Viral Change: Trends in Michigan Teacher Attrition and Mobility Before and During the COVID-19 Pandemic

June 12, 2023

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Abstract: The COVID-19 pandemic has raised even greater concerns about a growing teacher shortage. In this study, we use administrative data on more than 140,000 Michigan traditional public and charter school teachers in an interrupted time series framework to understand how teacher attrition and supply may have shifted after the onset of the COVID-19 pandemic. Our results suggest that Michigan teachers were more likely to leave the profession, less likely to leave their districts, and more likely to switch schools within their district after the 2020-21 and 2021-22 school years relative to pre-pandemic trends. Additionally, teachers in low COVID-19 rate communities, as well as those in districts that offered fully in-person instruction at the start of the 2020-21 school year, were more likely to leave the teaching profession or switch districts following the 2019-20 school year compared to teachers in fully remote districts.

Acknowledgements: We greatly appreciate feedback from audiences at the Association for Public Policy Analysis and Association for Education Finance and Policy annual meetings. The research reported here was supported by the Research on Education Access and Choice (REACH) private philanthropy to the Education Policy Innovation Collaborative.

This research result used data structured and maintained by the MERI-Michigan Education Data Center (MEDC). MEDC data is modified for analysis purposes using rules governed by MEDC and are not identical to those data collected and maintained by the Michigan Department of Education (MDE) and/or Michigan's Center for Educational Performance and Information (CEPI). Results, information, and opinions solely represent the analysis, information, and opinions of the author(s) and are not endorsed by, or reflect the views or positions of, grantors, MDE, and CEPI or any employee thereof.

This research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305C180025 to The Administrators of the Tulane Educational Fund. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

1. Introduction

Educators and policymakers across the country have been raising alarms about a growing teacher shortage (Mauriello & Higgins, 2022; Natanson, 2022; Schmitt & deCourcy, 2022). In Michigan, where this study is situated, teacher shortages were so severe in the 2018-19 academic year that 2,500 classrooms were staffed by long-term substitutes[1] – nearly ten times the number placed in classrooms five years prior (French & Wilkinson, 2019; Vakil, 2020). Such a high rate of vacancies is likely due to multiple factors, prominent among them the diminishing supply of new teacher graduates; between academic years 2011-12 and 2017-18, both enrollment in and completion of Michigan teacher preparation programs declined by more than 60 percent (USDOE, 2019). In addition, teacher attrition has been steadily increasing in Michigan; the proportion of teachers leaving their districts increased from 5.2 percent in 2010-11 to 8.2 percent in 2018-19 (Hopkins, Kilbride, & Strunk, 2021b).

As is the case across the country, teacher staffing challenges have been particularly acute in certain kinds of Michigan school districts and for certain types of teachers. For instance, in 2018-19, approximately 12 percent of teachers exited districts with the highest proportions of Black and economically disadvantaged students relative to 7 percent in districts with the fewest of these students. Similarly, while the overall quantity of teachers in Michigan has decreased by approximately 1.5 percent between 2010-11 and 2018-19, the number of teachers with math or science endorsements has diminished by almost six and seven percent, respectively, while the number of teachers with special education endorsements has decreased by more than 12 percent (Hopkins, Kilbride, et al., 2021b). Given these trends, Michigan has been reporting critical

[1] In Michigan, individuals with as little as 60 college credits in any subject can be hired as a long-term substitute and staff a classroom for up to one full academic year. This requirement was notably waived for existing school employees who could be hired as a substitute teacher, provided they have a high school diploma for the spring of the 2021-2022 school year under House Bill 4294.

teacher shortages in career and technical education, special education, elementary education, and science (Breen, 2020).

The COVID-19 pandemic has raised even greater concerns about the supply of teachers. A survey administered to Michigan educators by the Michigan Education Association (MEA) in summer 2020 found that 32 percent of 15,000 respondents considered leaving public education or retiring earlier than planned due to the pandemic, while eight percent had already decided to leave (Kimball, 2020). At the same time, an EDUStaff survey of 6,400 substitute teachers in Michigan found that 22 percent did not want to return to teaching in the 2020-21 school year (Krafcik, 2020).[2] Another survey of more than 7,000 Michigan educators administered in fall 2020 that found that 46 percent of Michigan teachers considered leaving the teaching profession as result of concerns related to the pandemic and 37 percent of teachers considered leaving their districts (Hopkins et al., 2021).

While data from these surveys raise substantial concerns about all Michigan schools' and districts' abilities to recruit and retain teachers in the aftermath of the pandemic, it is likely that pandemic-induced staffing challenges varied across teachers, schools, and districts. In particular, given that the pandemic took a greater health and economic toll on the same communities that were already experiencing greater difficulties with recruiting and retaining teachers, it seems plausible that pre-pandemic inequities in staffing challenges were exacerbated by the pandemic (McIlwain & Harbatkin, 2021; Strunk, Harbatkin, et al., 2022). In addition, staffing challenges may have varied across districts that chose to operate using different instructional modalities (i.e., remote, in-person, or hybrid) during the 2020-21 school year and by school governance model (i.e., traditional public schools relative to charter schools) given disparities in contract and

[2] Additionally, the EDUStaff survey found that, among substitutes that wanted to return to teach, most preferred to teach in the classroom (89 percent) and they were willing to be trained in virtual instruction (84 percent).

other protections offered to teachers in these schools. Moreover, given the particular shortage of teachers with different endorsements, and the need for more teachers of color who reflect Michigan's public school student population (Barrett, 2021; Drake & Cowen, 2021), it seems likely that teachers with these credentials and characteristics may have responded differently to pandemic shocks.

In this study, we use administrative data on more than 140,000 Michigan traditional public and charter school teachers in an interrupted time series (ITS) framework to understand how teacher attrition and supply may have shifted after the onset of the COVID-19 pandemic. In particular, we ask: 1) How have teachers' propensities to leave the Michigan public school system, switch districts, or switch schools shifted since the onset of the COVID-19 pandemic?; 2) Are these trends different across teachers who taught in communities that were disproportionately impacted by the COVID-19 pandemic or those who taught in a remote or hybrid setting (relative to in-person) during the 2020-21 school year?; and 3) Do these patterns differ across teachers with varying demographic characteristics and credentials, those assigned to schools with different student populations or districts in different locales, and teachers at traditional public schools compared to charter schools?

Our results suggest that Michigan teachers were *more* likely to leave the profession, *less* likely to leave their districts, and *more* likely to switch schools within their district after the 2020-21 and 2021-22 school years relative to pre-pandemic trends. We also find significant heterogeneity across teachers with different demographic characteristics and those working in different types of schools, districts, and communities.

In the remainder of the paper, we first provide a brief review of the literature on teacher attrition and mobility trends during the pandemic. We then describe the Michigan public school

employee-level data and our methods of estimating mobility and attrition trends during the pandemic. The fourth section describes our results. The fifth section concludes with a discussion of results and implications for policymakers.

2. Relevant Literature

A large literature addresses both the national changes in, and drivers of, teacher attrition and mobility over the past several decades, documenting a national turnover rate ranging between 5.1% and 8.4% in the years since such data have been available (Carver-Thomas & Darling-Hammond, 2019). While understanding these aggregate trends are important, focusing on national averages alone can obscure the fact that turnover rates vary dramatically along several dimensions of teacher, job, and regional characteristics. For example, non-White teachers experience higher turnover rates than their White peers (e.g., Carver-Thomas, 2018; Easton-Brooks, 2014; Ingersoll & May, 2011). Meanwhile, attrition rates are higher among novice teachers than their mid-career counterparts (Clandinin et al., 2015; Cowen et al., 2018; Ingersoll, 2003). Turnover also varies by locale, where urban schools and districts tend to experience high turnover rates as do rural districts (Carver-Thomas & Darling-Hammond, 2017; Cowen et al., 2018; Nguyen, 2020).

While these pre-pandemic data are important to understand long-term trends in the teacher labor market, the COVID-19 pandemic may have affected both the overall turnover rate as well as the patterns across different teacher and job setting characteristics. First, teachers in communities that were disproportionately impacted by the COVID pandemic may have made and continue to make different mobility decisions. In particular, potential changes in teacher attrition are likely to be more acute in school districts with higher COVID-19 test-positivity, infection, and death rates during the brunt of the pandemic. Counties and districts with higher

COVID-19 rates were often subjected to more stringent or extended safety protocols (Executive Orders, 2020). Health concerns may have been more prominent among teachers assigned to schools in these areas and, thus, may have impacted teachers' employment decisions. Importantly, the communities most impacted by the virus are also those that have traditionally faced the greatest difficulties with teacher staffing—those in urban areas and with the greatest proportions of low-income, Black and Latino student populations (Garcia & Weiss, 2019).

Teacher mobility decisions also may have been impacted by districts' instructional modalities. For instance, at the beginning of the 2020-21 school year, 58 percent of Michigan districts offered fully in-person instruction, 17 percent offered hybrid instruction, and 23 percent of districts offered only remote instruction. By May of 2021, 74 percent of districts offered fully in-person instruction, 19 percent offered hybrid, and only 5 percent offered only fully remote instruction (Hopkins, Kilbride, & Strunk, 2021a). Decisions about which modalities to offer and whether teachers should be required to teach in person were often fraught, as educators expressed substantial concerns both about the safety of returning to in-person instruction, especially before teachers could become vaccinated, and the difficulties for both themselves and their students should they remain virtual (Dodge, 2020; French, 2020; Heubeck, 2020). At the same time, many parent groups and politicians expressed outrage at the closure of school buildings and the likely adverse effects of remote learning on student achievement and mental health (Higgins, 2021; Mauger, 2020). This challenging context may have impacted teachers' employment decisions if, for example, a school's chosen instructional modality increased the possibility that teachers were at risk of contracting the coronavirus or made teachers feel more or less supported by their administrations and communities.

There also is reason to believe that certain kinds of teachers, in particular those certified to teach students with disabilities and English learners, were more impacted by the pandemic. Although there has been less discussion about differential effects of the pandemic on teachers with varied endorsements (see Barry & Sass, 2023; Bruno, 2023), survey data from the fall of 2020 suggest that Michigan teachers were especially concerned about the impacts of the pandemic on students with disabilities and on English learners (Hopkins et al., 2021). These teachers were at times unable to provide the services their students required and were often frustrated by their inability to meet students' increasing needs during the pandemic. This sense of inefficacy may have contributed to differential mobility decisions. In addition, given that there were critical shortages of special education, English learner, and STEM teachers prior to the pandemic (Citizen's Research Council of Michigan, 2019), teachers with these endorsements may have faced different employment opportunities during and coming out of the pandemic, thus impacting their job decisions.

In addition, there may have been increased churn between traditional public and charter schools as teachers move to what they perceive is a more attractive workplace (Hanushek, Kain, & Rivkin, 2004; Kirby, Berends, & Naftel, 1999; Krieg, 2006; Murnane, Singer, & Willett, 1989; Rosenholtz & Simpson, 1990; Smith & Ingersoll, 2004). Moreover, the makeup of the teacher workforce in charter and traditional public schools—both nationally and in Michigan—suggests that there may be differential patterns in mobility and attrition; as in the larger US, charter school teachers in Michigan are, on average, younger and less experienced, more likely to be non-White, and more often located in or near areas that have been more impacted by the pandemic (e.g., Detroit, Grand Rapids; Anderson & Nagel, 2020).

Given the potential for pandemic-induced changes in teacher attrition and mobility patterns, researchers have begun to document trends across different contexts. Goldhaber and Theobald (2022) find that the percentage of teachers in Washington who switched schools or left the profession after the last full pre-pandemic school year, 2018-19, was 14.2 percent across the state. After the 2019-2020 and 2020-2021 school years, 13.8 and 15.1 percent of teachers switched schools or left the profession, respectively, suggesting only moderate responses to the pandemic in Washington state. Though the response may have just been delayed as Goldhaber & Theobald (2023) find that 19.8 percent of teachers switched schools or left the profession, a historic high for Washington State. Bacher-Hicks, Chi, and Orellana (2023) examine patterns in the Massachusetts context, where 15.0 percent of teachers transferred schools within the state or left the profession during summer 2019. Turnover during summer 2020 was generally stable (14.8 percent), however, teacher turnover increased by 18 percent in summer 2021 (to 17.5 percent). Finally, in Arkansas, Camp, Zamarro, and McGee (2023) find that 20.1 percent of teachers switched schools within the state or exited the teaching profession prior to the start of the 2019-20 school year and turnover increased in each of the following three school years (7.5, 13.4 and 25.9 percent prior to 2020-21, 2021-22, 2022-23, respectively). Thus, emerging literature suggests that teacher attrition and mobility may have increased in the years after the start of the pandemic.

