mechanism, it suggests that the adverse effects are more pronounced among students who are considerably less likely to share classrooms with migrants.

Does the migrant effect vary by the educational needs of entering students? While I do not observe the prior test scores of hurricane migrants, I use the English learner and special education status of incoming migrants as a proxy for their educational needs. Appendix Table 6 presents the results of regressions where the migrant share variable is interacted with the share of migrants who are identified as English learners or special education students in middle school s and grade g at the time of their entry into the district. The results suggest that the adverse effects of migrants are significantly larger when the incoming migrants have higher educational needs. Interestingly, this is only true for high-performing middle school students who are less likely to be exposed to migrants in classroom settings. For example, a 5 percentage point increase in migrant share increases the test scores of high-performing students in middle school by a statistically significant 0.38σ (p-value<0.001) if none of the entering migrants are identified as

English learners. In contrast, a similar increase in migrant share decreases the test scores of these students by a statistically significant 0.24σ if all of the entering migrants are English learners. Similarly, migrant share has no statistically significant effect on high-performing student test scores (p-value of 0.994) if none of the entering migrants are identified as special education, yet this effect becomes more negative as the share of entering migrants who are special education students increases.

These two exercises suggest that the adverse effects of the influx are larger for student groups who are less likely to share classrooms with migrants, especially when the incoming migrants have higher educational needs. This is in contrast to what one would expect if negative classroom externalities were the main drivers of the adverse effects. For example, an increase in migrant share is expected to lead to a much larger increase in class size for low-performing students due to tracking based on prior achievement. Further, once again due to tracking, low-performing middle school students are more likely to receive lower-achieving migrants into their classrooms. Given what we know about the effects of class size and peer quality, these two mechanisms are more likely to hurt low-performing students than high-performing students. Yet, the findings presented thus far reveal that it is the latter group that experiences the more adverse effects.

A possible mechanism that might drive these findings is compensatory resource reallocation where district (or school) resources are shifted towards schools/classrooms that receive a larger influx of high-need migrants. It is important to note that across-school resource reallocation is unlikely to explain the aforementioned migrant effects mainly because the empirical approach that exploits the within-school, across-grade variation in migrant share already accounts for any effects of cross-school resource reallocation. Therefore, I focus on within-school resource reallocation using teachers as the main resource that schools have at their disposal in the short-run.[xxviii]

In particular, I examine how teacher quality distribution by existing student prior achievement changes as migrant share increases. I use three proxies for teacher quality: (1) leave-out-year teacher value-added score calculated in a similar way to Chetty, Friedman, and Rockoff (2014)[xxix]; (2) whether the teacher was classified as "highly effective" under LUSD's high-stakes teacher evaluation system in 2016-17 school year; and (3) whether the teacher was classified as "unsatisfactory" in 2016-17. While the first measure provides a more complete picture about the teacher effectiveness distribution, the last two measures are also important to consider as they are the only measures of teacher effectiveness observed by principals, and are used in high-stakes personnel decisions in LUSD.[xxx]

Using these three measures, I first estimate the effect of school-by-grade migrant share on the quality of teachers assigned to different types of ELA and math courses (remedial, regular, and advanced). In particular, using course assignments of each teacher in February, I estimate the coefficient on the migrant share variable in regressions using school fixed-effects where the dependent variable is the corresponding measure of teacher quality. The top panel of Table 6 examines the effect of migrant share on teacher quality distribution across different course types using teacher-by-course level data and shows that an increase in migrant share significantly increases teacher quality in remedial courses and reduces teacher quality in advanced courses. For example, a 5-percentage point increase in migrant share increases leave-out-year value-added score by 5.5 percent of the standard deviation in student test scores (or 64 percent of the standard deviation in teacher value-added scores) in remedial courses while it reduces teacher value-added in advanced courses by nearly the same amount. A similar increase in migrant share also increases the likelihood that a highly effective teacher is assigned to a remedial course by 13 percentage points (nearly triples this likelihood based on the dependent variable mean), and the likelihood that an unsatisfactory teacher is assigned to an advanced course by 18 percentage points (nearly doubling this likelihood based on the dependent variable mean).

This reallocation of teachers across different course types is expected to affect teacher quality experienced by low-performing and high-performing teachers due to the aforementioned classroom segregation by prior achievement. The bottom panel in Table 6 examines the effect of migrant share on teacher quality experienced by students (along the three measures of quality) averaged across all ELA and math courses. The estimates suggest that a 5-percentage point increase in migrant share reduces the average teacher value-added experienced by high-performing students by 6 percent of the standard deviation in student test scores (or nearly 70 percent of the standard deviation in teacher value-added scores), and nearly triples the likelihood that low-performing students are assigned to a highly effective teacher.[xxxi]

I also conduct a falsification exercise similar to Appendix Table 3, replacing student outcomes with average teacher leave-out-year value-added score for each student (district-assigned teacher effectiveness categories are not available for 2016-17) and estimating the pseudo effect of migrant share on teacher quality in 2016-17 school year. If the effects on teacher quality are indeed driven by the influx rather than existing teacher assignment practices in these schools and grades, one would expect to obtain zero effects in this exercise. Indeed, the results (available upon request) suggest precisely estimated zero effects on teacher quality with an estimated coefficient of 0.003 (p-value of 0.723) on the migrant share variable for high-performers compared to a coefficient of -0.012 (p-value of 0.026) in 2017-18.

Finally, I check to see whether the effect of migrant share on teacher quality is more pronounced when the share of migrants entering a school-grade wo are high-need (identified as an English learner or special education) increases. The results (available upon request) support this hypothesis although the estimates are less precisely estimated. For example, an increase in migrant share has no effect on the leave-out-year teacher value-added scores for high-performing students (p-value of 0.962) if none of the entering migrants are identified as English learners. In contrast, a 5 percentage point increase in migrant share decreases teacher value-added scores for high-performing students by 7.5 percent of the standard deviation in test scores if all of the entering migrants are English learners, although the interaction term is imprecisely estimated (p-value of 0.345).

These results, while not sufficient to rule out classroom disruptions as a mechanism, suggest that resource reallocation within schools is an important driver of the adverse effects of the influx on student test scores. For high-performing middle school students, classroom disruptions are likely smaller as these students are less likely to share classrooms with migrants, yet the migrant influx still has a negative effect on these students due to compensatory resource reallocation. In contrast, for low-performing students, negative classroom externalities are likely offset by the reallocation of teachers across classrooms.

VI. Second Year Effects

The findings presented in Table 1 reveal that roughly half of the hurricane migrants left the district before the beginning of 2018-19 school year. An important question then is the extent to which the first-year effects of the migrant influx persist in the second year. Table 7 repeats the same analysis in Tables 4 and 5, replacing the first-year test scores, disciplinary incidents, and attendance of existing students with the outcomes in 2018-19 school year. The results indicate that the first-year adverse effects on high-performing students in middle and high school persist in the second year even though the estimated coefficients are slightly smaller. For example, a 5-percentage point increase in migrant share decreases the second year test scores of middle school students who were high-performing in 2016-17 school year by a statistically significant 0.12σ (compared to a statistically significant first year effect of 0.15σ) and increases disciplinary incidents by 40 percent of the dependent variable mean (compared to 50 percent in the first year). On the other hand, the results reveal a positive effect of the migrant influx on the test scores of low-performing students in middle school in the second year, with an estimated effect of 0.13σ.

There are several mechanisms that could explain the dissipating effects in the second year. One possibility is differential attrition from the sample wherein the students who were most adversely affected by the migrant influx leave the district at the end of the first year. To investigate this mechanism, Appendix Table 7 repeats the analysis in Table 4 conditional on observing the student in the sample in 2018-19 school year. If it is indeed differential attrition that is driving the second-year effects, one would expect significantly different first-year effects that are smaller in magnitude in this exercise. The estimated effects are almost identical to the first-year effects reported in Table 4, providing evidence against this hypothesis.

To further check the extent of differential attrition in the second year, the bottom panel in Appendix Table 5 presents the results of the imputation exercise for the second year test scores of existing middle school student, this time assigning the attriters their test scores in the first year (2017-18), or their average, maximum, and minimum test scores in the prior four years. The estimated effects of migrant share are virtually identical to those estimated without imputation for high-performing students. On the other hand, the positive effects observed for low-performing students vanish entirely when I use the imputed test scores, providing evidence suggesting that differential attrition could be a major factor driving the second-year test score effects for this student group.

