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COVID-19 Working Paper: Migration, Local Mobility, and the Spread of COVID-19 in Rural America

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Abstract

This paper examines how movement between and within communities was linked to the initial arrival and spread of Coronavirus (COVID-19) infections into and through nonmetropolitan (nonmetro) counties. Drawing on data from governmental and non-governmental sources, the analysis reveals patterns of hierarchical diffusion, with COVID-19 infections quickly spreading to progressively smaller places during the first 3 months of 2020. COVID-19 arrived earlier in nonmetro counties with stronger migration ties to metro regions. Once present in a nonmetro county, the infection spread more quickly in those where populations were less able to limit day-to-day movements, and overall nonmetro counties were less able to limit day-to-day mobility compared to metro counties. From April through June 2020, counties where mobility remained high (similar to pre-pandemic levels) showed COVID-19 infection rates twice those of counties with greater reductions in day-to-day mobility. While infection rates increased across all nonmetro counties through summer 2020, the gap persisted between counties with reduced local mobility and those with high mobility. These findings suggest that in the absence of medical interventions (e.g., vaccines and treatment), limiting movement between and within places may slow the spread of highly contagious viruses, and certain types of places may be less able to implement these nonmedical tactics and may therefore be at greater risk in future pandemics. The analysis also suggests that more risk-prone communities may benefit from more robust testing programs.

Keywords: Coronavirus, COVID-19, migration, local mobility, urban-rural hierarchy

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What Is the Issue?

Coronavirus (COVID-19) infections were first detected in the United States on January 20, 2020, and quickly spread across the country. With limited medical interventions available, public health officials quickly turned to mobility restrictions to slow the spread of this highly contagious virus between and within places. Teleworking, remote schooling, takeout-only dining, and limiting social gatherings reduced local-scale mobility, while travel restrictions and mandatory quarantines curtailed movements between communities. Despite these efforts, the virus spread between and within locations, yet the pace and severity were uneven across space. This paper examines how movements between and within places were linked to the initial arrival and subsequent spread of COVID-19 in nonmetropolitan (nonmetro) counties. Understanding the geographical dimensions of the COVID-19 pandemic is important for informing effective policy responses when facing similar public health crises in the future.

What Did the Study Find?

- COVID-19 infections quickly spread from the largest metropolitan centers to progressively smaller and more rural regions.
- Nonmetro counties with the strongest migration connections to metropolitan regions tend to be micropolitan (those with a population between 10,000 and 49,999), metropolitan-adjacent, Government-dependent, and recreation counties.
- COVID-19 arrived 1 to 2 weeks earlier in nonmetro counties with the strongest migration connections to metropolitan regions and was slower to arrive in counties with weaker metropolitan migration ties.
- Nonmetro counties were less able to limit local day-to-day mobility than metropolitan counties.
- Micropolitan counties showed the greatest reductions in day-to-day mobility compared to other nonmetropolitan counties.
- Farm-dependent counties maintained local mobility that was most like pre-pandemic levels, while Government-dependent and recreation counties showed the greatest reductions in local mobility.
- Starting April 15, 2020, new infection rates in counties where mobility declined the most were 50 percent less than counties where mobility remained similar to pre-pandemic levels, suggesting restrictions of local movement can slow the spread of COVID-19 infections in the community.

How Was the Study Conducted?

The analysis drew on three different data sources. The U.S. Department of Commerce, Bureau of the Census county-to-county migration flow files 2012–16 provide information on movement between places. Google's "Community Mobility Reports" provide information on day-to-day movements within a community from January through December 2020. The Johns Hopkins University Coronavirus Resource Center maintains a database of daily county-level information on new COVID-19 infections since the onset of the pandemic in early 2020. We first used the county-to-county migration flow files to compute metropolitan gross migration rates, pairing each nonmetro county with the aggregation of all metropolitan counties. This metropolitan gross migration rate provided an estimate of nonmetro-metro migration connectedness, or the strength of ties linking nonmetro counties to metro regions. The analysis grouped nonmetro counties into quartiles (four equally sized groups) based on gross migration rate and then profiled these quartiles in terms of geographic distribution, position in the urban hierarchy, and economic structure. The study then traced the level of COVID-19 infections over the first 6 months of the pandemic to determine how the timing and pace of infections differed across the four quartiles. The study applied the same approach with quartiles for the analysis of local mobility by first grouping nonmetro counties based on the level of mobility reduction as of April 15, 2020, when mobility levels were at their lowest. The authors provided similar profiles of the mobility quartiles in terms of geographic distribution, position along the urban-rural hierarchy, and economic structure, and concluded by tracing new COVID-19 infections over time for the four quartiles to assess how infection levels varied by degree of mobility reduction.