We contribute to this growing literature by documenting teacher mobility and attrition trends during the COVID-19 pandemic using administrative data from Michigan between 2012-13 and 2022-23. In addition to examining overall mobility and attrition trends, the available literature explores differences in these patterns across race and ethnicity, experience, grade level, locale, composition of the student population, and measures of teacher effectiveness.

Using the administrative data in Michigan, along with other data sources collected by the state, we are able to document trends for many of the same subgroups of teachers but also explore differences across community-level COVID-19 incidence and the modalities offered to students at the height of the pandemic.

3. Data and Methods

Data

We use administrative, employee-level data on K-12 Michigan employees between fall 2012 and fall 2022. These data, provided by the Michigan Department of Education (MDE) and the Center for Educational Performance and Information (CEPI), include demographic, credential, and tenure information for all employees of the school system as well as descriptions of their grade, school, and district assignments. We use these data to create teacher-level demographic indicators, including gender, race/ethnicity, years of experience as a teacher, and certification/endorsement type (e.g., elementary, math, science, special education, and English learner). We are able to identify both traditional public and charter school teachers such that we can examine whether post-pandemic attrition and mobility differ between traditional public and charter school teachers.

Our main outcomes of interest are a set of indicators that capture teacher exits from the Michigan education system and mobility across districts or schools. We infer exits from a date of termination indicator in the administrative record as well as the absence of a public school employee's unique identifier in the following year(s), and district and school mobility are identified by changes in district and school assignment codes, respectively. Each indicator identifies exits from the public school teacher labor force, as well as across- and within-district school switches, that occurred at the completion of each school year. For example, our indicator for within-district school moves changes from 0 to 1 following the 2018-19 school year if a

teacher working in school A during the 2018-19 school year moves to school B in the same district for the 2019-20 school year. While we are able to observe employment at the start of the 2022-23 school year, we are unable to describe exits from the Michigan education system or mobility across schools or districts that occurred at the conclusion of the 2022-23 school year without data from the 2023-24 school year, which is currently unavailable. Thus, we only report results for the first three school years following the start of the COVID-19 pandemic (i.e., attrition and mobility occurring after the 2019-20, 2020-21, and 2021-22 school years).

We merge these data with multiple datasets that provide additional district- and county-level information. All district- and county-level data are assigned to teachers based on their school assignment and the district or county in which that school resides. First, we incorporate publicly available data from the Michigan Department of Health and Human Services on daily, county-level counts of COVID-19 cases collected between May 2020 and May 2021. We transform these data into 7-day average rates per 100,000 individuals in the county on the first day each month, with population densities taken from the US Census data. For our analysis, we assign teachers to low, medium, and high COVID-19 rate terciles based on the 7-day average COVID-19 rate observed for July 1, 2020.[3]

We also include data on districts' instructional modalities during the 2020-21 school year. The Education Policy Innovation Collaborative (EPIC) worked in partnership with MDE and CEPI throughout the 2020-21 school year to understand each district's instructional modality for each month of the school year (for more information, please see Hopkins, Kilbride, & Strunk, 2021a). For each district, we know the instructional modalities offered in each month (fully in-

[3] Districts in the low tercile were operating in counties with 0 to 15 COVID-19 cases per 100,00 individuals, medium tercile districts had 16-95 cases, and high tercile districts had greater than 95 cases. We also estimate models that incorporate COVID-19 case rates from September 1, 2020 and January 1, 2021 and we find similar results (available from the authors upon request).

person, hybrid, fully remote, or a combination of multiple modalities), and we assign teachers to each modality type based on the instructional modalities offered by their assigned district in September 2020.[4] Teachers working in a district that only offered one instructional modality in September 2020 were assigned to that modality. Given that districts were able to offer multiple instructional modalities each month during the 2020-21 school year, teachers working in a district that offered multiple instructional modalities in September 2020 were assigned to the "most in-person" option (i.e., fully in-person is the "most in-person" option, followed by hybrid and fully remote instruction in that order). For example, a teacher was considered to be working in a "fully in-person" district if that teacher's district offered 1) just fully-in person and no other modality options; 2) all three modalities, 3) fully in-person and hybrid instruction, or 4) fully in-person and fully remote instruction.

Finally, we include data on whether schools may be considered "hard-to-staff." Teacher exit rates tend to be substantially higher in schools serving large numbers of economically disadvantaged[5] students (e.g., Hanushek, Kain, and Rivkin, 2004). Consequently, we use the proportion of economically disadvantaged students in a school as our primary measure of a "more challenging" teaching environment. We assign teachers to small, medium, and large economically disadvantaged student population terciles based on enrollment counts unique to

[4] We choose September 2020 because districts' modality in this month was the most likely to impact teachers' decisions going into the 2020-21 school year. We also estimate models that group teachers into instructional modalities based on the modality most commonly offered by their assigned district during the fall 2020 semester as well as the entire 2020-21 school year and we find similar results (available from the authors upon request).
[5] In Michigan, students are identified as "economically disadvantaged" if they qualify for free or reduced-price milk or meals through the National School Lunch Program (i.e., Supplemental Nutrition Eligibility). This includes homeless-identified students who are categorically eligible for free meals.

each school year.[6] Our models also control for school-level student shares by race/ethnicity,[7] English learner status, and special education status, as well as the districts' urbanicity (i.e., urban, suburban/town, and rural). We obtain all these measures from Educational Entity Master database and MI School Data Student Headcount reports which are publicly available from MDE and CEPI.

Analytic Sample

Our analytic sample includes 140,531 individual public and charter school teachers working in 4,158 Michigan schools between 2012-13 and 2022-23. This sample includes all Michigan school employees with a teaching assignment for at least one year during the sample period, excluding teachers working at private schools and teachers assigned to adult education, early childhood, and summer migrant education programs. Our analyses of exits, as well as within- and across-district school switches, include slightly different subsamples of the overall analytic sample. The analysis of teacher exits utilizes the full analytic sample, including teachers with multiple school or district assignments in a given school year. The analyses of within- and across-district school switches include teachers with 100% FTE in their primary school or district, respectively (i.e., a single school or district assignment each school year).

Table 1 provides summary statistics for the full analytic sample in just three years (2012-13, 2016-17, and 2021-22) from the longer time series to show sample characteristics from the beginning, middle (both pre-pandemic) and end (pandemic) of our panel. As seen in the table, we are able to analyze mobility and attrition trends for more than 80,000 unique teachers each

[6] Small tercile schools include those where less than 45 percent of the student population was considered economically disadvantaged, medium tercile schools had 46 to 70 percent, and large tercile schools had at least 71 percent economically disadvantaged students.

[7] In models where we estimate attrition and mobility rates across teachers in schools with varying non-White student population, small tercile schools include those where less than 13 percent of the student population was non-White, medium tercile schools had 14 to 38 percent, and large tercile schools had at least 39 percent non-White students.

school year. The far majority (between 82 and 85 percent) of these teachers remained in their school placements each year. Across the sample period, exits from the teaching profession and across-district switches increased (approximately 8 to 10 percent for exits and 3 to 5 percent for district moves), while a decreasing share of teachers switched schools within their current districts (from approximately 5 to 3 percent).

Similar to other states across the country, the population of teachers in Michigan during this time was predominantly female (75 percent) and White (90 percent), however, the share of Asian, Black, Latino, and other race teachers all increased across the sample period. The share of the workforce with three or fewer years of teaching experience, or those who had an elementary, special education, English learner, or STEM endorsement, was generally consistent across years. The characteristics of the school Michigan teachers worked in were also similar across time, though the share of non-White, special education, and English learner students increased slightly during the sample period.

Empirical Strategy

To understand how teachers' propensity to leave the Michigan school system, switch districts, or switch schools shifted during COVID-19 pandemic, we use an Interrupted Time Series (ITS) framework to investigate trends in teacher attrition and mobility before and during the pandemic. Because we observe the entirety of teachers' employment spells in the Michigan school system since fall 2012, we can track whether teachers exit the profession, switch districts, or switch schools between academic years. We estimate the following linear probability model:

$$Y_{it} = \alpha + \beta_1 TREND_{it} + \boldsymbol{\beta_2'} \boldsymbol{T}_{it} + \boldsymbol{\beta_3'} \boldsymbol{TCHAR}_{it} + \boldsymbol{\beta_4'} \boldsymbol{SCHAR}_{ist} + \boldsymbol{\beta_5'} \boldsymbol{DCHAR}_{idt} + \varepsilon_{it} \quad (1)$$

where Y is one of three indicators for attrition, district mobility, and school mobility of teacher i in year t. We estimate separate regressions for each outcome and focus on teachers that either did

or did not experience each type of mobility. For example, when estimating trends in attrition, we compare teachers that left the school system to those who *stayed* in their original school/district assignment. We make similar comparisons for models examining within- and across-district school switches. *TREND* is the time elapsed (i.e., years) since fall 2012; $\boldsymbol{T}$ is a vector of indicators identifying years during the pandemic (i.e., 2019-20, 2020-21, and 2021-22). $\boldsymbol{TCHAR}$ is a vector of teacher characteristics (i.e., gender, race/ethnicity, experience as a teacher, or endorsements in a shortage area). $\boldsymbol{SCHAR}$ is a vector of school characteristics for school *s* (i.e., school-level student shares by gender, race/ethnicity, and economically disadvantaged, English learner, and special education status). $\boldsymbol{DCHAR}$ is a vector of indicators for district *d*, controlling for assignment in a charter school and district urbanicity (i.e., suburban/town or rural). The resulting coefficient on *TREND* captures the change in average attrition or mobility rates over time. For each of the indicators in $\boldsymbol{T}$, $\boldsymbol{\beta_2'}$ is the year-specific net-change in attrition or mobility from pre-COVID-19 trends that results from all of the previously discussed factors.

We then extend the ITS specification in model (1) to derive evidence on the ways attrition and mobility may differ across teachers working in communities disproportionately impacted by the COVID-19 pandemic and districts that offered different instructional modalities:

$$Y_{it} = \alpha + \gamma_1 TREND_{it} + \boldsymbol{\gamma_2'T}_{it} + \boldsymbol{\gamma_3'}(\boldsymbol{T_{it}} * \boldsymbol{X_{id}}) + \boldsymbol{X_{id}} + \boldsymbol{\gamma_4'TCHAR}_{it} + \boldsymbol{\gamma_5'SCHAR}_{ist} + \boldsymbol{\gamma_6'DCHAR}_{idt} + \varepsilon_{it} \quad (2)$$

In this model, *X* represents either the 7-day average COVID-19 rate observed for July 1, 2020 or the instructional modality offered by a teacher's assigned district in September 2020. All other variables are the same as in model (1). To estimate heterogeneity across instructional modalities, for example, *X* would include a vector of modality indicators (minus the reference category). In this example, the vectors of coefficients, $\boldsymbol{\gamma_2'}$ and $\boldsymbol{\gamma_3'}$, capture post-COVID-19 net-changes in

attrition or mobility between teachers in the reference modality, those working in districts offering in-person instruction, and all others, respectively.

Finally, we estimate a specification to explore differences in attrition and mobility across teachers with different demographic characteristics or endorsements, as well as those assigned to different types of schools and districts:

$$Y_{it} = \alpha + \theta_1 TREND_{it} + \boldsymbol{\theta_2'} \boldsymbol{T}_{it} + \boldsymbol{\theta_3'} (\boldsymbol{T_{it}} * \boldsymbol{Z_{isdt}}) + \boldsymbol{\theta_4'} \boldsymbol{MODALITY_{id}} + \boldsymbol{\theta_5'} \boldsymbol{TCHAR}_{it} + \boldsymbol{\theta_6'} \boldsymbol{SCHAR}_{ist} + \boldsymbol{\theta_7'} \boldsymbol{DCHAR}_{idt} + \varepsilon_{it} \quad (3)$$

In this model, Z represents either one unique covariate or a vector of related characteristics from $\boldsymbol{TCHAR}$ (i.e., gender, race/ethnicity, experience as a teacher, or endorsement in a shortage area), $\boldsymbol{SCHAR}$ (i.e., school-level shares of economically disadvantaged or non-White students), or $\boldsymbol{DCHAR}$ (i.e., assignment to a charter school or urbanicity).[8] Model (3) also controls for the vector $\boldsymbol{MODALITY}$, which summarizes the instructional modalities offered by the teachers' assigned district in September 2020. All other variables are the same as in model (1). To estimate heterogeneity across teacher race/ethnicity, $\boldsymbol{Z}$ would include a vector of racial/ethnic indicators (minus the reference category). In this example, the vectors of coefficients, $\boldsymbol{\theta_2'}$ and $\boldsymbol{\theta_3'}$, capture post-COVID-19 net-changes in attrition or mobility between the reference modality, White teachers, and teachers of all other racial/ethnic subgroups, respectively.