Did the teacher reallocation practice continue in the second year? This is an important question that could be driving the second-year effects. I examine this possibility using the second-year teacher assignments of middle school students in ELA and math courses, similar to the bottom panel of Table 6. The results (available upon request) suggest small and insignificant effects on the three measures of teacher quality. For example, a 5-percentage point increase in migrant share increases the average leave-out-year value-added scores of high-performing students' teachers in the second year by 3.5 percent of the standard deviation in student test scores (p-value of 0.393) and reduces the same teacher quality measure by 2 percent of the standard deviation in student test scores (p-value of 0.210) for low-performing students. These findings suggest that the effect of migrant share on teacher quality in the second year is unlikely to explain the adverse effects observed for high-performing middle school students.

There are a number of reasons why schools may not have engaged in compensatory resource reallocation in the second year such as the change in the size and educational needs of migrants in schools after the first year. For existing students who remained in the district in 2018-19 school year, I find that a 5-percentage point increase in migrant share in 2017-18 increases the migrant share the student experiences in 2018-19 by only 0.7 percentage points, suggesting a significant decline in migrant share in the second year. Further, the educational needs of hurricane migrants who stayed in the district changed considerably in the second year. There is evidence in the literature suggesting that migrant achievement improves considerably in the years following their entry into the host community (e.g., Figlio and Özek 2020a). This was also the case among the hurricane migrants: Migrants who stayed in the district in 2018-19 experienced test score gains of 0.45σ in math and 0.31σ in ELA, which could have reduced the need for school administrators to reallocate resources in the second year and mitigated the adverse effects on existing students. Finally, additional funding and resources provided to the district by the state and the U.S. Department of Education, most of which arrived by the end of the first year, could have could have helped the district, for instance, hire new teachers to better accommodate the needs of hurricane migrants in the second year.[xxxii]

VII. Concluding Remarks

In this study, I examine the effects of internal migration driven by severe natural disasters on host communities using the large migrant influx of students from Puerto Rico into Florida public schools following Hurricane Maria. I find that an increase in migrant share significantly reduces existing student test scores in the first year, increases disciplinary incident rates in middle and high school, and increases the likelihood that existing students leave their schools before the start of the following school year. The results indicate that these first-year adverse effects are primarily driven by the effect on middle school students who were high-performing in the prior year. I also find evidence suggesting that schools reallocate resources in a compensatory fashion when faced with a large migrant influx, assigning more effective teachers to classrooms with lower-performing students that receive more migrants, which could explain the adverse effects on higher-performing students in the first year. The adverse effects in the first year slightly decline, yet persist, for high-performing middle and high school students in the second year. These findings suggest that the current cost estimates associated with severe natural disasters likely underestimate the true cost of these disasters. Further, they provide evidence that a large, unexpected migrant influx affects the educational outcomes of existing students through channels other than changes in peer quality, raising concern about using unexpected migratory flows to identify peer effects in education.

That said, there are several factors that could limit the external validity of these findings. For example, severe natural disasters typically create migration that is less predictable (and more transitory) than other climate change related incidents such as droughts or sea level rise. As such, the effects of climate migration due to severe natural disasters on host communities could be different than the effects of climate migration in general. Second, the effects of Hurricane Maria migrants could be more severe than other cases of internal climate migration due to natural disasters in the United States since Hurricane Maria migrants came from a region that is linguistically distinct than the host community that received them, yet I find significant short-term adverse effects in schools with higher shares of Spanish-speaking students, refuting this hypothesis. Finally, the effects of natural disaster-induced internal migration in developing countries that are more resource-constrained could be more severe than the effects of internal migration in a developed country, which I examine in this study.

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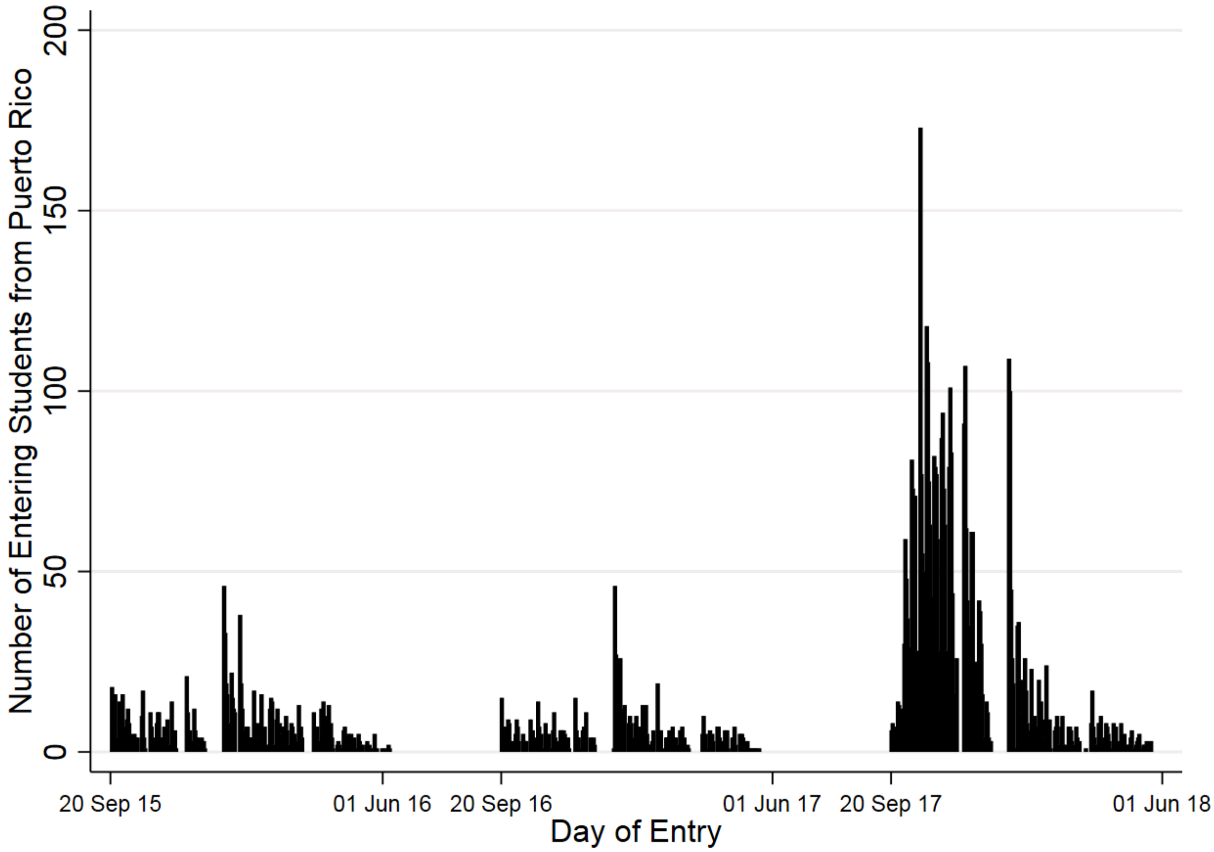
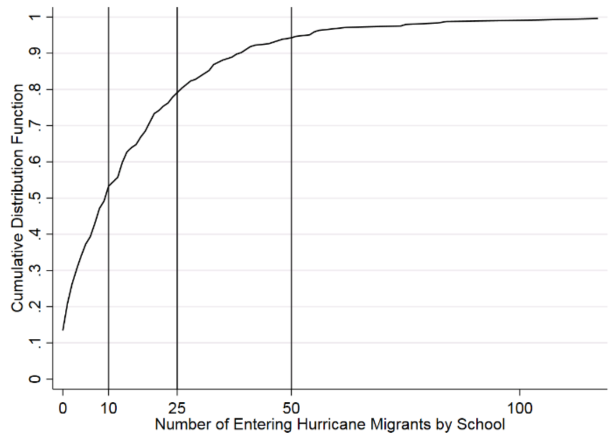
Figure 1 - Distribution of Puerto Rican Migrants in the Aftermath of Hurricane Maria Compared to Puerto Rican Migrants During the Same Time Frame in Prior Two School Years



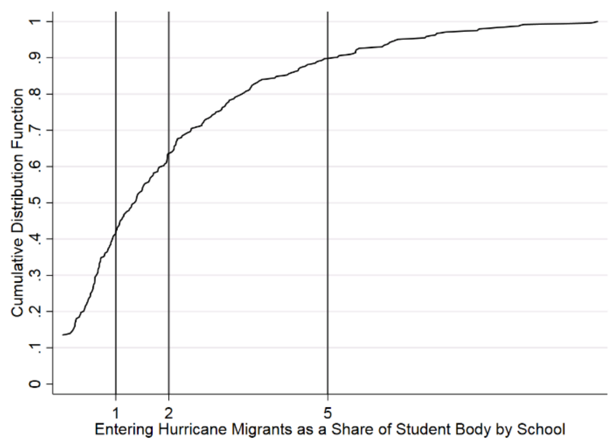
Notes: The figure presents the number of Puerto Rican students who entered LUSD for the first time between September 20, 2017 and June 1, 2018 by entry day, along with the number of Puerto Rican students who entered LUSD during the same time frame in the prior two school years.