Migration, Local Mobility, and the Spread of COVID-19 in Rural America

Introduction

This study examines the spread of COVID-19 into and across nonmetro counties during the first 6 months of the pandemic. The first confirmed case of COVID-19 in the United States was reported on January 20, 2020, and total infections surpassed 1,000 by early March. The highly contagious virus first appeared in hotspot cities like New York and Seattle, but cases quickly emerged in places down the urban hierarchy. A case identified in Humboldt County, California on February 21, marked the virus's first appearance in a nonmetro county. Additional cases were soon reported elsewhere in the nonmetro West in Umatilla County, Oregon, as well as in Grafton County, New Hampshire. By late March, more than 25 percent of nonmetro counties had reported at least one COVID-19 case. By April 11, just 7 weeks after the virus first arrived in a nonmetro county, three out of four nonmetro counties had documented cases of COVID-19 infections.

Public health officials knew early on that individuals contracted COVID-19 after inhaling respiratory droplets from people already infected. Movement of infected individuals between places introduced the virus to previously uninfected communities. Once the virus became present in each place, movement within communities (for commuting, shopping, recreation, and socializing) accelerated its spread. Facing a dangerous global pandemic, public officials in early March issued a series of stay-at-home orders to reduce both types of movement. States ordered mandatory 14-day quarantines for interstate travelers, people were asked to work from home, students shifted to remote learning, restaurants closed or operated with limited capacity, and large public gatherings were suspended. These policy responses were based on knowledge about the ways different types of human movement contribute to the diffusion of contagious diseases over time and space.

Human movements between and within places vary considerably across space, so their contribution to the spread of COVID-19 varies spatially. Some rural communities have long histories as recreation or tourist destinations and will have more established migration connections to larger cities. Similarly, some communities may be better positioned to reduce local mobility due to the structure of their economy, such as easier access to certain goods and services. This paper examined how these forms of movement—migration and local mobility—contributed to the initial spread of COVID-19 into and within rural regions. Two questions guided the authors' analysis:

1. How did past patterns of migration relate to the spread of COVID-19 into rural counties during the initial months of the pandemic?
2. How did differences in the early reduction of work-related mobility relate to the spread of COVID-19 within rural counties during 2020?

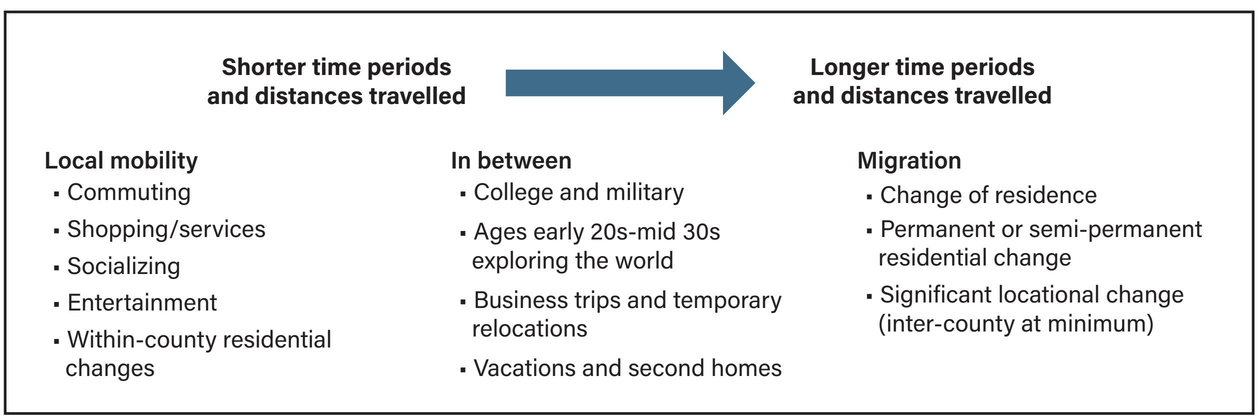
Understanding the ways migration and mobility contribute to the spread of COVID-19 is important given the pandemic's long duration, the emergence of new virus strains, and the likelihood of similar crises in the future. Knowing which rural communities are more prone to early exposure of new viruses or new strains can enable more efficient allocation of monitoring and mitigation resources. Further, identifying which communities have reduced capacities to curtail local mobility could allow policy makers to better distribute vaccines and other medical interventions, given that behavioral responses (i.e., stay-at-home orders) to reduce local diffusion are less likely to be effective.