[8] We also estimate models that examine differences across teachers in districts with varying collective bargaining agreement (CBA) restrictiveness as a growing body of research shows that districts' re-opening decisions may have been driven by the restrictiveness of the local teachers' union (e.g., Grossman, Reckhow, Strunk, & Turner, 2020; Hartney & Finger, 2020; Valant, 2020). To complete this analysis, we use data collected from CBAs from 517 public school districts (96% of public school districts in Michigan). Using a Partial Independence Item Response (PIIR) model, Strunk, Cowen, et al. (2022) created a measure of CBA restrictiveness for Michigan school districts, which measures the extent to which CBAs constrain districts' ability to make teacher personnel decisions. We use these measures to divide teachers into terciles based on their assigned districts' CBA restrictiveness; teachers in the lowest quartile work in a district with the least restrictive CBA, and teachers in the highest quartile work in a district with the most restrictive CBA. We do not find any significant differences across teachers in these three types of districts and results are shown in Appendix Table A14.

4. Results

Research Question 1: How have teachers' propensities to leave the Michigan public school system, switch districts, or switch schools shifted after the onset of the COVID-19 pandemic?

Figure 1 presents results from model (1) estimating teacher attrition and mobility trends at the end of each school year before and during the COVID-19 pandemic. Appendix Table 1 provides the full set of estimates underlying the figure. The last full pre-pandemic school year is denoted by the vertical red line (2018-19). The solid lines in pre-pandemic school years represent existing teacher attrition and mobility trends prior to the state-wide school building closures in spring 2020 (i.e., the estimate on $TREND$ from model [1]), while the dashed lines show how these trends would extend into the 2019-20 through 2021-22 school years in the absence of the pandemic. The point estimates on the solid lines in 2019-20, 2020-21, and 2021-22 show how teacher attrition and mobility trends changed during the pandemic relative to existing trends (i.e., the year-specific estimates on vector $\boldsymbol{T}$ in model [1]).

The line with circle markers in the top panel shows trends in teacher attrition from the Michigan public school teacher workforce before and during the pandemic. Prior to spring 2020 school building closures, attrition rates were slightly decreasing (-0.12 percentage point change year-over-year). Attrition marginally declined after the first pandemic-affected school year (2019-20); the decrease, however, was quite small and not statistically significant (-0.07 percentage points). Following the 2020-21 and 2021-22 school years, teachers were significantly *more* likely to leave the Michigan public school system (1.34 and 2.22 percentage points). These increases represent a 17 and 28 percent increase over the last full pre-pandemic school year, respectively. These increases are generally in line with attrition trends observed in other states.

By contrast, across-district school switches (shown by the line with diamond markers in the middle panel) were increasing prior to the pandemic (0.49 percentage points year-over-year).

District switches decreased significantly in all three pandemic-impacted school years. Following the 2019-20 school year, district switches were 3.03 percentage points below the pre-pandemic trend, representing a 76 percent decline compared to the 2018-19 school year. The rate of district switches rebounded after the 2020-21 and 2021-22 school years, but still remained significantly below the pre-pandemic trend (-1.21 and -0.99 percentage points after 2020-21 and 2021-22, respectively, or 30 and 24 percent less than the share of district switches following the 2018-19 school year).

Last, we find that within-district school moves were declining prior to the onset of the pandemic but increased at the end of each pandemic-impacted school year (shown by the line with triangle markers in the bottom panel). However, these increases were relatively small and not statistically significant in the first year. After the 2020-21 and 2021-22 school years, school switches significantly increased by 0.41 percentage points in both years relative to the pre-pandemic trend, representing a consistent 14 percent increase in within-district school mobility compared to the last full pre-pandemic school year.

It is somewhat difficult to compare Michigan's within- and between-district mobility trends with those in Washington, Massachusetts, and Arkansas because school mobility is reported in aggregate in the three studies focusing on those states (i.e., both within- and across-district school switches). In all three of those states, the percentage of teachers switching schools declined slightly in the first pandemic school year before increasing in the second year. By contrast, the large decrease in Michigan teachers' propensity to switch districts after the 2019-20 school year implies a much larger net decrease in aggregate school switches in Michigan relative to other states. Similarly, our estimated changes in a teachers' propensity to switch schools or

switch districts after the 2020-21 and 2021-22 school year suggest a much more modest decline in aggregate school switches in Michigan relative to other states.

Research Question 2: Are these trends different across teachers who taught in communities that were disproportionately impacted by the COVID-19 pandemic or those who taught in a remote or hybrid setting (relative to in-person) during the 2020-21 school year?

Figure 2 shows results from model (2) estimating changes in attrition and mobility trends for teachers working in communities disproportionately impacted by the pandemic and those in districts offering different instructional modalities at the height of the pandemic. The point estimates in each figure present year-specific estimates of teacher attrition or mobility for each subgroup of teachers following the 2019-20, 2020-21, and 2021-22 school years relative to the pre-pandemic trend, which is represented by the zero line in each panel. Trend estimates for teachers in the reference group for each analysis (e.g., teachers in low COVID-19 rate or in-person districts) are taken directly from the coefficients on vector $\boldsymbol{T}$ in model (2). All other trend deviations for comparison group teachers are calculated by adding coefficients from vectors $\boldsymbol{T}$ and $\boldsymbol{T} * \boldsymbol{X}$ in each respective model. Tables with the full set of estimates from model (2) can be found in Appendix Tables A2 and A3.

Attrition and mobility trends during the pandemic differed significantly across teachers working in communities disproportionately impacted by the pandemic. The top panel of Figure 2 highlights three trends. First, teachers in districts with the highest COVID-19 rates were less likely to leave teaching altogether than their peers in low COVID-19 rate districts, although these differences were only statistically significant after the 2019-20 school year. Second, teachers in communities with medium and high COVID-19 rates were *less* likely than their peers in low COVID-19 areas to leave their districts after the first and third pandemic-impacted years. Notably, the overall increase in district mobility after the 2021-22 school year documented in Figure 1 above, appears to be largely driven by teachers who were in areas with the lowest

COVID-19 rates during the pandemic. Third, and by contrast, teachers' propensities to switch schools during the pandemic does not differ based on the prevalence of COVID-19 in their communities.

These results seem counterintuitive given the discourse surrounding school reopening prior to fall 2020. The communities in Michigan most impacted by the COVID-19 pandemic, however, were typically located in urban areas that educate the greatest proportions of low-income, Black, and Latino student populations (Goldhaber et al., 2022). Districts in these same communities were also the most likely to offer fully remote instruction throughout the 2020-21 school year (Hopkins, Kilbride, & Strunk, 2021a); in our sample, more than 75% of teachers in schools in areas with high COVID-19 rates worked in districts offering only fully remote instruction at the start of the 2020-21 school year. Conversely, more than half of the teachers in schools in areas with low COVID-19 rates worked in districts that offered fully in-person instruction at the start of the 2020-21 school year. Thus, it is possible that teachers were more concerned with the instructional modalities offered by districts during the 2020-21 school year than community-level incidence rates of COVID-19 when deciding to leave the teaching profession entirely or switch districts.

To understand how the instructional modalities offered by districts may have been associated with teacher attrition and mobility rates during the pandemic, the bottom panel of Figure 2 examines these trends separately for teachers working in fully in-person, hybrid, and fully remote districts. Unsurprisingly, given the correlation between COVID-19 incidence and instructional modality offerings, the patterns in this panel are nearly identical to those previously discussed. Specifically, teachers in fully remote districts were significantly less likely to leave the teaching profession or switch districts following the 2019-20 school year compared to

teachers in fully in-person districts. Again, we find no significant differences in within-district school switches across modalities.

Research Question 3: Do these patterns differ across teachers with varying demographic characteristics and credentials, those assigned to schools with different student populations or districts in different locales, and teachers at traditional public schools compared to charter schools?

To understand how teacher mobility and attrition trends differed across subgroups of teachers during the pandemic, Figures 3 through 5 show estimates from model (3) estimating changes in attrition and mobility trends across multiple individual (race/ethnicity and experience), school (economic and racial composition of the student population), and district (charter status and urbanicity) characteristics. The structure of these figures is similar to Figure 2, and tables with the full set of estimates from model (3) can be found in Appendix Tables A4 through A9. As discussed in the description of model (3), the estimates shown in Figures 3 through 5 also control for the instructional modality offered by districts during the pandemic. Appendix Tables A4 through A9 also show specifications that do not control for modality, however, nearly all of the significant relationships that will be discussed in these figures persist across both specifications.

We do not graphically present results from specifications that follow the overall trends shown in Figure 1 and have no significant or substantive differences in pandemic-era attrition and mobility between subgroups, which include gender, teacher endorsements in shortage areas (special education and English learner relative to general education, as well as math and science relative to non-STEM), and grade level assignment (elementary relative to middle or high school). Tables with the full set of estimates from these models can be found in Appendix Tables A10 through A13.

Figure 3 shows attrition and mobility trends during the pandemic by teacher race/ethnicity (top panel) and experience level (bottom panel). Given that most of the Michigan teacher workforce is White, attrition and mobility trends for this subgroup are much more precisely estimated compared to other teachers. Thus, the confidence intervals for White teachers are much smaller compared to the estimates for other non-White teachers.

We find significant differences in attrition and mobility by race/ethnicity, even when controlling for districts' instructional modalities. Specifically, attrition rates after each school year were generally consistent across subgroups, although Asian teachers were less likely to leave than White teachers following the 2019-20 and 2021-22 school years while teachers in the "other" race category were more likely to leave after the 2021-22 school year. Black teachers were consistently less likely than White teachers to switch districts after all three pandemic-era school years. Latino teachers were also significantly less likely than their White peers to move districts after the 2019-20 and 2020-21 school years, though this was not the case after the 2021-22 school year. Finally, Black teachers were less likely to switch schools after the 2019-20 and 2020-21 school years while all other groups did not significantly differ from the pre-pandemic trend. Together, these results indicate that Black and Latino teachers were less likely than White teachers to switch schools and districts during the pandemic, and not significantly more or less likely to exit the workforce entirely. This alleviates some concerns about the pandemic exacerbating the shortage of teachers of color.

New and more experienced teachers left the profession and their districts at different rates during the pandemic (see the bottom panel of Figure 3). As the pandemic continued into the 2020-21 and 2021-22 school years, teachers with less than three years of experience in the classroom were increasingly and significantly more likely than their more experienced

colleagues to leave the profession altogether. After the 2021-22 school year, novice teachers were 3.4 percentage points more likely to leave the Michigan teacher workforce than teachers in the 2018-19 school, and between 1.0 and 1.5 percentage points more likely to leave than teachers with four or more years of experience. Novice teachers were also considerably less likely than more experienced teachers to switch districts following the 2019-20 school year. District mobility rates were more consistent across experience levels in the following two school years.

Next, Figure 4 shows attrition and mobility trends for teachers working in schools with small, medium, and large shares of economically disadvantaged (top panel) and non-White (bottom panel) students. Since districts that offered remote instruction throughout the 2020-21 school year generally included schools with the largest shares of these students (see Hopkins, Kilbride, & Strunk, 2021a), we find many of the same trends as discussed in Figure 2. Specifically, teachers working in schools with the largest populations of economically disadvantaged or non-White students were significantly *less* likely to leave the teaching profession entirely after the 2019-20 and 2020-21 school years. In fact, teachers in schools with large non-White student populations were less likely to leave the profession after the 2019-20 school year compared to pre-pandemic trends, while teachers in schools with greater proportions of White students were *more* likely to leave compared to pre-pandemic trends. Teachers in large economically disadvantaged and non-White schools were also significantly less likely to switch districts at the start of the pandemic (2019-20) than teachers in small economically disadvantaged and non-White schools, though there were no differences in district switches for these teachers by the 2021-22 school year. Finally, teachers in large economically disadvantaged and non-White schools were consistently less likely to switch schools within their district across

all three pandemic interrupted school years relative to teachers in small economically disadvantaged and non-White schools.

There is also reason to believe that teacher attrition and mobility will differ across traditional public and charter schools during the pandemic, as charter schools in Michigan employ a younger population of teachers who are also more likely to be non-White and located in regions that have been more heavily impacted by the pandemic (Anderson & Nagel, 2020). In addition, although charter schools in Michigan were no more or less likely to plan to return to school in-person in fall 2020, charter schools were more likely to remain remote or offer hybrid instruction throughout the 2020-21 school year, whereas traditional public school districts were more likely to return to in-person instruction (Hopkins, Kilbride, & Strunk, 2021a). Because charter schools serve a relatively disadvantaged student population in Michigan (Bettinger, 2005; DeAngelis & DeGrow, 2018; Eberts & Hollenbeck, 2002), it is especially important to understand teacher mobility in this sector of schools.