Figure 2 - Distribution of Puerto Rican Migrants Across Schools

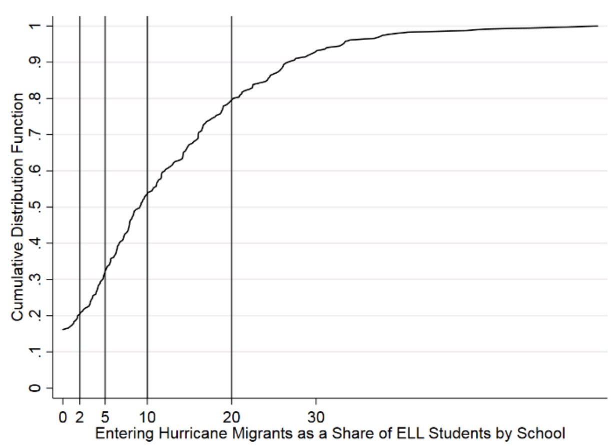
(A) Number of Migrants



(B) Migrants as a Share of Student Body



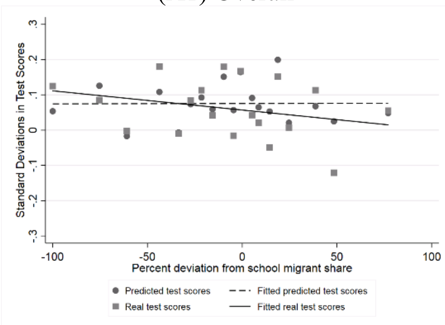
(C) Migrants as a Share of English Learner Students



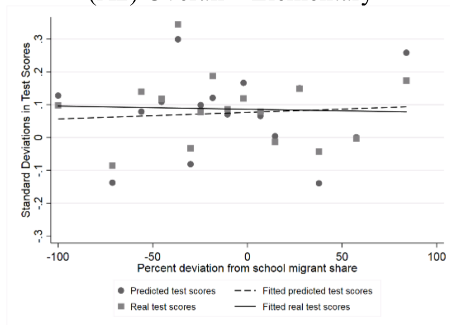
Notes: Figures present the cumulative distribution of (1) the number of Puerto Rican hurricane migrants by school in Panel A; (2) the share of Puerto Rican hurricane migrants by school in Panel B; and (3) the share of Puerto Rican hurricane migrants among English learner students by school in Panel C. The migrant shares in Panels B and C are multiplied by 100.

Figure 3 - Effects of Hurricane Migrants on Student Test Scores in the First Year, by Grade Level and Prior Year Achievement

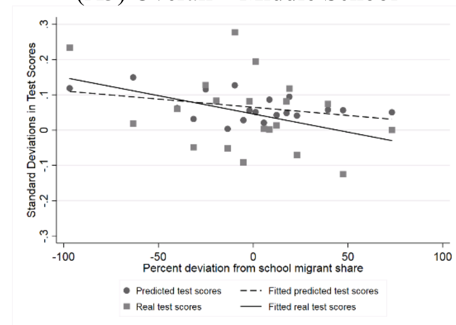
(A1) Overall



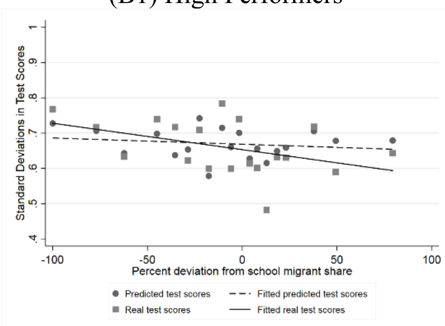
(A2) Overall – Elementary



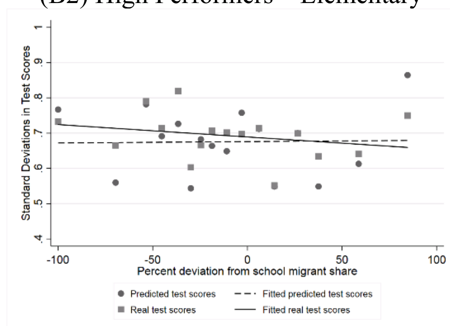
(A3) Overall – Middle School



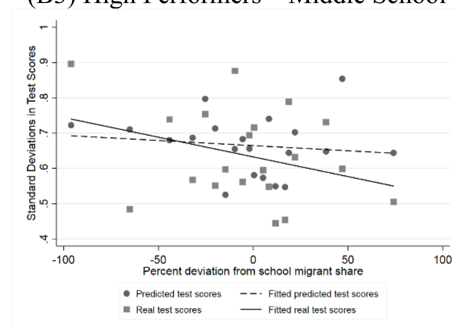
(B1) High Performers



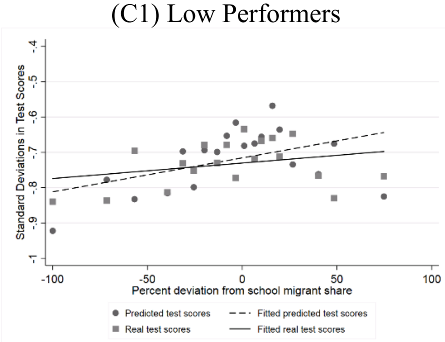
(B2) High Performers – Elementary



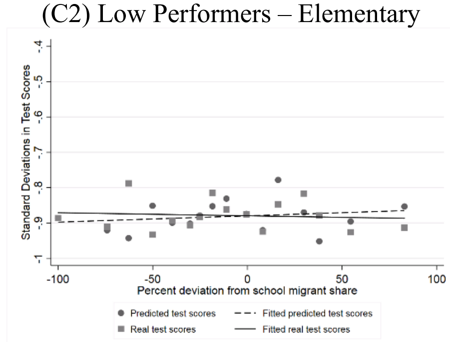
(B3) High Performers – Middle School



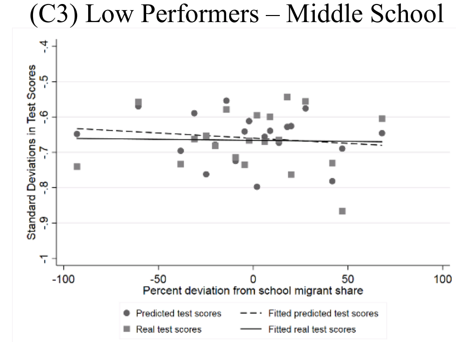
(C1) Low Performers



(C2) Low Performers – Elementary



(C3) Low Performers – Middle School



Notes: Predicted test scores are created by first running a regression that includes the student attributes given in Table 2, grade fixed-effects, school fixed-effects, and existing student attributes averaged at the school-by-grade level. I then predict test scores using the estimated coefficients and collapse the data to 20 groups defined according to the percent change in migrant share (relative to the migrant share in that school).

Table 1 - Differences in Student Characteristics and Outcomes between Puerto Rican Hurricane Migrants, Puerto Rican Migrants in Prior Two Years, and Existing Students

	(I)	(II)	(III)
	Hurricane Maria Migrants	Migrants in Prior Two Years	Existing students
Student characteristics			
Receives subsidized meals	95.06	82.55	68.72
	(21.66)	(37.96)	(46.36)
White	0.651	0.793	27.23
	(8.046)	(8.873)	(44.52)
Hispanic	98.67	99.05	40.23
	(11.45)	(9.712)	(49.04)
Black	0.651	0.159	25.38
	(8.046)	(3.981)	(43.52)
Special education	16.26	19.62	11.60
	(36.91)	(39.72)	(32.03)
English learner	83.89	74.14	13.93
	(36.77)	(43.80)	(34.63)
English non-native	95.04	89.90	36.26
	(21.72)	(30.14)	(48.08)
U.S. born			87.41
			(33.17)
Male	51.19	52.35	51.60
	(49.99)	(49.96)	(49.97)
Age (in days)	4014.6	3952.1	4349.3
	(1349.9)	(1339.0)	(1347.7)
First year outcomes			
ELA score	-1.316	-1.345	0.057
	(1.030)	(1.056)	(0.967)
Math score	-1.048	-1.118	0.050
	(1.055)	(0.982)	(0.976)
% absent days (0-100)	8.359	10.46	5.606
	(9.314)	(11.01)	(7.130)
Disciplinary incident	4.861	6.928	11.73
	(21.51)	(25.40)	(32.17)
Before the start of following school year -			
Left the school (excluding terminal grades)	68.28	56.74	22.50
	(46.54)	(49.56)	(41.76)
Left the district (excluding 12th grade)	46.15	28.26	8.924
	(49.86)	(45.04)	(28.51)
Second year outcomes			
ELA score	-1.021	-1.140	0.087
	(1.085)	(1.051)	(0.941)
Math score	-0.656	-0.839	0.046
	(1.081)	(1.007)	(0.968)
% absent days (0-100)	7.335	9.755	5.194
	(7.752)	(9.555)	(6.953)