Figures 5 shows the differences in attrition and mobility patterns for teachers assigned to traditional public and charter schools (top panel) and those in districts in different locales (bottom panel). Since charter districts in Michigan are generally represented by a single school, the top panel of Figure 5 only provides estimates for models estimating teachers' propensities to leave the teaching profession entirely or switch districts (i.e., a move from a charter district to a school in a traditional public district or school switches across charter districts).

Charter school teachers were less likely than traditional public school teachers to leave the teaching profession after the 2019-20 and 2020-21 school years, although these differences were not significant at traditional levels. Additionally, charter school teachers were considerably less likely than traditional public school teachers to leave their district/charter after the 2019-20

school year. However, we find no significant differences between traditional public and charter school teachers' propensities to switch districts after the next two school years, though public school teachers were consistently more likely to leave their districts than were charter teachers.

Unsurprisingly, attrition and mobility trends for teachers in urban districts mirror many of the same findings described for teachers who worked in high COVID-19 rate districts or those that offered remote instruction at the start of the 2020-21 school year (see the bottom panel of Figure 5). In particular, urban teachers were significantly less likely to leave teaching or their districts after the 2019-20 and 2020-21 school years compared to their colleagues teaching in rural districts. Unlike the trends discussed in Figure 2, however, urban teachers were also consistently less likely to switch schools than teachers in both suburban or rural districts following the 2019-20 and 2020-21 school years.

5. Discussion & Conclusion

Teachers are schools' most valuable resource; they are the single most important school-related factor in student achievement (Boyd et al., 2005; Chetty, Friedman, & Rockoff, 2011, 2014; Hanushek, 1971; Hanushek et al., 2005; Kane, Rockoff, & Staiger, 2006; Murnane, 1975; Rivkin, Hanushek, & Kain, 2005; Rockoff, 2004). Now more than ever, these front-line workers are critically important to help students succeed as we progress through and emerge from the pandemic. Given the negative link between teacher turnover and student success (Guin, 2004; Ingersoll, 2001; Ronfeldt, Loeb, & Wyckoff, 2013), at least when turnover occurs not because teachers are seeking better fits (Dhaliwal, Lai, & Strunk, 2022; Jackson, 2013), it is particularly critical for researchers and policymakers to understand patterns in teacher mobility and attrition during and after the pandemic.

This study, utilizing administrative data from Michigan, shows how teacher attrition and mobility patterns shifted in the state after each of the first three school years affected by the pandemic (2019-20, 2020-21, and 2021-22). Similar to the trends documented in Washington, Massachusetts, and Arkansas (Bacher-Hicks, Chi, & Orellana, 2023; Camp, Zamarro, & McGee, 2023; Goldhaber & Theobald, 2022, 2023), we estimate that the rate of teacher attrition in Michigan was relatively stable after the initial state-wide school closures in spring 2020 but teachers were more than a percentage point more likely to leave the profession following the 2020-21 school year (a 17 percent increase relative to the 2018-19 school year) and more than two percentage points more likely to leave after the 2021-22 school year (a 28 percent increase). Even though these estimates likely mean that Michigan avoided the pandemic-induced "mass exodus" of teachers reported on by national news outlets at the start of the pandemic (e.g., Dill, 2022; Kamenetz, 2022; Rahman, 2022), the continued increase in attrition in each subsequent school year is troubling since schools and districts will be forced to address a significant reduction in the teacher workforce in the coming school years.

Moreover, heterogeneity analyses suggest that some districts and teachers were more impacted than others by teacher attrition following the pandemic. Importantly, we find that districts in areas with the lowest COVID-19 rates during the pandemic experienced the greatest rate of district-level attrition, with substantially and significantly higher rates of district switching after the 2021-22 school year than prior to the pandemic and greater than districts in areas with medium or high rates of COVID-19. During the years most directly impacted by the pandemic (2019-20 and 2020-21), these same districts were more likely to lose teachers from the workforce altogether relative to pre-pandemic trends. This counterintuitive finding seems to be explained by districts' choices of instructional modalities; districts in areas with high COVID-19

rates were the most likely to operate remotely during the pandemic, perhaps allowing teachers the flexibilities necessary to care for their own families and conveying a prioritization of teachers' safety. This suggests that the prevailing narrative that school districts should not have shuttered school buildings given the massive impacts on student performance that resulted from the pandemic may be an oversimplification. The counterfactual may have been that even more teachers would have exited their districts and the profession altogether if their districts did not choose to operate remotely. Of course, we cannot know if this would have been the case, but it does suggest the need to consider multiple perspectives when reviewing decisions surrounding instructional modality during the pandemic.

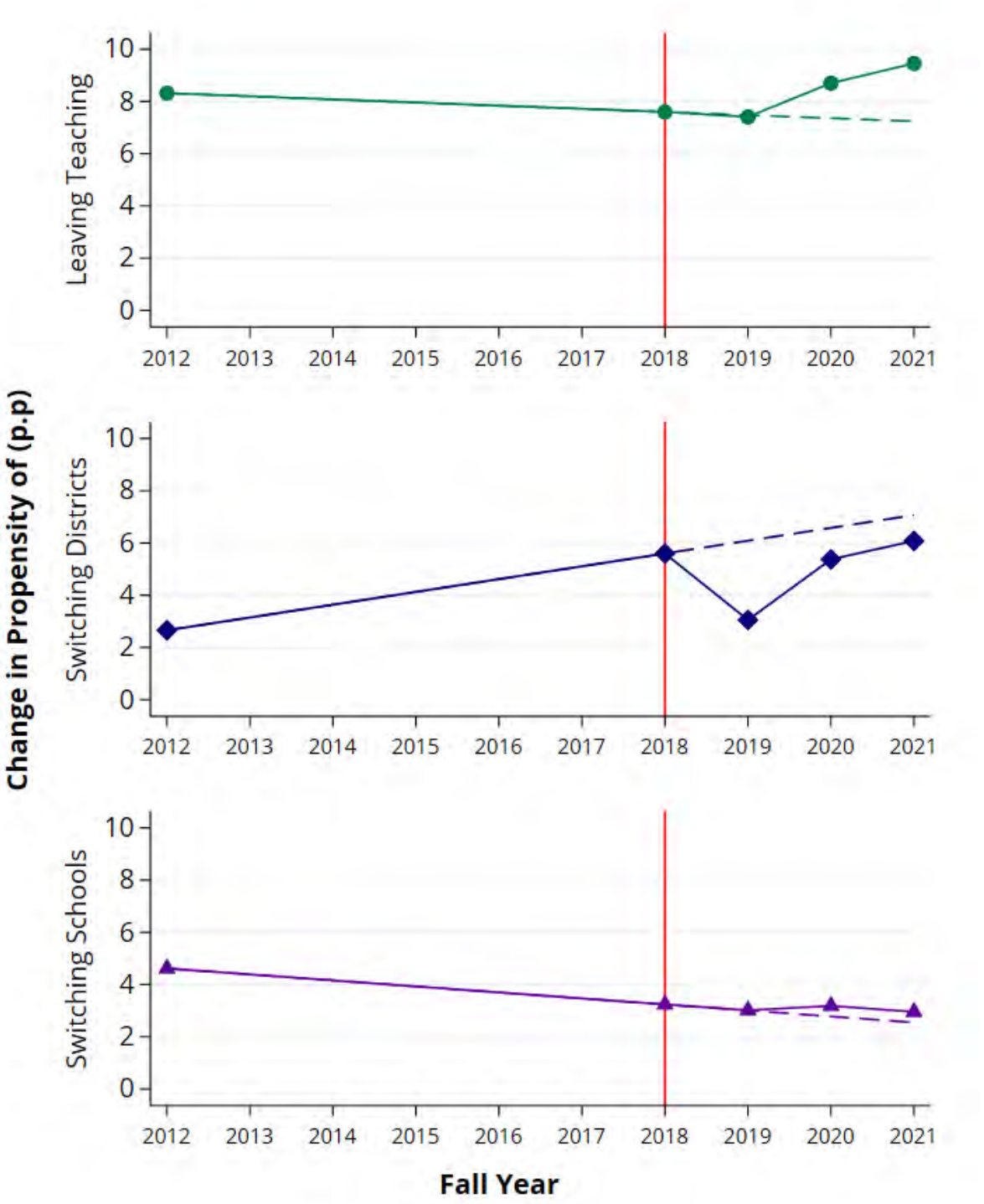
However, we do not find evidence that the pandemic may have exacerbated the shortage of Black and Latino teachers in Michigan. While the state still faces substantial underrepresentation of Black and Latino teachers relative to its student population – only 7.9 percent of the teacher workforce was Black or Latino in 2021-2022, relative to 27.6 percent of the students in Michigan – these teachers were not significantly more likely to exit the Michigan teacher workforce during the pandemic than in the years prior, nor were they more likely than White teachers to do so.

Additionally, we find that novice teachers in their first three years of teaching were more likely to leave the Michigan teacher workforce in the wake of the pandemic than were their experienced peers, and substantially more likely to exit the workforce than they had been prior to the pandemic. This trend is in some ways counterintuitive, as one narrative extant during the pandemic expected more senior, older, teachers to exit, fearing for their safety because of a disease that more severely impacted the older population (Mueller et al., 2020; Will, 2020). That earlier career and presumably younger teachers exited after the pandemic may instead reflect a

general disillusionment with the profession as teachers were increasingly blamed for interruptions to learning and the substantial learning loss that has resulted from the pandemic (Fahle et al., 2023; Laats, 2022; Strunk et al., 2023; Vazquez Toness & Lurye, 2022). This is alarming as novice teachers are the future of the teacher workforce. As more veteran teachers retire in the coming years, Michigan may face a dearth of teachers, thus exacerbating the teacher shortage regardless of state and district efforts to improve the new teacher supply.

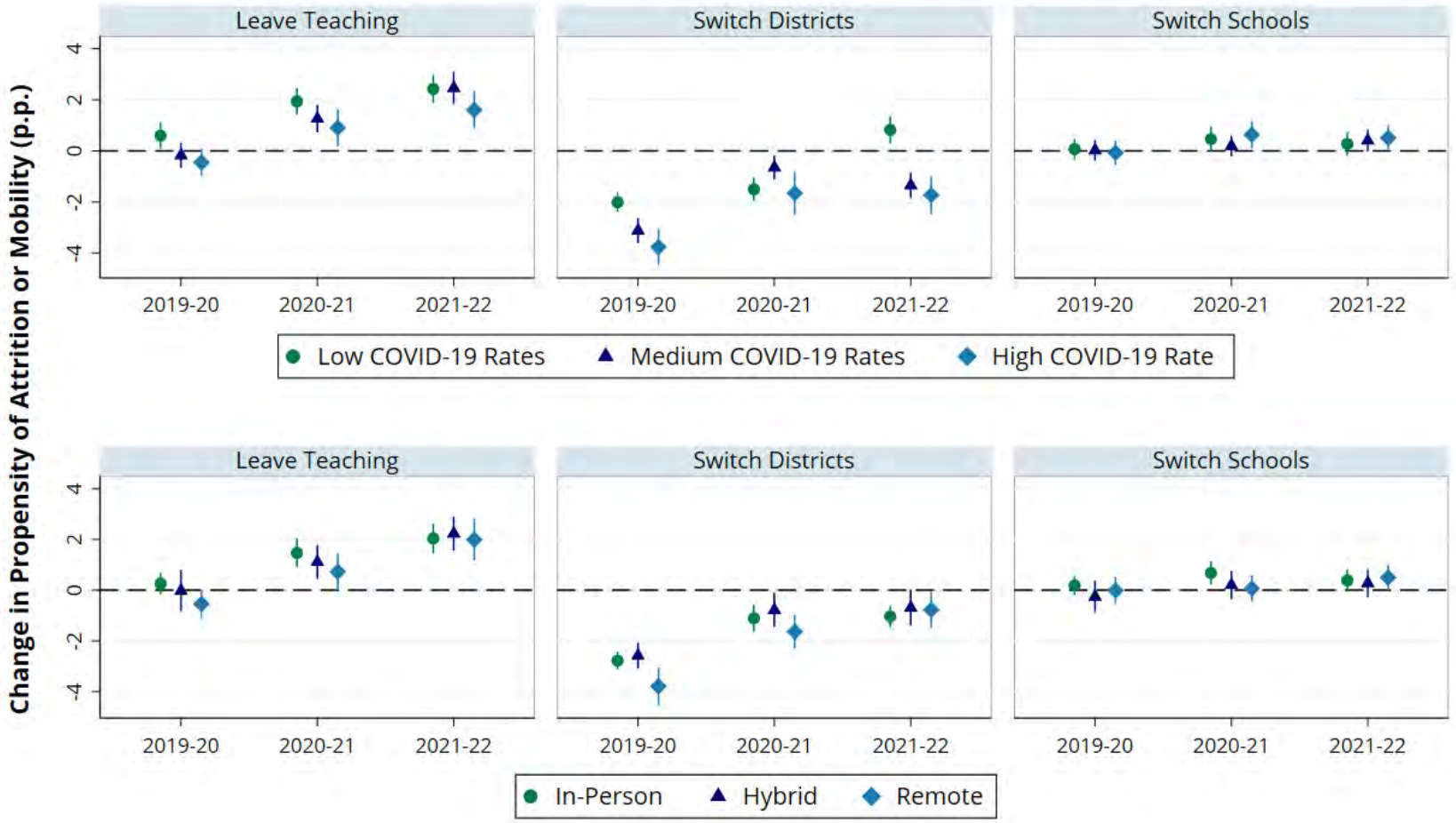
As we move forward in the years ahead, students need a stable and high-quality teacher workforce to reverse the negative effects of COVID-19 and progress through their academic careers. This study helps shed light on teacher mobility and attrition from the workforce in Michigan before and during the pandemic and provides insight into some of the factors associated with this mobility. Overall, this knowledge will enable district administrators and lawmakers to craft policy that can better maintain equitable K-12 educational opportunities both in Michigan and nationally.