	(I)	(II)	(III)
Disciplinary incident	10.94	13.22	12.79
	(31.22)	(33.88)	(33.40)
Number of students	3,991	1,891	194,616

Notes: Standard deviations in parentheses. Column (I) presents the average outcomes of Hurricane Maria migrants from Puerto Rico in the first year after they entered the anonymous district (top panel) and other characteristics (bottom panel); column (II) presents the statistics for the migrants from Puerto Rico who entered the district after the September 21st of the prior two school years; and column (III) presents the statistics for the existing district students at the beginning of 2017-18 school year. The last row provides the number of students in the first year the migrants entered the school district. Indicator variables are multiplied by 100.

Table 2 – Estimated Associations between Existing Student Characteristics and the School Hurricane Migrant Share

Prior year outcomes	
ELA score	-0.050***
	(0.011)
Math score	-0.044***
	(0.012)
Disciplinary incident	-0.508
	(0.325)
% absent days (0-100)	0.192**
	(0.079)
Other student characteristics	
Born in Puerto Rico	1.687***
	(0.170)
White	-3.430***
	(0.558)
Black	-3.396***
	(0.716)
Hispanic	7.185***
	(0.487)
Male	11.304
	(13.795)
English non-native	5.199***
	(0.450)
U.S. born	-0.307
	(0.325)
Received subsidized meals	6.418***
	(1.059)
Special education	-0.207
	(0.518)
English learner	2.887***
	(0.398)
Age (in days)	-98.206*
	(53.319)

Notes: Standard errors, clustered at the school level, are given in parentheses. The estimated coefficients represent the coefficient on the school-level migrant share variable (in percentage points) in regressions where the dependent variable is the corresponding student characteristic. *, **, *** statistical significance at 10, 5, and 1 percent levels. Indicator variables are multiplied by 100.

Table 3 – Estimated Associations between Existing Student Characteristics and School-by-Grade Hurricane Migrant Share

	(I)	(II)
School fixed-effects	No	Yes
Prior year outcomes		
ELA score	-0.040***	0.004
	(0.007)	(0.004)
Math score	-0.036***	0.005
	(0.008)	(0.006)
Disciplinary incident	-0.072	0.010
	(0.110)	(0.095)
% absent days (0-100)	0.171***	-0.053***
	(0.025)	(0.015)
Other student characteristics		
Born in Puerto Rico	1.196***	-0.048
	(0.077)	(0.045)
White	-2.234***	0.026
	(0.200)	(0.071)
Black	-2.454***	-0.074
	(0.243)	(0.064)
Hispanic	4.906***	0.034
	(0.248)	(0.080)
Male	0.053	-0.048
	(0.057)	(0.086)
English non-native	3.495***	0.019
	(0.189)	(0.082)
U.S. born	-0.295***	-0.011
	(0.097)	(0.052)
Received subsidized meals	4.081***	0.013
	(0.363)	(0.065)
Special education	-0.113	0.031
	(0.115)	(0.056)
English learner	1.693***	0.058
	(0.118)	(0.087)
Age (in days)	-3.174***	0.184
	(0.660)	(0.490)
Cohort size	2.031	0.871
	(1.610)	(0.938)
Joint test for balance of observed attributes		
F-stat	7.45	1.38
p-value	0.000	0.160

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The estimated coefficients represent the coefficient on the school-by-grade level migrant share variable (in percentage points) in regressions where the dependent variable is the corresponding student or cohort characteristic with and without school fixed-effects. School-by-grade migrant share is defined as the number of Puerto Rican hurricane migrants who entered the school-grade between September 20, 2017 and the end of 2017-18 school year divided by the number of existing students in the school-grade at the beginning of 2017-18, multiplied by 100. *, **, *** statistical significance at 10, 5, and 1 percent levels. Indicator variables are multiplied by 100.

Table 4 – Effects of Hurricane Migrant Share on Existing Student Test Scores in the First Year, by Grade Level and Student Prior Achievement

	(I)	(II)	(III)
School fixed-effects	No	Yes	Yes
Student and cohort characteristics	No	No	Yes
All students			
Overall	-0.039***	-0.010***	-0.008**
	(0.007)	(0.004)	(0.004)
Elementary school	-0.028***	-0.005	-0.003
	(0.009)	(0.004)	(0.004)
Middle school	-0.049***	-0.018**	-0.015**
	(0.010)	(0.008)	(0.006)
High-performing students			
Overall	-0.030***	-0.016***	-0.014***
	(0.005)	(0.004)	(0.004)
Elementary school	-0.023***	-0.011**	-0.006
	(0.006)	(0.004)	(0.004)
Middle school	-0.037***	-0.029***	-0.031***
	(0.008)	(0.010)	(0.008)
Low-performing students			
Overall	-0.013***	-0.003	-0.001
	(0.005)	(0.005)	(0.005)
Elementary school	-0.004	-0.001	-0.001
	(0.005)	(0.005)	(0.005)
Middle school	-0.019***	-0.004	0.003
	(0.007)	(0.010)	(0.009)

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The first columns presents the coefficient on the migrant share variable (in percentage points) without school fixed-effects, the second column introduces school fixed-effects, and the third column adds the student covariates given in Table 2, along with their averages at the school-by-grade level. *, **, *** represent statistical significance at 10, 5, and 1 percent levels.

Table 5 – Effects of Hurricane Migrant Share on Existing Student Non-Test Outcomes in the First Year, by Grade Level and Student Prior Achievement

	Disciplinary incidents	Absence rate	Left school by 2018-19
All students			
Overall	0.161*	-0.012	0.409***
	(0.084)	(0.022)	(0.127)
	[12.207]	[5.574]	[21.536]
Elementary school	0.000	-0.006	0.431***
	(0.069)	(0.012)	(0.135)
	[5.385]	[4.723]	[23.145]
Middle or high school	0.492*	-0.024	0.774
	(0.269)	(0.090)	(0.498)
	[16.904]	[6.160]	[19.552]
High-performing students			
Overall	0.307**	0.036	2.060**
	(0.129)	(0.023)	(1.046)
	[6.364]	[4.139]	[15.220]
Elementary school	0.184	0.030	1.428
	(0.126)	(0.019)	(0.924)
	[3.950]	[4.315]	[16.758]
Middle or high school	0.794**	0.067	4.057*
	(0.329)	(0.060)	(2.194)
	[7.817]	[4.033]	[13.313]
Low-performing students			
Overall	0.420	-0.058*	1.025
	(0.281)	(0.035)	(0.718)
	[24.678]	[6.069]	[27.225]
Elementary school	0.347	-0.053	1.014
	(0.217)	(0.034)	(0.652)
	[11.246]	[5.539]	[29.454]
Middle or high school	0.400	-0.011	6.518***
	(0.676)	(0.061)	(2.460)
	[30.332]	[6.292]	[25.444]

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The numbers provide the coefficient on the migrant share variable in regressions that control for grade fixed-effects, school fixed-effects, the student attributes given in Table 2, and their averages at the school-by-grade level. The numbers in brackets provide the dependent variable mean for the given subsample. *, **, *** represent statistical significance at 10, 5, and 1 percent levels. Regressions where the dependent variable is the indicator for leaving school before the start of 2018-19 school year exclude students in the terminal grades of their schools. Indicator variables are multiplied by 100.

Table 6 - Effects of Hurricane Migrant Share on Teacher Course Assignments in Middle School in the First Year

	Leave-out-year teacher value-added score	Identified as highly effective in the previous year	Identified as unsatisfactory in the previous year
	By course type		
Remedial courses	0.011**	0.025***	-0.014*
N = 956	(0.005)	(0.008)	(0.008)
Regular courses	0.003	0.010**	-0.002
N = 3,773	(0.003)	(0.005)	(0.007)
Advanced courses	-0.010**	0.003	0.036***
N = 1,542	(0.004)	(0.007)	(0.010)
	By student prior achievement		
High performers	-0.012**	-0.006	-0.012
N = 17,298	(0.005)	(0.012)	(0.019)
Low performers	0.000	0.020**	-0.013
N = 13,576	(0.004)	(0.008)	(0.012)

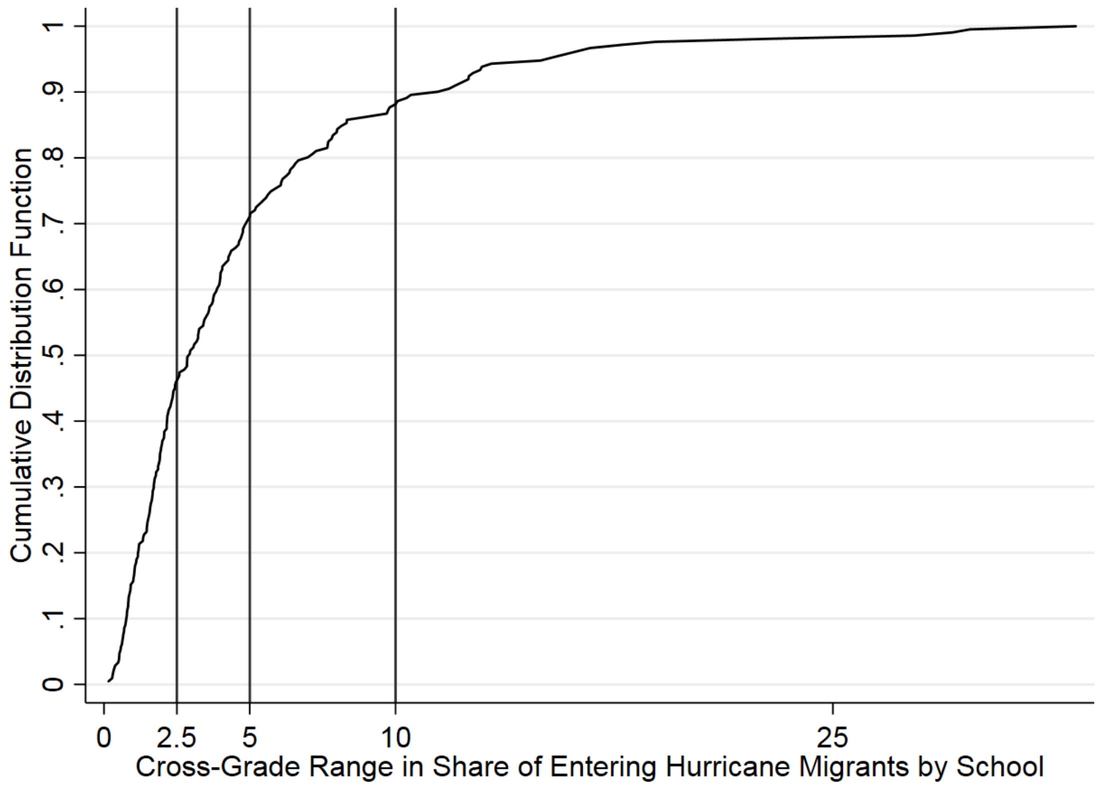
Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The numbers given in the top panel provides the coefficient on the migrant share variable in teacher-by-course level regressions (where the outcome variable is the given teacher quality measure) that control for grade and school fixed-effects, and student attributes given in Table 2 averaged at the school-by-grade level. The numbers given in the bottom panel provides the coefficient on the migrant share variable in student-level regressions (where the outcome variable is the given teacher quality measure averaged over all ELA and math courses of the student) that control for grade and school fixed-effects, student attributes given in Table 2, and their averages at the school-by-grade level. *, **, *** represent statistical significance at 10, 5, and 1 percent levels.

Table 7 – Effects of Hurricane Migrant Share on the Second Year Outcomes of Existing Student Outcomes, by Grade Level and Student Prior Achievement

		Test scores	Disciplinary incidents	Absence rate
All students				
	Overall	0.001	0.064	0.010
		(0.004)	(0.096)	(0.016)
			[12.851]	[5.607]
	Elementary school	0.002	0.056	0.008
		(0.005)	(0.096)	(0.013)
			[8.182]	[4.616]
	Middle or high school	0.005	0.149	0.042
		(0.007)	(0.294)	(0.062)
			[16.613]	[6.406]
High-performing students				
	Overall	0.001	0.304*	0.050*
		(0.005)	(0.160)	(0.029)
			[7.683]	[4.230]
	Elementary school	0.005	0.197	0.037
		(0.005)	(0.183)	(0.030)
			[6.167]	[4.076]
	Middle or high school	-0.024**	0.654*	0.105
		(0.010)	(0.356)	(0.068)
			[8.531]	[4.316]
Low-performing students				
	Overall	0.001	-0.001	-0.004
		(0.006)	(0.334)	(0.046)
			[27.115]	[6.329]
	Elementary school	-0.003	0.070	0.006
		(0.007)	(0.369)	(0.045)
			[20.605]	[5.592]
	Middle or high school	0.025***	-0.032	0.033
		(0.010)	(0.604)	(0.093)
			[30.484]	[6.710]

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The numbers provide the coefficient on the migrant share variable in regressions that control for grade fixed-effects, school fixed-effects, the student attributes given in Table 2, and their averages at the school-by-grade level. The numbers in brackets provide the dependent variable mean for the given subsample. *, **, *** represent statistical significance at 10, 5, and 1 percent levels. *, **, *** represent statistical significance at 10, 5, and 1 percent levels. Indicator variables are multiplied by 100.

Appendix Figure 1 – Distribution of the Cross-Grade Range in Puerto Rican Migrant Share by School



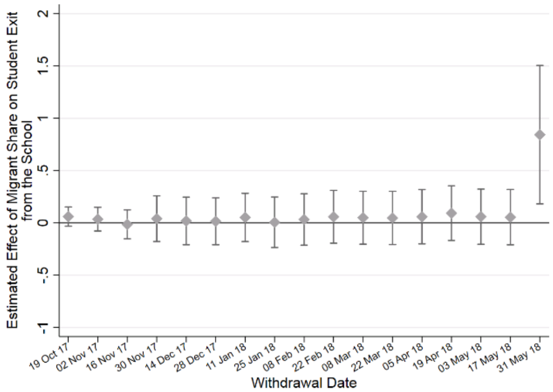
Notes: Figure presents the cumulative distribution of the cross-grade range in the share of Puerto Rican hurricane migrants by school. The migrant share is multiplied by 100.

Appendix Figure 2 – The Effects of Migrant Share on Student Mobility During the 2017-18 School Year

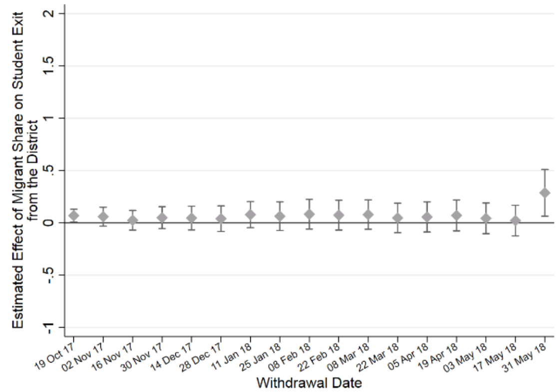
Outcome: Left the School in 2017-18 School Year by Withdrawal Date	Outcome: Left the District in 2017-18 School Year by Withdrawal Date

All Students

(A)

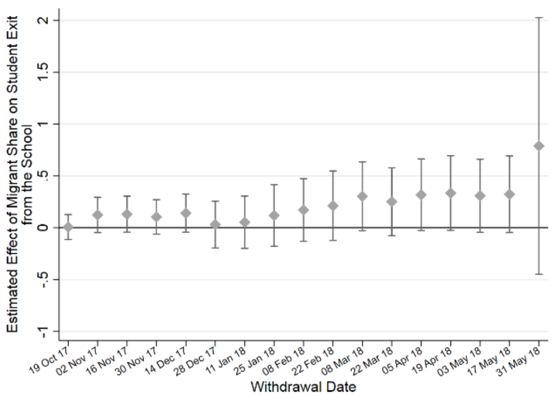


(B)