Figure 1: End-of-Year Trends in Attrition and Mobility, Michigan Traditional Public and Charter School Teachers, 2012-13 through 2021-22



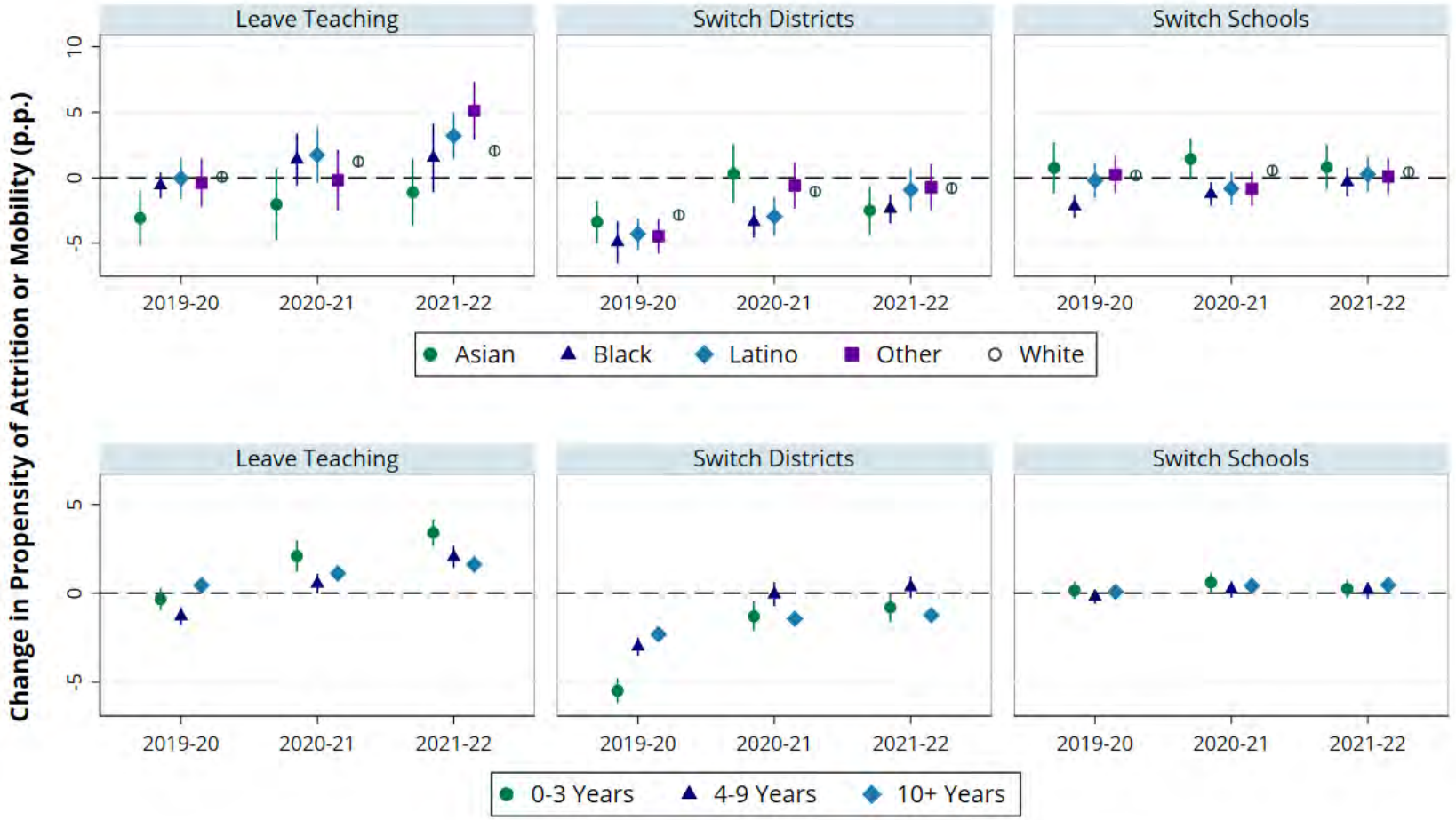
Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively).

Figure 2: End-of-Year Trends in Attrition and Mobility by County-Level COVID-19 Cases per 100,000 Individuals and District-Level Instruction Modality, Michigan Traditional Public and Charter School Teachers, 2012-13 through 2021-22



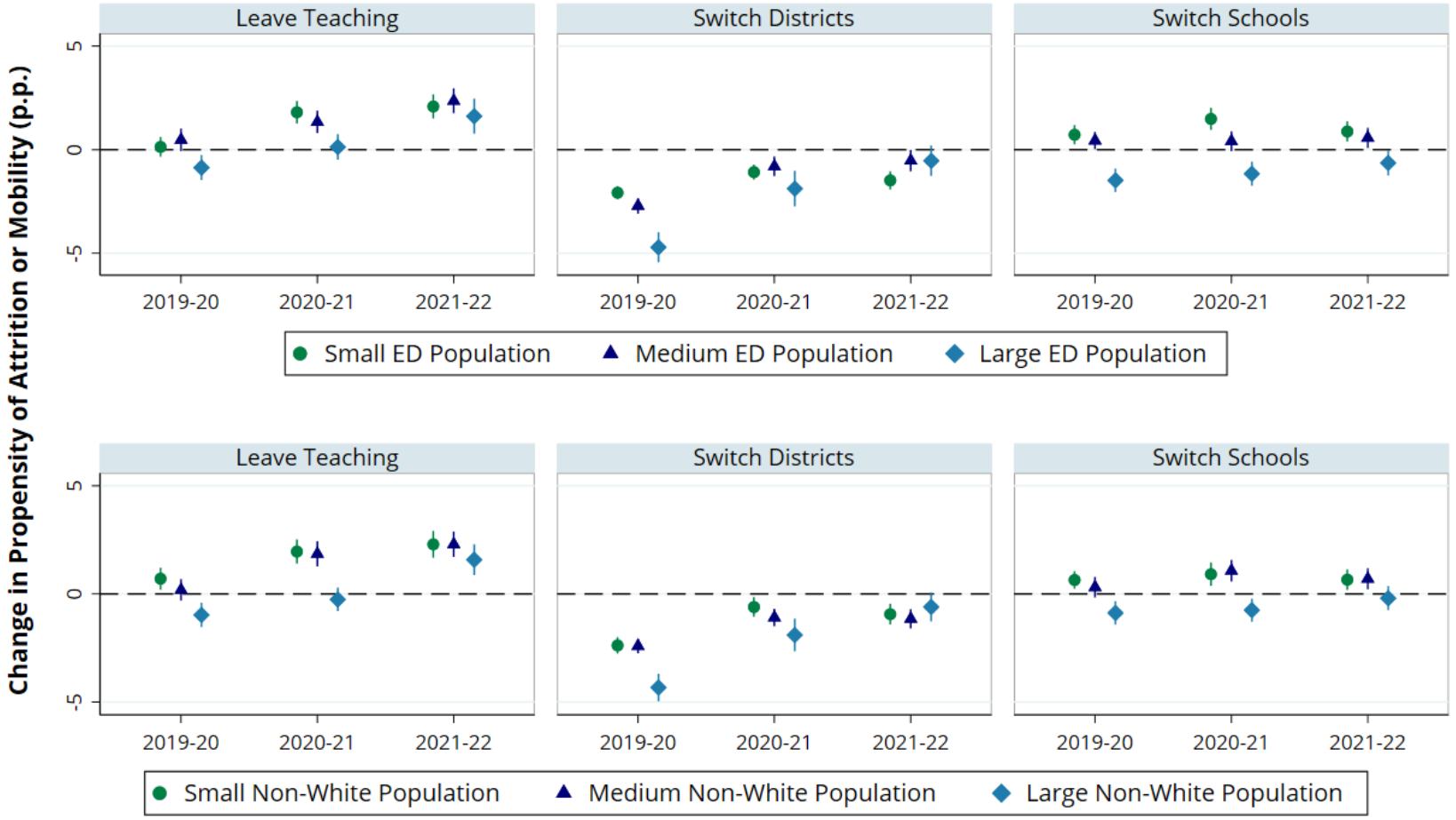
Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively).

Figure 3: End-of-Year Trends in Attrition and Mobility by Teacher Race/Ethnicity and Experience Level, Michigan Traditional Public and Charter School Teachers, 2012-13 through 2021-22



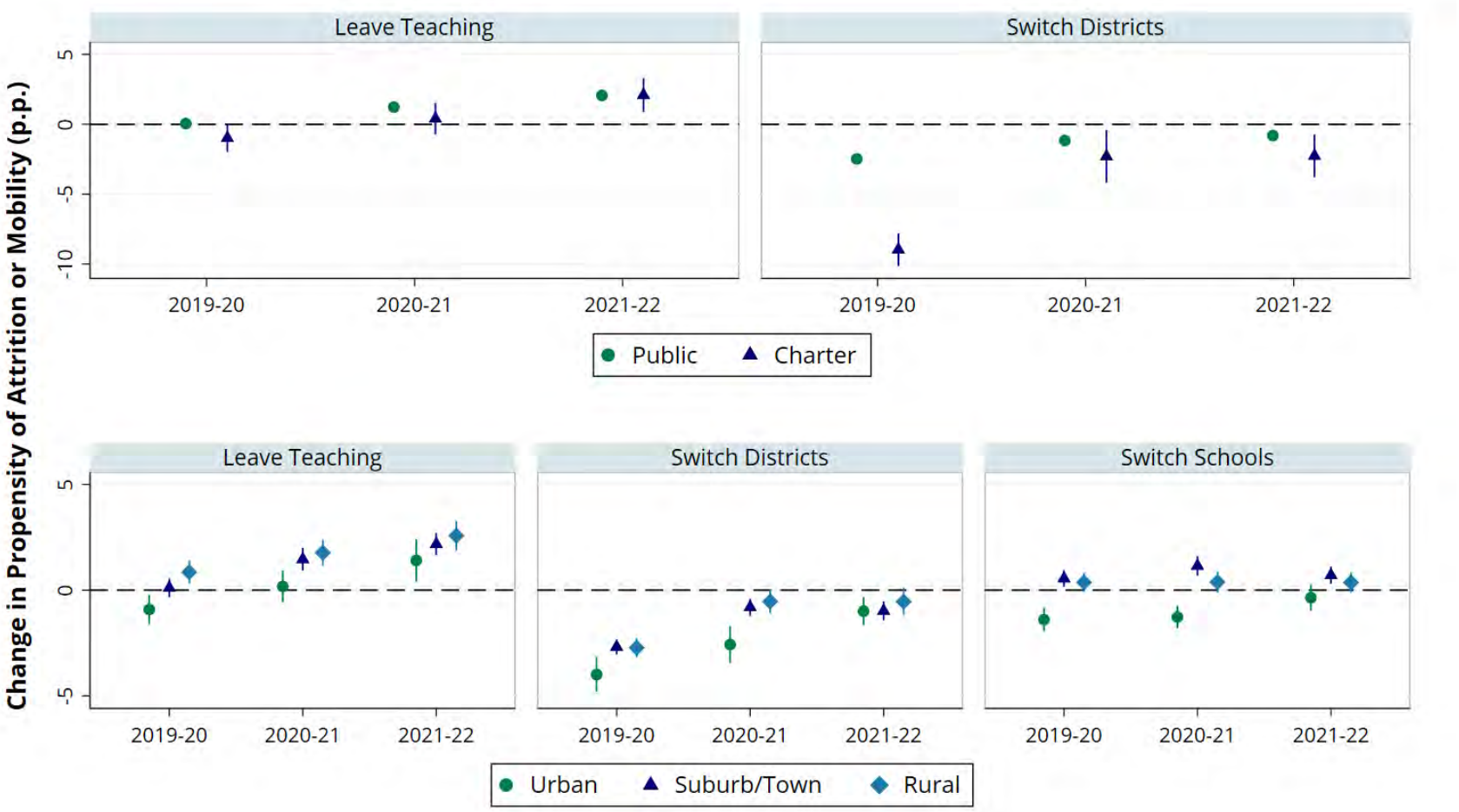
Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively).