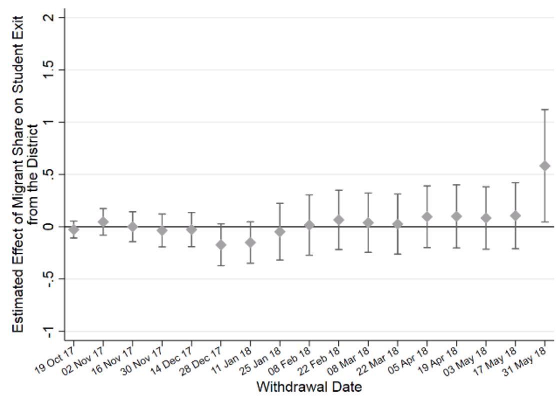


High-Performing Students in Middle School

(C)

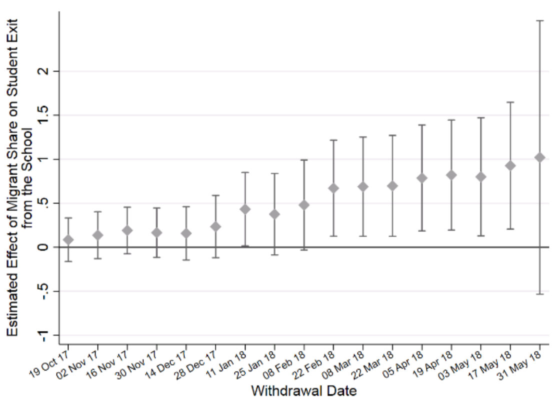


(D)

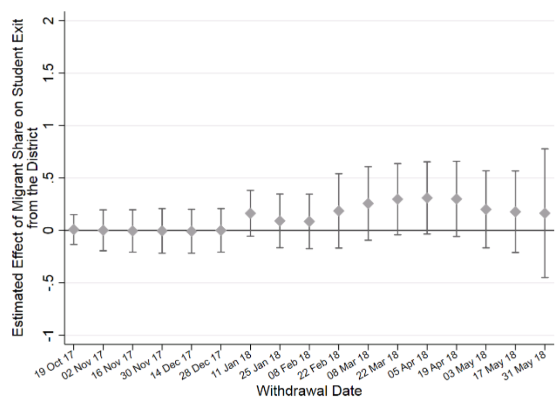


Low-Performing Students in Middle School

(E)



(F)



Notes: Each bar in Panel A presents the estimated coefficient (along with the 95% confidence interval) on the migrant share variable (using Equation (1)) in regressions where the dependent variable is an indicator that equals 1 if the student left the school they attended at the beginning of 2017-18 school year by the date given on the x-axis (the last entry on the x-axis represents the end of school year). Panel B repeats the same analysis replacing the outcome with an indicator that equals 1 if the student left the district by the date given on the x-axis. Panels (C) and (D) repeat the same analysis for high-performing middle school students who were proficient in both subjects in the previous school year whereas Panels (E) and (F) use the sample of low-performing middle school students who were not proficient in both subjects. Regressions exclude students who were in the terminal grades of their schools.

Appendix Table 1 – Estimated Associations between Existing Student Characteristics and the Share of Age-Appropriate Hurricane Migrants by School-Grade

	(I)	(II)
School fixed-effects	No	Yes
Prior year outcomes		
ELA score	-0.042***	0.005
	(0.008)	(0.004)
Math score	-0.036***	0.007
	(0.009)	(0.006)
Disciplinary incident	-0.111	-0.005
	(0.125)	(0.111)
% absent days (0-100)	0.181***	-0.056***
	(0.028)	(0.016)
Other student characteristics		
Born in Puerto Rico	1.368***	-0.043
	(0.086)	(0.051)
White	-2.525***	0.004
	(0.217)	(0.080)
Black	-2.806***	-0.125*
	(0.276)	(0.074)
Hispanic	5.572***	0.097
	(0.266)	(0.090)
Male	0.050	-0.016
	(0.064)	(0.097)
English non-native	4.008***	0.059
	(0.203)	(0.095)
U.S. born	-0.429***	-0.040
	(0.111)	(0.059)
Received subsidized meals	4.582***	-0.011
	(0.403)	(0.074)
Special education	-0.177	0.053
	(0.131)	(0.064)
English learner	1.940***	0.044
	(0.131)	(0.104)
Age (in days)	-3.957***	0.254
	(0.787)	(0.576)
Cohort size	4.366**	1.337
	(2.138)	(1.421)

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The estimated coefficients represent the coefficient on the age-appropriate hurricane migrant share variable (in percentage points) in regressions where the dependent variable is the corresponding student or cohort characteristic with and without school fixed-effects. Age-appropriate migrant share is defined as the number of Puerto Rican hurricane migrants who are age-appropriate for the grade in which they are placed divided by the number of existing students in the school-grade at the beginning of 2017-18, multiplied by 100. *, **, *** statistical significance at 10, 5, and 1 percent levels. Indicator variables are multiplied by 100.

Appendix Table 2 – Effects of Hurricane Migrant Share on Existing Student Outcomes in the First Year, by Grade Level and Student Prior Achievement, 2SLS Estimates

	Test scores	Disciplinary incidents	Absence rate	Left school by 2018-19
All students				
Overall	-0.007	0.265**	-0.004	0.644***
	(0.004)	(0.113)	(0.022)	(0.178)
		[12.207]	[5.574]	[21.536]
Elementary school	0.004	0.089	-0.008	0.585***
	(0.004)	(0.084)	(0.016)	(0.180)
		[5.385]	[4.723]	[23.145]
Middle or high school	-0.019**	0.495	0.027	2.227***
	(0.008)	(0.379)	(0.072)	(0.787)
		[16.904]	[6.160]	[19.552]
High-performing students				
Overall	-0.015***	0.473**	0.057**	1.791
	(0.005)	(0.197)	(0.028)	(1.247)
		[6.364]	[4.139]	[15.220]
Elementary school	0.001	0.352**	0.038	2.660**
	(0.004)	(0.174)	(0.024)	(1.206)
		[3.950]	[4.315]	[16.758]
Middle or high school	-0.043***	1.013**	0.101	4.939**
	(0.011)	(0.481)	(0.068)	(2.445)
		[7.817]	[4.033]	[13.313]
Low-performing students				
Overall	0.003	0.180	-0.054	1.156
	(0.007)	(0.434)	(0.046)	(0.966)
		[24.678]	[6.069]	[27.225]
Elementary school	0.008	0.288	-0.083*	1.921**
	(0.006)	(0.298)	(0.043)	(0.836)
		[11.246]	[5.539]	[29.454]
Middle or high school	-0.000	-0.270	-0.007	4.952*
	(0.011)	(0.885)	(0.082)	(2.932)
		[30.332]	[6.292]	[25.444]

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The number provided present the 2SLS results instrumenting for the migrant share variable with the age-appropriate migrant share variable. All regressions include grade and school fixed-effects, student attributes given in Table 2, and their averages at the school-by-grade level. F-stats of the excluded instrument range between 36 and 761. *, **, *** represent statistical significance at 10, 5, and 1 percent levels. Regressions where the dependent variable is the indicator for leaving school before the start of 2018-19 school year exclude students in the terminal grades of their schools. The numbers in brackets provide the dependent variable mean for the given subsample. Indicator variables are multiplied by 100.

Appendix Table 3 – The Pseudo Effects of Hurricane Migrant Share on Existing Student Outcomes in 2016-17

	Test scores	Disciplinary incidents	Absence rate	Left school by 2017-18
All students				
Overall	-0.004	0.074	0.028	-0.175
	(0.004)	(0.100)	(0.019)	(0.131)
		[12.401]	[6.116]	[21.171]
Elementary school	-0.002	0.081	0.014	-0.155
	(0.004)	(0.093)	(0.011)	(0.131)
		[5.831]	[4.935]	[22.573]
Middle or high school	0.000	0.098	0.045	-0.817*
	(0.008)	(0.278)	(0.062)	(0.433)
		[17.023]	[6.946]	[19.528]
High-performing students				
Overall	-0.006	-0.003	0.014	0.146
	(0.005)	(0.200)	(0.020)	(1.757)
		[6.556]	[4.104]	[14.192]
Elementary school	-0.005	0.162	-0.012	-2.414
	(0.005)	(0.179)	(0.020)	(1.689)
		[4.082]	[3.924]	[14.957]
Middle or high school	-0.003	-0.140	0.035	1.835
	(0.010)	(0.407)	(0.045)	(2.089)
		[7.952]	[4.206]	[13.352]
Low-performing students				
Overall	-0.001	0.449	0.056*	-0.200
	(0.005)	(0.276)	(0.032)	(0.468)
		[24.148]	[6.405]	[23.248]
Elementary school	0.004	0.689***	-0.005	-0.832
	(0.006)	(0.225)	(0.034)	(0.609)
		[12.136]	[5.469]	[24.904]
Middle or high school	0.001	0.106	0.092	2.332
	(0.010)	(0.626)	(0.067)	(1.411)
		[30.339]	[6.888]	[21.936]

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The estimated represent the coefficient on the migrant share variable (in percentage points) assigned to students in school *s* and grade *g* in 2016-17 school year in regressions where the outcome is the corresponding outcome of interest in 2016-17 controlling for grade and school fixed-effects, student attributes listed in Table 2, and their averages at the school-by-grade level. The second and third panels repeats the same analysis for high-performing students who were proficient in both subjects and low-performing students who were not proficient in both subjects in 2015-16 school year. *, **, *** statistical significance at 10, 5, and 1 percent levels. Indicator variables are multiplied by 100. The numbers in brackets provide the dependent variable mean for the given subsample. Regressions where the dependent variable is the indicator for leaving school before the start of 2017-18 school year exclude students in the terminal grades of their schools.

Appendix Table 4 – Estimated Associations between Existing Student Characteristics and School-by-Grade Hurricane Migrant Share, Conditional on Staying in the District in 2018-19 School Year

Prior year outcomes	
ELA score	0.004
	(0.004)
Math score	0.004
	(0.006)
Disciplinary incident	0.013
	(0.091)
% absent days (0-100)	-0.039***
	(0.014)
Other student characteristics	
Born in Puerto Rico	-0.048
	(0.045)
White	0.013
	(0.070)
Black	-0.051
	(0.064)
Hispanic	0.028
	(0.081)
Male	-0.020
	(0.094)
English non-native	0.010
	(0.085)
U.S. born	0.007
	(0.056)
Received subsidized meals	0.062
	(0.064)
Special education	0.020
	(0.064)
English learner	0.072
	(0.096)
Age (in days)	0.034
	(0.468)
Cohort size	1.656
	(1.432)

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The estimated coefficients represent the coefficient on the migrant share variable (in percentage points) in regressions where the dependent variable is the corresponding student or school-by-grade characteristic for students who stayed in the district until in 2018-19 school year. School-by-grade migrant share is defined as the number of Puerto Rican hurricane migrants who entered the school-grade between September 20, 2017 and the end of 2017-18 school year divided by the number of existing students in the school-grade at the beginning of 2017-18, multiplied by 100. *, **, *** statistical significance at 10, 5, and 1 percent levels. Indicator variables are multiplied by 100.

Appendix Table 5 – Estimated First and Second Year Effects of Migrant Share on Existing Student Test Scores in Middle School with Imputed Test Scores for Attriters

	All students	High performers	Low-performers
	Effects in 2017-18 School Year		
Imputed value…			
None	-0.016**	-0.032***	0.002
	(0.007)	(0.009)	(0.009)
2016-17 year score	-0.014**	-0.030***	0.002
	(0.006)	(0.008)	(0.009)
Prior 3-year average	-0.015**	-0.030***	0.002
	(0.006)	(0.008)	(0.009)
Prior 3-year maximum	-0.014**	-0.030***	0.002
	(0.007)	(0.008)	(0.009)
Prior 3-year minimum	-0.015**	-0.029***	0.002
	(0.006)	(0.008)	(0.008)
	Effects in 2018-19 School Year		
Imputed value…			
None	0.005	-0.024**	0.025***
	(0.007)	(0.010)	(0.010)
2017-18 year score	-0.010	-0.034***	0.004
	(0.009)	(0.010)	(0.011)
Prior 4-year average	-0.005	-0.027***	0.005
	(0.007)	(0.009)	(0.010)
Prior 4-year maximum	-0.005	-0.027***	0.005
	(0.007)	(0.009)	(0.010)
Prior 4-year minimum	-0.006	-0.025***	0.002
	(0.008)	(0.009)	(0.011)

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The estimated coefficients represent the coefficient on the migrant share variable (in percentage points) in test score regressions where students who left the sample before being tested in 2017-18 (upper panel) or 2018-19 (lower panel) are assigned the corresponding test score based on their test score history. All regressions control for grade and school fixed-effects, student attributes listed in Table 2, and their averages at the school-by-grade level. *, **, *** statistical significance at 10, 5, and 1 percent levels.

Appendix Table 6 – Differential Effects of Hurricane Migrant Share on Existing Middle School Student Test Scores in the First Year, by Existing Student Prior Achievement and Migrant Educational Needs

	All students	Low performers	High performers
By migrant English learner status			
Migrant share * % English learner	-0.082***	-0.020	-0.123***
	(0.024)	(0.029)	(0.029)
Migrant share	0.057***	0.023	0.076***
	(0.021)	(0.025)	(0.026)
By migrant special education status			
Migrant share * % special education	-0.068**	-0.018	-0.115***
	(0.028)	(0.038)	(0.040)
Migrant share	0.004	0.009	-0.000
	(0.010)	(0.014)	(0.014)

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The estimated coefficients represent the coefficient on the migrant share variable (in percentage points) and its interaction with the share of migrants who are identified as English learners (upper panel) or special education students (lower panel) in school s and grade g at the time of their entry into the district. All regressions control for grade and school fixed-effects, student attributes listed in Table 2, and their averages at the school-by-grade level. *, **, *** statistical significance at 10, 5, and 1 percent levels.

Appendix Table 7 – The Effects of Hurricane Migrant Share on Existing Student Outcomes in 2017-18, Conditional on Observing the Relevant Outcome in 2018-19, by Grade Level and Student Achievement in 2016-17

		Test scores	Disciplinary incidents	Absence rate
All students				
	Overall	-0.008**	0.120	-0.020
		(0.004)	(0.083)	(0.012)
			[9.721]	[4.558]
	Elementary school	-0.003	0.000	-0.016
		(0.004)	(0.069)	(0.012)
			[5.382]	[4.515]
	Middle or high school	-0.015**	0.852*	-0.013
		(0.006)	(0.441)	(0.044)
			[16.579]	[4.626]
High-performing students				
	Overall	-0.013***	0.364**	0.024
		(0.004)	(0.145)	(0.022)
			[5.804]	[3.986]
	Elementary school	-0.005	0.210	0.016
		(0.004)	(0.133)	(0.022)
			[3.925]	[4.185]
	Middle or high school	-0.031***	1.082***	0.059
		(0.008)	(0.356)	(0.060)
			[7.265]	[3.831]
Low-performing students				
	Overall	0.000	0.534*	-0.009
		(0.005)	(0.301)	(0.036)
			[22.317]	[5.570]
	Elementary school	-0.000	0.421*	-0.023
		(0.006)	(0.255)	(0.034)
			[11.341]	[5.361]
	Middle or high school	0.005	0.570	0.022
		(0.009)	(0.715)	(0.061)
			[28.318]	[5.684]

Notes: Standard errors, clustered at the school-by-grade level, are given in parentheses. The estimated represent the coefficient on the migrant share variable (in percentage points) for the corresponding outcome of interest in the first year conditional on observing the student in the sample in 2018-19 school year. The numbers in brackets provide the dependent variable mean for the given subsample. All regressions control for grade and school fixed-effects, student attributes listed in Table 2, and their averages at the school-by-grade level. *, **, *** represent statistical significance at 10, 5, and 1 percent levels. Regressions where the dependent variable is the indicator for leaving school before the start of 2018-19 school year exclude students in the terminal grades of their schools. Indicator variables are multiplied by 100.

[i] For example, a recent World Bank report concludes that climate change could force more than 143 million people to move within their countries by 2050 in just three regions of the world: Sub-Saharan Africa, South Asia and Latin America (Kumari Rigaud et al. 2018).
[ii] These weather and climate disasters include droughts, freezes, tropical cyclones, wildfires, winter storms, severe storms, and flooding.