Figure 4: End-of-Year Trends in Attrition and Mobility by School-Level Share of Economically Disadvantaged and Non-White Students, Michigan Traditional Public and Charter School Teachers, 2012-13 through 2021-22



Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively).

Figure 5: End-of-Year Trends in Attrition and Mobility by Charter School Assignment and District Urbanicity, Michigan Traditional Public and Charter School Teachers, 2012-13 through 2021-22



Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively).

Table 1: Descriptive Statistics, Michigan Traditional Public and Charter School Teachers, Selected Years

	2012-2013	2016-2017	2021-2022
Teachers (%)			
Total Teachers *(N)*	86,708	82,879	83,357
No Move	84.40	84.88	82.72
Leave Teaching	8.32	7.77	9.86
Switch Districts	2.66	4.02	4.83
Switch Schools	4.62	3.33	2.59
Female	75.09	75.34	75.76
Asian	0.65	0.72	0.92
Black	5.16	5.04	6.00
Latino	1.09	1.24	1.52
Other Race	1.01	1.15	1.36
White	92.08	91.85	90.20
Novice Teacher	16.09	15.81	17.64
Elementary Endorsement	38.35	38.08	38.01
Special Education Endorsement	13.70	13.88	13.84
English Learner Endorsement	0.35	0.62	1.06
Math Endorsement	9.66	9.41	9.50
Science Endorsement	7.99	7.81	7.96
School Characteristics (%)			
Female	48.28	48.25	48.36
Asian	2.94	3.37	3.64
Black	18.63	17.79	17.97
Latino	6.84	7.87	8.59
Other Race	3.92	4.82	5.61
Economically Disadvantaged	51.47	49.34	53.06
Special Education	15.25	15.38	16.08
English Learner	5.22	6.95	7.09
Total Enrollment (log)	6.29	6.29	6.24
District Characteristics (%)			
Chater	8.39	9.38	9.21
Suburban/Town	53.29	55.44	57.11
Rural	20.63	18.67	19.17
Hybrid	19.18	19.45	19.29
Remote	26.98	27.07	26.13
County Characteristics (%)			
Medium COVID-19 Cases	40.17	41.40	41.41
High COVID-19 Cases	31.95	32.67	33.22

Notes: Sample includes all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. Sample excludes private school teachers and teachers assigned to adult education, early childhood, and summer migrant education programs. "Switch Schools" includes all within-district school switches. "Switch Districts" includes all across-district school switches. We infer exits from a date of termination indicator in the administrative record as well as the absence of a public school employee's unique identifier in the time series. "Other Race" includes teachers who identify as "American Indian or Alaska Native," "Native Hawaiian or Pacific Islander," or "Two or more races."

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Appendix

Table A1: End-of-Year Teacher Attrition and Mobility, Michigan Traditional Public and Charter Teachers, 2012-13 through 2021-22

	Leave Teaching (1)	Switch Districts (2)	Switch Schools (3)
Trend	-0.0012***	0.0049***	-0.0023***
	(0.0003)	(0.0003)	(0.0003)
2019-2020	-0.0007	-0.0303***	0.0001
	(0.0018)	(0.0020)	(0.0015)
2020-2021	0.0134***	-0.0121***	0.0041*
	(0.0020)	(0.0022)	(0.0018)
2021-2022	0.0222***	-0.0099***	0.0041*
	(0.0022)	(0.0021)	(0.0019)
Female	0.0026**	-0.0033***	0.0020**
	(0.0009)	(0.0006)	(0.0007)
Asian	0.0245***	0.0001	-0.0025
	(0.0059)	(0.0038)	(0.0028)
Black	0.0184**	-0.0124	0.0084***
	(0.0067)	(0.0078)	(0.0021)
Latino	0.0083*	0.0033	0.0036
	(0.0035)	(0.0024)	(0.0024)
Other	0.0088*	0.0006	0.0044+
	(0.0034)	(0.0038)	(0.0023)
0-3 Years Experience (Novice)	0.0353***	0.0328***	0.0035***
	(0.0026)	(0.0015)	(0.0010)
10+ Years Experience (Experienced)	0.0077***	-0.0240***	-0.0046***
	(0.0011)	(0.0012)	(0.0008)
Elementary Endorsement	-0.0243***	-0.0053***	0.0099***
	(0.0012)	(0.0009)	(0.0013)
SWD Endorsement	0.0041**	0.0173***	0.0244***
	(0.0016)	(0.0013)	(0.0019)
EL Endorsement	-0.0287***	-0.0036	0.0025
	(0.0044)	(0.0052)	(0.0037)
Math Endorsement	-0.0130***	0.0068***	0.0006
	(0.0012)	(0.0011)	(0.0007)
Science Endorsement	-0.0109***	0.0061***	-0.0019**
	(0.0013)	(0.0011)	(0.0007)
School Characteristics	Y	Y	Y
District Urbanicity	Y	Y	Y
Observations	841297	784402	784402

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A2: End-of-Year Teacher Attrition and Mobility by July 2020 County-Level COVID-19 Cases per 100,000 Individuals, Michigan Traditional Public and Charter Teachers, 2012-13 through 2021-22

	Leave Teaching (1)	Switch Districts (2)	Switch Schools (3)
Trend	-0.0011***	0.0047***	-0.0023***
	(0.0003)	(0.0003)	(0.0003)
2019-2020	0.0060*	-0.0201***	0.0007
	(0.0027)	(0.0019)	(0.0021)
2020-2021	0.0194***	-0.0150***	0.0047+
	(0.0027)	(0.0023)	(0.0024)
2021-2022	0.0243***	0.0082**	0.0027
	(0.0028)	(0.0027)	(0.0024)
Medium Rates*2019-2020	-0.0078*	-0.0111***	-0.0005
	(0.0031)	(0.0024)	(0.0024)
Medium Rates*2020-2021	-0.0068*	0.0085**	-0.0028
	(0.0033)	(0.0028)	(0.0024)
Medium Rates*2021-2022	0.0004	-0.0217***	0.0013
	(0.0035)	(0.0031)	(0.0022)
High Rates*2019-2020	-0.0105***	-0.0175***	-0.0014
	(0.0032)	(0.0035)	(0.0027)
High Rates*2020-2021	-0.0104*	-0.0016	0.0017
	(0.0042)	(0.0045)	(0.0029)
High Rates*2021-2022	-0.0082*	-0.0255***	0.0024
	(0.0042)	(0.0037)	(0.0024)
Medium Rates	-0.0074***	0.0321***	0.0021
	(0.0019)	(0.0027)	(0.0014)
High Rates	-0.0035	0.0406***	0.0031
	(0.0026)	(0.0032)	(0.0019)
Teacher Characteristics	Y	Y	Y
School Characteristics	Y	Y	Y
District Urbanicity	Y	Y	Y
Observations	840162	783514	783514

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A3: End-of-Year Teacher Attrition and Mobility by September 2020 District-Level Instruction Modality, Michigan Traditional Public and Charter Teachers, 2012-13 through 2021-22

	Leave Teaching (1)	Switch Districts (2)	Switch Schools (2)
Trend	-0.0009**	0.0052***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)
2019-2020	0.0026	-0.0278***	0.0019
	(0.0021)	(0.0018)	(0.0019)
2020-2021	0.0147***	-0.0111***	0.0068**
	(0.0029)	(0.0027)	(0.0023)
2021-2022	0.0204***	-0.0103***	0.0039+
	(0.0030)	(0.0022)	(0.0023)
Remote*2019-2020	-0.0080*	-0.0101**	-0.0020
	(0.0033)	(0.0034)	(0.0031)
Remote *2020-2021	-0.0074	-0.0053	-0.0061*
	(0.0047)	(0.0037)	(0.0030)
Remote *2021-2022	-0.0004	0.0026	0.0011
	(0.0051)	(0.0038)	(0.0027)
Hybrid*2019-2020	-0.0028	0.0020	-0.0044
	(0.0045)	(0.0025)	(0.0034)
Hybrid *2020-2021	-0.0036	0.0033	-0.0048
	(0.0044)	(0.0039)	(0.0031)
Hybrid *2021-2022	0.0020	0.0034	-0.0011
	(0.0042)	(0.0036)	(0.0028)
Remote	-0.0005	0.0031	0.0027
	(0.0029)	(0.0032)	(0.0017)
Hybrid	-0.0026	-0.0008	0.0029
	(0.0022)	(0.0022)	(0.0019)
Teacher Characteristics	Y	Y	Y
School Characteristics	Y	Y	Y
District Urbanicity	Y	Y	Y
Observations	802292	749072	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A4: End-of-Year Teacher Attrition and Mobility by Race/Ethnicity, Michigan Traditional Public and Charter Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0012***	-0.0009**	0.0049***	0.0052***	-0.0023***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	0.0002	0.0006	-0.0282***	-0.0285***	0.0013	0.0018
	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0015)	(0.0016)
2020-2021	0.0139***	0.0123***	-0.0101***	-0.0105***	0.0052**	0.0056**
	(0.0020)	(0.0020)	(0.0019)	(0.0019)	(0.0018)	(0.0019)
2021-2022	0.0223***	0.0207***	-0.0081***	-0.0079***	0.0044*	0.0044*
	(0.0022)	(0.0022)	(0.0020)	(0.0019)	(0.0019)	(0.0019)
Asian*2019-2020	-0.0320**	-0.0314**	-0.0060	-0.0052	0.0059	0.0057
	(0.0107)	(0.0108)	(0.0082)	(0.0083)	(0.0094)	(0.0099)
Asian*2020-2021	-0.0290*	-0.0326*	0.0122	0.0135	0.0088	0.0088
	(0.0143)	(0.0135)	(0.0111)	(0.0114)	(0.0077)	(0.0080)
Asian*2021-2022	-0.0336**	-0.0318*	-0.0187*	-0.0171+	0.0038	0.0038
	(0.0128)	(0.0130)	(0.0093)	(0.0098)	(0.0082)	(0.0086)
Black*2019-2020	-0.0098+	-0.0066	-0.0298*	-0.0208*	-0.0216***	-0.0236***
	(0.0052)	(0.0051)	(0.0118)	(0.0082)	(0.0044)	(0.0045)
Black*2020-2021	-0.0036	0.0016	-0.0327***	-0.0234***	-0.0163***	-0.0180***
	(0.0090)	(0.0104)	(0.0074)	(0.0056)	(0.0043)	(0.0045)
Black*2021-2022	-0.0072	-0.0054	-0.0264**	-0.0158**	-0.0059	-0.0078
	(0.0129)	(0.0137)	(0.0088)	(0.0053)	(0.0053)	(0.0055)
Latino*2019-2020	0.0004	-0.0011	-0.0159**	-0.0144*	-0.0041	-0.0039
	(0.0082)	(0.0083)	(0.0057)	(0.0059)	(0.0064)	(0.0067)
Latino*2020-2021	0.0093	0.0050	-0.0201**	-0.0192**	-0.0139*	-0.0139*
	(0.0110)	(0.0108)	(0.0070)	(0.0073)	(0.0060)	(0.0063)
Latino*2021-2022	0.0135	0.0113	-0.0051	-0.0013	-0.0003	-0.0017
	(0.0087)	(0.0088)	(0.0078)	(0.0082)	(0.0064)	(0.0067)
Other*2019-2020	-0.0054	-0.0045	-0.0163*	-0.0162*	0.0011	0.0005
	(0.0092)	(0.0094)	(0.0065)	(0.0063)	(0.0069)	(0.0072)
Other*2020-2021	-0.0156	-0.0142	0.0034	0.0045	-0.0129*	-0.0141*
	(0.0114)	(0.0119)	(0.0088)	(0.0090)	(0.0062)	(0.0066)
Other*2021-2022	0.0325**	0.0304**	-0.0044	0.0005	-0.0030	-0.0034
	(0.0112)	(0.0113)	(0.0086)	(0.0090)	(0.0065)	(0.0069)
Asian	0.0352***	0.0322***	0.0015	0.0014	-0.0046	-0.0042
	(0.0071)	(0.0071)	(0.0043)	(0.0041)	(0.0032)	(0.0033)
Black	0.0206***	0.0175***	-0.0034	-0.0072	0.0129***	0.0142***
	(0.0051)	(0.0043)	(0.0098)	(0.0061)	(0.0026)	(0.0027)
Latino	0.0057	0.0061	0.0077*	0.0084**	0.0055+	0.0059+
	(0.0041)	(0.0042)	(0.0030)	(0.0030)	(0.0032)	(0.0033)
Other	0.0073+	0.0067	0.0024	0.0001	0.0060*	0.0073*
	(0.0042)	(0.0044)	(0.0038)	(0.0034)	(0.0029)	(0.0031)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	841297	802292	784402	749072	784402	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A5: End-of-Year Teacher Attrition and Mobility by Experience, Michigan Traditional Public and Charter Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0011**	-0.0008*	0.0048***	0.0051***	-0.0022***	-0.0023***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	-0.0133***	-0.0129***	-0.0310***	-0.0301***	-0.0018	-0.0020
	(0.0025)	(0.0025)	(0.0026)	(0.0026)	(0.0020)	(0.0021)
2020-2021	0.0079**	0.0054+	-0.0027	-0.0005	0.0023	0.0021
	(0.0029)	(0.0028)	(0.0034)	(0.0034)	(0.0023)	(0.0024)
2021-2022	0.0211***	0.0204***	-0.0001	0.0035	0.0021	0.0016
	(0.0031)	(0.0032)	(0.0032)	(0.0031)	(0.0023)	(0.0024)
Novice*2019-2020	0.0090*	0.0096**	-0.0255***	-0.0248***	0.0035	0.0036
	(0.0036)	(0.0036)	(0.0031)	(0.0031)	(0.0025)	(0.0026)
Novice*2020-2021	0.0149**	0.0155***	-0.0140***	-0.0125**	0.0040+	0.0040
	(0.0046)	(0.0046)	(0.0042)	(0.0043)	(0.0024)	(0.0025)
Novice*2021-2022	0.0154***	0.0137**	-0.0128**	-0.0115**	0.0014	0.0008
	(0.0044)	(0.0043)	(0.0043)	(0.0043)	(0.0023)	(0.0025)
Experienced*2019-2020	0.0172***	0.0174***	0.0082***	0.0070***	0.0020	0.0028
	(0.0026)	(0.0026)	(0.0018)	(0.0018)	(0.0018)	(0.0018)
Experienced*2020-2021	0.0042	0.0057*	-0.0108***	-0.0139***	0.0016	0.0021
	(0.0028)	(0.0028)	(0.0027)	(0.0028)	(0.0019)	(0.0020)
Experienced*2021-2022	-0.0034	-0.0041	-0.0117***	-0.0159***	0.0025	0.0030
	(0.0032)	(0.0033)	(0.0028)	(0.0028)	(0.0018)	(0.0019)
Novice	0.0316***	0.0306***	0.0377***	0.0378***	0.0027*	0.0036**
	(0.0028)	(0.0029)	(0.0017)	(0.0016)	(0.0012)	(0.0013)
Experienced	0.0062***	0.0065***	-0.0231***	-0.0228***	-0.0051***	-0.0055***
	(0.0012)	(0.0012)	(0.0013)	(0.0013)	(0.0010)	(0.0010)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	841297	802292	784402	749072	784402	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6: End-of-Year Teacher Mobility and Attrition by School-Level Share of Economically Disadvantaged Students, Michigan Traditional Public and Charter Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0012***	-0.0009**	0.0049***	0.0052***	-0.0023***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	0.0023	0.0014	-0.0195***	-0.0208***	0.0064**	0.0072**
	(0.0024)	(0.0024)	(0.0016)	(0.0016)	(0.0023)	(0.0024)
2020-2021	0.0198***	0.0181***	-0.0092***	-0.0108***	0.0140***	0.0149***
	(0.0028)	(0.0028)	(0.0019)	(0.0018)	(0.0027)	(0.0027)
2021-2022	0.0228***	0.0209***	-0.0131***	-0.0148***	0.0083***	0.0088***
	(0.0030)	(0.0030)	(0.0023)	(0.0022)	(0.0024)	(0.0025)
Medium*2019-2020	0.0012	0.0034	-0.0057***	-0.0063***	-0.0030	-0.0028
	(0.0031)	(0.0030)	(0.0016)	(0.0016)	(0.0029)	(0.0029)
Medium*2020-2021	-0.0044	-0.0047	0.0019	0.0028	-0.0105**	-0.0108***
	(0.0031)	(0.0032)	(0.0024)	(0.0022)	(0.0032)	(0.0032)
Medium*2021-2022	0.0027	0.0027	0.0078**	0.0095***	-0.0031	-0.0031
	(0.0034)	(0.0036)	(0.0028)	(0.0023)	(0.0029)	(0.0028)
Large*2019-2020	-0.0128***	-0.0100**	-0.0329***	-0.0264***	-0.0199***	-0.0220***
	(0.0037)	(0.0037)	(0.0044)	(0.0037)	(0.0033)	(0.0034)
Large*2020-2021	-0.0180***	-0.0168***	-0.0141**	-0.0080+	-0.0238***	-0.0265***
	(0.0040)	(0.0040)	(0.0046)	(0.0044)	(0.0034)	(0.0035)
Large*2021-2022	-0.0062	-0.0047	0.0012	0.0095*	-0.0125***	-0.0152***
	(0.0052)	(0.0054)	(0.0045)	(0.0039)	(0.0029)	(0.0030)
Medium	0.0021	0.0024	-0.0011	0.0011	-0.0021	-0.0027
	(0.0021)	(0.0021)	(0.0020)	(0.0018)	(0.0022)	(0.0023)
Large	0.0107**	0.0108**	0.0088**	0.0109***	0.0050	0.0060
	(0.0035)	(0.0034)	(0.0034)	(0.0029)	(0.0036)	(0.0037)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	841297	802292	784402	749072	784402	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A7: End-of-Year Teacher Mobility and Attrition by School-Level Share of Non-White Students, Michigan Public and Charter School Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0012***	-0.0009**	0.0049***	0.0052***	-0.0023***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	0.0062*	0.0070**	-0.0228***	-0.0238***	0.0055**	0.0065**
	(0.0027)	(0.0026)	(0.0019)	(0.0019)	(0.0020)	(0.0021)
2020-2021	0.0213***	0.0196***	-0.0055*	-0.0060**	0.0078**	0.0091***
	(0.0027)	(0.0028)	(0.0024)	(0.0023)	(0.0027)	(0.0027)
2021-2022	0.0242***	0.0229***	-0.0096***	-0.0094***	0.0060*	0.0066**
	(0.0030)	(0.0031)	(0.0028)	(0.0025)	(0.0024)	(0.0024)
Medium*2019-2020	-0.0041	-0.0052+	0.0006	-0.0003	-0.0033	-0.0034
	(0.0030)	(0.0028)	(0.0017)	(0.0017)	(0.0028)	(0.0028)
Medium*2020-2021	-0.0009	-0.0011	-0.0027	-0.0049*	0.0024	0.0016
	(0.0033)	(0.0034)	(0.0026)	(0.0024)	(0.0031)	(0.0031)
Medium*2021-2022	0.0017	0.0000	0.0011	-0.0022	0.0003	0.0004
	(0.0033)	(0.0035)	(0.0030)	(0.0025)	(0.0029)	(0.0028)
Large*2019-2020	-0.0176***	-0.0168***	-0.0248***	-0.0195***	-0.0139***	-0.0152***
	(0.0037)	(0.0037)	(0.0037)	(0.0031)	(0.0031)	(0.0032)
Large*2020-2021	-0.0238***	-0.0221***	-0.0178***	-0.0130**	-0.0142***	-0.0166***
	(0.0037)	(0.0038)	(0.0043)	(0.0040)	(0.0033)	(0.0033)
Large*2021-2022	-0.0082+	-0.0071	-0.0023	0.0033	-0.0063*	-0.0085**
	(0.0044)	(0.0046)	(0.0043)	(0.0036)	(0.0032)	(0.0031)
Medium	-0.0037*	-0.0023	-0.0052**	-0.0028+	0.0012	0.0002
	(0.0018)	(0.0018)	(0.0017)	(0.0014)	(0.0018)	(0.0018)
Large	0.0060+	0.0087**	-0.0012	0.0022	0.0030	0.0017
	(0.0032)	(0.0033)	(0.0049)	(0.0038)	(0.0034)	(0.0035)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	841297	802292	784402	749072	784402	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A8: End-of-Year Teacher Mobility and Attrition by Charter School Assignment, Michigan Public and Charter School Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts	
	(1)	(2)	(3)	(4)
Trend	-0.0013***	-0.0010**	0.0050***	0.0053***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	0.0012	0.0005	-0.0243***	-0.0247***
	(0.0019)	(0.0019)	(0.0020)	(0.0018)
2020-2021	0.0133***	0.0123***	-0.0109***	-0.0116***
	(0.0022)	(0.0021)	(0.0023)	(0.0021)
2021-2022	0.0219***	0.0207***	-0.0070**	-0.0080***
	(0.0022)	(0.0022)	(0.0022)	(0.0020)
Charter*2019-2020	-0.0169**	-0.0103+	-0.0728***	-0.0650***
	(0.0053)	(0.0053)	(0.0061)	(0.0060)
Charter*2020-2021	-0.0093	-0.0083	-0.0233*	-0.0114
	(0.0059)	(0.0060)	(0.0092)	(0.0097)
Charter*2021-2022	-0.0024	0.0002	-0.0322***	-0.0145+
	(0.0061)	(0.0063)	(0.0077)	(0.0079)
Charter	0.0506***	0.0470***	0.1008***	0.0975***
	(0.0040)	(0.0040)	(0.0078)	(0.0063)
Teacher Characteristics	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y
Observations	841297	802292	784402	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A9: End-of-Year Teacher Mobility and Attrition by District Urbanicity, Michigan Public and Charter School Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0012***	-0.0009**	0.0049***	0.0052***	-0.0022***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	-0.0107**	-0.0091**	-0.0419***	-0.0399***	-0.0139***	-0.0139***
	(0.0037)	(0.0035)	(0.0049)	(0.0042)	(0.0027)	(0.0028)
2020-2021	0.0019	0.0018	-0.0275***	-0.0257***	-0.0125***	-0.0127***
	(0.0038)	(0.0038)	(0.0050)	(0.0044)	(0.0026)	(0.0027)
2021-2022	0.0153**	0.0141**	-0.0117**	-0.0099**	-0.0025	-0.0035
	(0.0049)	(0.0051)	(0.0044)	(0.0034)	(0.0032)	(0.0032)
Suburban/Town*2019-2020	0.0113**	0.0102**	0.0151***	0.0130***	0.0185***	0.0194***
	(0.0040)	(0.0039)	(0.0045)	(0.0039)	(0.0032)	(0.0033)
Suburban/Town*2020-2021	0.0140**	0.0128**	0.0194***	0.0176***	0.0236***	0.0242***
	(0.0046)	(0.0048)	(0.0050)	(0.0044)	(0.0031)	(0.0032)
Suburban/Town*2021-2022	0.0077	0.0077	0.0016	0.0001	0.0091**	0.0106***
	(0.0057)	(0.0059)	(0.0047)	(0.0038)	(0.0030)	(0.0031)
Rural*2019-2020	0.0189***	0.0177***	0.0154**	0.0127**	0.0177***	0.0176***
	(0.0043)	(0.0042)	(0.0047)	(0.0041)	(0.0031)	(0.0033)
Rural*2020-2021	0.0184***	0.0159**	0.0227***	0.0204***	0.0158***	0.0165***
	(0.0049)	(0.0050)	(0.0055)	(0.0047)	(0.0030)	(0.0031)
Rural*2021-2022	0.0130*	0.0117+	0.0047	0.0045	0.0064+	0.0072*
	(0.0059)	(0.0063)	(0.0056)	(0.0043)	(0.0033)	(0.0032)
Suburban/Town	-0.0131***	-0.0118***	-0.0020	-0.0006	-0.0159***	-0.0164***
	(0.0033)	(0.0034)	(0.0034)	(0.0030)	(0.0024)	(0.0023)
Rural	-0.0147***	-0.0135***	0.0011	0.0035	-0.0287***	-0.0300***
	(0.0035)	(0.0035)	(0.0033)	(0.0031)	(0.0035)	(0.0033)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	841297	802292	784402	749072	784402	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A10: End-of-Year Teacher Attrition and Mobility by Special Education and English Learner Endorsement; Michigan Traditional Public and Charter Teachers; 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0011***	-0.0009**	0.0050***	0.0053***	-0.0023***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	0.0008	0.0010	-0.0309***	-0.0302***	0.0027+	0.0029+
	(0.0019)	(0.0019)	(0.0020)	(0.0019)	(0.0016)	(0.0016)
2020-2021	0.0136***	0.0125***	-0.0132***	-0.0125***	0.0054**	0.0055**
	(0.0020)	(0.0020)	(0.0023)	(0.0022)	(0.0018)	(0.0019)
2021-2022	0.0225***	0.0217***	-0.0126***	-0.0113***	0.0041*	0.0038+
	(0.0023)	(0.0022)	(0.0021)	(0.0019)	(0.0019)	(0.0020)
English Learner*2019-2020	0.0042	0.0038	0.0063	0.0047	-0.0185*	-0.0192*
	(0.0088)	(0.0088)	(0.0081)	(0.0080)	(0.0075)	(0.0076)
English Learner*2020-2021	-0.0149	-0.0153	0.0106	0.0092	0.0041	0.0037
	(0.0115)	(0.0119)	(0.0106)	(0.0105)	(0.0105)	(0.0107)
English Learner*2021-2022	-0.0097	-0.0105	0.0150	0.0128	-0.0016	-0.0018
	(0.0086)	(0.0088)	(0.0097)	(0.0096)	(0.0107)	(0.0108)
Special Education*2019-2020	-0.0092*	-0.0073	0.0006	0.0003	-0.0157***	-0.0162***
	(0.0045)	(0.0048)	(0.0026)	(0.0028)	(0.0024)	(0.0025)
Special Education*2020-2021	-0.0045	-0.0059	0.0055+	0.0040	-0.0071*	-0.0075*
	(0.0038)	(0.0039)	(0.0031)	(0.0029)	(0.0028)	(0.0030)
Special Education*2021-2022	-0.0031	-0.0079*	0.0137***	0.0129**	0.0007	0.0024
	(0.0038)	(0.0037)	(0.0037)	(0.0041)	(0.0027)	(0.0030)
English Learner	-0.0237***	-0.0228**	-0.0087	-0.0093	0.0042	0.0048
	(0.0068)	(0.0069)	(0.0073)	(0.0069)	(0.0047)	(0.0048)
Special Education	0.0075***	0.0084***	0.0149***	0.0154***	0.0265***	0.0258***
	(0.0019)	(0.0019)	(0.0014)	(0.0014)	(0.0020)	(0.0018)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	817098	786201	763027	735004	763027	735004