[iii] As of this writing, the most recent example of internal migration driven by a severe natural disaster in the United States was the migration in the aftermath of the Camp Fire in California where an estimated 20,000 people relocated to Chico, California from the nearby town of Paradise in Fall 2018 (https://www.npr.org/2019/01/14/685137701/in-the-aftermath-of-the-camp-fire-a-slow-simmering-crisis-in-nearby-chico?, accessed 1/15/19).
[iv] A recent study by Kishore et al. (2018) estimates nearly 3,000 deaths related to Hurricane Maria in Puerto Rico from September 20 through December 31, 2017.
[v] See Hinojosa, Román, and Meléndez (2018).
[vi] https://www.flgov.com/2018/05/18/gov-scott-education-commissioner-pam-stewart-to-visit-puerto-rico-offer-continued-assistance-to-displaced-students/, accessed on 11/26/2018.
[vii] For example, there is evidence in the literature suggesting that refugees generally are more impoverished with lower earnings than economic migrants, and have lower levels of education and language skills when they arrive (Connor, 2010; Potocky-Tripodi, 2004). To the best of my knowledge, there is no study to date that examines selection in internal migration driven by severe natural disasters.
[viii] For example, roughly 40 percent of Haitian earthquake migrants left Florida public schools within 18 months after the earthquake (Figlio and Özek, 2019).
[ix] Throughout the remainder of the paper, I use FSA scores in ELA and math standardized to zero mean and unit variance at the grade-year level in the test score analysis.
[x] I also check the accuracy of this measure of Puerto Rican hurricane migrants using the "hurricane migrant" flag created by the district in school records, and reach almost identical numbers.
[xi] In this study, I focus on Hurricane Maria migrants from Puerto Rico, yet it is important to note that there were also students from U.S. Virgin Islands who entered the anonymous district after the hurricane. That said, Puerto Rican migrants constitute the overwhelming majority of the Hurricane Maria migrants in the district – only 300 students from U.S. Virgin Islands entered the district after the hurricane compared to nearly 4,000 students from Puerto Rico. It is also important to note that the main results presented below are robust to the inclusion of hurricane migrants from U.S. Virgin Islands.
[xii] It is important to note that it is harder to use "receiving subsidized meals" as a measure of student socioeconomic status in our data because of the United States Department of Agriculture's (USDA) recently implemented community eligibility provisions (CEP), which allow high poverty schools to provide free meals to all enrolled students without collecting household applications. As such, it is hard to compare the socioeconomic status of Puerto Rican migrants (as proxied by free or reduced priced lunch eligibility) with that of Katrina evacuees or Haitian earthquake refugees. 44 percent of Puerto Rican hurricane migrants who were identified as free or reduced price lunch eligible in our sample received free meals via schoolwide designations. For more information on CEPs, see Domina et al. (2017).
[xiii] This divergence in outcomes could partially be explained by differential attrition at the end of the first year. Hurricane migrants who left the district at the end of the first year had significantly lower ELA scores (0.11σ) (yet similar math scores) compared to the hurricane migrants who stayed. The former group also had higher absence rates. In contrast, differential attrition was less pronounced among Puerto Rican migrants in prior years – migrants who left the district before the beginning of the second year had similar test scores compared to those who stayed.
[xiv] The difference in disciplinary incident rates could be explained by the common finding in the literature suggesting that immigrant students are less likely to have disciplinary problems than natives (e.g., Figlio and Özek, 2020a).
[xv] Based on anecdotal evidence (e.g., media reports), many hurricane migrants stayed with their relatives who were already in the district at the time of the hurricane and some have arranged temporary housing in hotels or rental units. As a result of the migrant influx, the number of students in the district living in unstable housing circumstances (e.g., living in an emergency or transitional shelter; living in shared housing due to loss of housing or economic hardship; living in cars, parks, campgrounds, public spaces, abandoned buildings, substandard housing, bus or train stations; or living in a hotel or motel) increased by 58 percent in 2017-18 school year.
[xvi] School migrant share is defined as the number of Puerto Rican hurricane migrants who entered the school between September 20, 2017 and the end of 2017-18 school year divided by the number of existing students in the school at the beginning of 2017-18, multiplied by 100.
[xvii] These include, but are not limited to, Carrell and Hoekstra (2010, 2012), Carrell, Hoekstra, and Kuka (2018), and Figlio and Özek (2019).
[xviii] It is important to note that, while this empirical strategy accounts for endogenous sorting of migrants across schools, an important shortcoming is that the estimates fail to capture any potential effects of resource reallocation across schools. That said, given the unexpected nature of the influx and based on my conversations with the district,

schools did not receive any additional funding in the first year. Therefore, I do not expect across-school resource reallocation to have a major effect on student outcomes in the first year.

[xix] I normalize test scores at the year-by-grade level using all tested students (including the migrants), which could lead to an increase in the test scores of students in grades that received more migrants as these migrants had significantly lower test score. That said, in all specifications I control for grade fixed-effects which account for such discrepancies across grades.

[xx] The "Left school before the start of 2018-2019" variable is an indicator that equals 1 if (a) the student left the district before the start of 2018-19 school year or (b) stayed in the district but moved to another school before the start of 2018-19 school year. As such, it captures both within school-year student mobility (i.e., students who left the school during the 2017-18 school year) and those who left the school during the summer after the 2017-18 school year. The overwhelming majority of the variation in this mobility indicator comes from students leaving their schools after the 2017-18 school year – roughly 80% of the students who left their schools before the start of 2018-19 school year left after the end of 2017-18 school year.

[xxi] For example, as I describe in detail below, LUSD requires middle school students who score below the proficient level on prior year ELA tests to take a remedial ELA course in addition to the regular ELA course.

[xxii] Florida Department of Education classifies student test scores into 5 distinct categories, with 1 being the lowest level of achievement. Students who score in achievement levels 3 or higher are considered proficient in the corresponding subject.

[xxiii] Disciplinary incidents are less common at the elementary level in LUSD than in middle and high school. In particular, only 5 percent of the elementary school students were involved in a disciplinary incident in 2017-18 school year compared to 19 percent of middle and high school students.

[xxiv] It is important to note that the increase in disciplinary incident rates could be driven by changes in student behavior or changes in enforcement following the migrant influx. While it is hard to identify which mechanism is at play here given administrative data limitations, I examine the effect of migrant share on different types of referral action (i.e., what action was taken once the student was involved in a disciplinary incident) in middle and high school for high-performing students. The results indicate that an increase in migrant share also significantly increases the likelihood of receiving an in-school or out-of-school suspensions that are typically reserved for more serious incidents for these students. The results of this analysis are available from the author upon request.

[xxv] One possible, albeit unlikely, mechanism that might drive the effects on high-performing students is regression to the mean where high-performing students in school cohorts (i.e., students in the same school and grade) that received a larger share of migrants experience regression to the mean (that is unrelated to the influx) to a larger extent than students in other grades in the same school. If this is the case, one would expect a similar "effect" on high-performing students in the same school-grade in the previous school year. The bottom panel of Appendix Table 3 checks this hypothesis and repeats the falsification exercise using only the students who were proficient in both ELA and math in 2015-16 school year. The results reveal no significant "effect" on migrant share in 2017-18 on the outcomes of high-performing students in 2016-17, refuting this possibility.

[xxvi] For example, in 2017-18 school year, 98 percent of middle school students in LUSD who were proficient in both subjects took at least one advanced course in ELA or math while this number was 21 percent for low-performing students.

[xxvii] This difference is primarily driven by the influx of migrant students into remedial and regular courses: only 20 percent of the hurricane migrants took an advanced ELA or math course.

[xxviii] Based on anecdotal evidence and conversations with the district, reallocation of financial resources is unlikely to have played a major role in the first year. Besides, since I exploit within-school, across-grade variation in this study, the estimated effects do not capture any potential effects of cross-school resource reallocation following the migrant influx.

[xxix] I use the STATA command *vam* to estimate teacher value-added scores using student data linked to their teachers in middle school between 2005-06 and 2018-19 in LUSD. For more information on the procedure, please see Appendix A and B in Chetty, Friedman, and Rockoff (2014).

[xxx] Under LUSD's instructional personnel evaluation system, teachers' overall performance rating is determined by their instructional practice scores (67%) and value-added scores (33%). Teachers are classified into four distinct categories based on their value-added scores: (1) highly effective; (2) effective; (3) needs improvement; and (4) unsatisfactory. In the sample used in this analysis, roughly 5 percent of the teachers were rated as "highly effective" in the previous year and 6 percent were rated as "unsatisfactory" in the previous year.

[xxxi] Given that a 5 percentage point increase in migrant share reduces the test scores of high-performing middle school students by 0.15σ (Table 4), a 0.06σ decline in teacher quality represents 40 percent of the total effect of migrant share on high-performing middle school students. To better understand the potential long-term effects of

this reallocation, consider Chetty, Friedman, and Rockoff (2014) who finds that replacing a teacher in the bottom 5 percent of the value-added distribution with an average teacher for one year increases the present discounted value of earnings of students in that classroom by $250,000. Based on the estimates in the bottom panel of Table 6, a 15 percentage point increase in migrant share leads to a decline in teacher value-added similar to (in magnitude) the one considered by Chetty, Friedman, and Rockoff (2014).

[xxxii] For example, school districts in Florida received $95.8 million in federal reimbursements to cover costs of taking in the Puerto Rican migrants in the aftermath of Hurricane Maria at the beginning of 2018-19 school year.