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A11: End-of-Year Teacher Attrition and Mobility by STEM Endorsements; Michigan Traditional Public and Charter Teachers; 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0012***	-0.0009**	0.0049***	0.0052***	-0.0023***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	-0.0011	-0.0004	-0.0299***	-0.0295***	-0.0009	-0.0006
	(0.0019)	(0.0019)	(0.0020)	(0.0019)	(0.0015)	(0.0016)
2020-2021	0.0132***	0.0118***	-0.0110***	-0.0108***	0.0037*	0.0038*
	(0.0020)	(0.0021)	(0.0022)	(0.0021)	(0.0019)	(0.0019)
2021-2022	0.0211***	0.0197***	-0.0093***	-0.0086***	0.0034+	0.0032
	(0.0023)	(0.0023)	(0.0021)	(0.0020)	(0.0019)	(0.0020)
Math*2019-2020	0.0009	0.0010	-0.0040+	-0.0044*	0.0058*	0.0062*
	(0.0033)	(0.0034)	(0.0022)	(0.0022)	(0.0026)	(0.0027)
Math *2020-2021	-0.0023	-0.0022	-0.0052+	-0.0049+	0.0028	0.0031
	(0.0031)	(0.0031)	(0.0028)	(0.0028)	(0.0022)	(0.0023)
Math *2021-2022	0.0055	0.0047	-0.0034	-0.0025	0.0056**	0.0054*
	(0.0039)	(0.0040)	(0.0031)	(0.0030)	(0.0021)	(0.0022)
Science*2019-2020	0.0042	0.0034	-0.0011	-0.0018	0.0054*	0.0059*
	(0.0039)	(0.0039)	(0.0019)	(0.0020)	(0.0024)	(0.0025)
Science *2020-2021	0.0053	0.0058	-0.0067*	-0.0077**	0.0013	0.0015
	(0.0038)	(0.0039)	(0.0029)	(0.0029)	(0.0023)	(0.0024)
Science *2021-2022	0.0064	0.0069	-0.0028	-0.0016	0.0019	0.0021
	(0.0041)	(0.0042)	(0.0031)	(0.0031)	(0.0021)	(0.0022)
Math	-0.0134***	-0.0142***	0.0080***	0.0080***	-0.0008	-0.0006
	(0.0013)	(0.0013)	(0.0012)	(0.0012)	(0.0009)	(0.0009)
Science	-0.0125***	-0.0137***	0.0072***	0.0075***	-0.0028**	-0.0028**
	(0.0015)	(0.0014)	(0.0011)	(0.0011)	(0.0009)	(0.0010)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	841297	802292	784402	749072	784402	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A12: End-of-Year Teacher Attrition and Mobility by Gender, Michigan Traditional Public and Charter Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0012***	-0.0009**	0.0049***	0.0052***	-0.0023***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	-0.0030	-0.0022	-0.0309***	-0.0311***	0.0026	0.0032+
	(0.0026)	(0.0026)	(0.0023)	(0.0022)	(0.0018)	(0.0019)
2020-2021	0.0154***	0.0148***	-0.0159***	-0.0158***	0.0056**	0.0059**
	(0.0027)	(0.0028)	(0.0025)	(0.0024)	(0.0020)	(0.0021)
2021-2022	0.0235***	0.0227***	-0.0137***	-0.0128***	0.0057**	0.0053*
	(0.0029)	(0.0030)	(0.0026)	(0.0025)	(0.0021)	(0.0022)
Female*2019-2020	0.0030	0.0028	0.0008	0.0014	-0.0033*	-0.0036*
	(0.0024)	(0.0024)	(0.0014)	(0.0014)	(0.0016)	(0.0016)
Female*2020-2021	-0.0026	-0.0037	0.0051**	0.0052**	-0.0021	-0.0022
	(0.0025)	(0.0026)	(0.0019)	(0.0020)	(0.0016)	(0.0016)
Female*2021-2022	-0.0017	-0.0028	0.0051**	0.0050*	-0.0022	-0.0018
	(0.0028)	(0.0028)	(0.0020)	(0.0020)	(0.0015)	(0.0016)
Female	0.0027**	0.0025**	-0.0043***	-0.0040***	0.0027***	0.0023***
	(0.0009)	(0.0010)	(0.0006)	(0.0006)	(0.0007)	(0.0007)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	841297	802292	784402	749072	784402	749072

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A13: End-of-Year Teacher Attrition and Mobility by Grade Level Assignment, Michigan Traditional Public and Charter Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0015***	-0.0012***	0.0050***	0.0053***	-0.0023***	-0.0024***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
2019-2020	-0.0029	-0.0020	-0.0348***	-0.0344***	0.0022	0.0032
	(0.0023)	(0.0023)	(0.0024)	(0.0022)	(0.0019)	(0.0020)
2020-2021	0.0156***	0.0148***	-0.0153***	-0.0149***	0.0044*	0.0046*
	(0.0025)	(0.0026)	(0.0027)	(0.0026)	(0.0019)	(0.0020)
2021-2022	0.0274***	0.0260***	-0.0114***	-0.0103***	0.0061**	0.0066**
	(0.0028)	(0.0028)	(0.0025)	(0.0023)	(0.0021)	(0.0022)
Elementary*2019-2020	0.0060*	0.0050+	0.0065***	0.0068***	-0.0035	-0.0043
	(0.0027)	(0.0027)	(0.0017)	(0.0016)	(0.0026)	(0.0027)
Elementary *2020-2021	-0.0027	-0.0033	0.0048*	0.0048*	0.0004	0.0001
	(0.0032)	(0.0033)	(0.0022)	(0.0022)	(0.0025)	(0.0025)
Elementary *2021-2022	-0.0067*	-0.0067*	0.0025	0.0020	-0.0062**	-0.0070**
	(0.0028)	(0.0029)	(0.0025)	(0.0025)	(0.0021)	(0.0022)
Elementary	-0.0249***	-0.0252***	-0.0077***	-0.0078***	0.0139***	0.0127***
	(0.0014)	(0.0014)	(0.0012)	(0.0011)	(0.0016)	(0.0016)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	703425	676709	656629	632520	656629	632520

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A14: End-of-Year Teacher Mobility and Attrition by Collective Bargaining Agreement Restrictiveness, Michigan Public and Charter School Teachers, 2012-13 through 2021-22

	Leave Teaching		Switch Districts		Switch Schools	
	(1)	(2)	(3)	(4)	(5)	(6)
Trend	-0.0006*	-0.0006^{+}	0.0046***	0.0046***	-0.0028***	-0.0028***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
2019-2020	-0.0011	-0.0011	-0.0241***	-0.0241***	0.0052*	0.0052*
	(0.0028)	(0.0028)	(0.0018)	(0.0018)	(0.0026)	(0.0026)
2020-2021	0.0162***	0.0162***	-0.0060*	-0.0060*	0.0105**	0.0105**
	(0.0035)	(0.0035)	(0.0026)	(0.0026)	(0.0033)	(0.0033)
2021-2022	0.0220***	0.0219***	-0.0040	-0.0040	0.0070**	0.0070**
	(0.0035)	(0.0035)	(0.0028)	(0.0028)	(0.0026)	(0.0026)
Middle Tercile*2019-2020	0.0036	0.0036	0.0026	0.0025	-0.0056^{+}	-0.0056^{+}
	(0.0033)	(0.0033)	(0.0018)	(0.0018)	(0.0030)	(0.0030)
Middle Tercile*2020-2021	-0.0054	-0.0054	0.0000	-0.0000	-0.0043	-0.0043
	(0.0039)	(0.0039)	(0.0028)	(0.0028)	(0.0034)	(0.0034)
Middle Tercile*2021-2022	-0.0009	-0.0009	0.0003	0.0003	-0.0022	-0.0022
	(0.0040)	(0.0040)	(0.0031)	(0.0031)	(0.0024)	(0.0024)
Top Tercile*2019-2020	-0.0027	-0.0025	0.0036^{+}	0.0038^{+}	-0.0001	-0.0001
	(0.0042)	(0.0042)	(0.0021)	(0.0021)	(0.0040)	(0.0040)
Top Tercile*2020-2021	-0.0040	-0.0038	-0.0037	-0.0035	-0.0066	-0.0066
	(0.0047)	(0.0047)	(0.0030)	(0.0030)	(0.0041)	(0.0041)
Top Tercile*2021-2022	-0.0052	-0.0050	-0.0023	-0.0021	0.0005	0.0005
	(0.0046)	(0.0046)	(0.0038)	(0.0038)	(0.0031)	(0.0031)
Middle Tercile	0.0025	0.0027	-0.0004	-0.0002	0.0083***	0.0083***
	(0.0020)	(0.0019)	(0.0014)	(0.0015)	(0.0016)	(0.0016)
Top Tercile	0.0002	0.0005	-0.0047**	-0.0044*	0.0088***	0.0086***
	(0.0025)	(0.0025)	(0.0018)	(0.0017)	(0.0021)	(0.0022)
Teacher Characteristics	Y	Y	Y	Y	Y	Y
School Characteristics	Y	Y	Y	Y	Y	Y
District Urbanicity	Y	Y	Y	Y	Y	Y
Instructional Modality	N	Y	N	Y	N	Y
Observations	704072	703924	660641	660518	660518	660518

Notes: All samples include all Michigan public and charter school teachers with a teaching assignment in at least one school year between 2012-13 and 2022-23. The "leave teaching" sample includes all teachers with multiple school or district assignments. The "switch districts" and "switch schools" samples include all Michigan teachers with 100% FTE in their primary school or district, respectively. School characteristics include the share of students in each school who are female, Asian, Black, Latino, Other race, economically disadvantaged, and eligible for special education or English learner services. Robust standard errors clustered at the school or district level in parentheses (for school and district mobility/attrition, respectively). $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$