Background

Demographers and others tracked the emergence and spread of COVID-19 at the county level and analyzed the spatial determinants of its spread and intensity in the United States (Maiti et al., 2021; Haischer et al., 2020; Paul et al., 2021). Several papers focused on the causes and impacts of COVID-19 transmission in rural counties (Cohen, 2020; Krumel and Goodrich, 2021; Dobis and McGranahan, 2021). These studies identified key county-level characteristics explaining spatial differences in levels and severity of transmission, including population density, age, race, occupations, access to healthcare, industry structure, and the presence of institutional populations in nursing homes and prisons. However, none of these studies included county-to-county migration or within-county mobility differences in their analyses.

Human movements can be temporary, permanent, or somewhere in between. They also can be very localized or cover vast distances. Spatial and temporal variations create a continuum of human movements, with migration and local mobility at opposite ends (figure 1). Local mobility includes shopping, socializing, and commuting to work, activities that tend to be relatively short in duration and cover shorter distances. Changes of residence from one county to another in the United States (international migration could be included as well) are typically longer lasting and often cover long distances; such moves are what scholars recognize as migration. These conceptual distinctions in types of human movements allow us to distinguish separate mechanisms through which COVID-19 can spread between and within places. Intermediate forms of human movement not included in this analysis—such as vacations, business travel, college attendance, military service, and time spent at a second home—likely contributed significantly to the transmission of COVID-19 during 2020 as well. Data on these types of place-to-place movements are severely limited compared with those on county-to-county migration flows.

Figure 1
Types of human movement from local mobility to migration



Source: USDA, Economic Research Service.

Migration Along Established Urban-Rural Pathways

All migration decisions rely to some degree on information. A potential migrant arrives at a decision to move after comparing their "…present location with all those about which he [sic] has knowledge" (Roseman 1971). Knowledge sources include formal information provided by real estate agencies, public officials, or local chambers of commerce. Sources also include family, friends, or personal visits. Initial migration increases the flow of information between origin and destination, facilitating further migration and establishing a migration pathway that tends to persist over time.

Brown et al. (2011) document this process in the rural United States when describing how retirement destinations emerge over time: "…in-migrant retirees sometimes recruit friends…to join them as permanent residents…. Once a place becomes established as an attractive vacation and retirement spot, migration networks are likely to develop and continue to recruit additional migrants over time." These self-reinforcing paths can connect places across great distances, including international borders. Temporary visits to rural areas can contribute to the development of entrenched migration paths, shaping the set of possible destinations a migrant is considering by providing information about specific places (Snepenger et al., 1995; Williams and Hall, 2000; Cuba, 1989). Circulation between a primary residence and a second home is also often a precursor to migration (Nelson and Nelson, 2011; Nelson and Cromartie, 2009).

As the COVID-19 pandemic accelerated and urban residents began to leave the city for the countryside, it is likely they followed established migration paths. During the early stages of the pandemic, the popular news media reported several stories of "COVID refugees" fleeing densely settled urban areas for rural destinations perceived to be safer (Bowlin, 2021; Bubola, 2021; Dillon, 2020; Hughes, 2020; Porter, 2020; Quealy, 2020; Tully and Stowe, 2020). These accounts document urban-to-rural migration across all regions of the United States, as well as in parts of Europe.

The authors hypothesize that nonmetro counties with higher migration connectivity to metro areas were more likely to experience outbreaks of COVID-19 during the first few weeks and months of the pandemic compared with less-connected nonmetro counties. Understanding the link between levels of migration and the initial spread of COVID-19 will allow communities to better prepare, as these established migration paths are likely to influence the early arrival of newly emerging virus strains and future pandemics.

Challenges To Reducing Local Mobility

Each State or territory has the right to enact policies or laws to manage public health, and by mid-March 2020—lacking effective treatments and without any vaccine—public health officials began to issue stay-at-home orders to slow the spread of COVID-19. The duration and severity of these orders varied over time and across space. On March 15, Puerto Rico became the first to impose restrictions on mobility, and by May 31, 39 States, the District of Columbia, and 2 territories (covering 73 percent of all counties) issued mandatory stay-at-home orders for at least some of the population. Six States and two territories issued advisory recommendations, while five States issued no such orders. On April 24, Alaska was the first State to begin rescinding these orders, and by the end of May, only seven States and one territory had mandatory restrictions limiting mobility for all residents (Moreland et al., 2020).

These measures dramatically reduced day-to-day mobility and movement within some communities, while others faced challenges in limiting local-scale movement. Rural areas have lower population densities and residents must travel greater distances for basic daily activities, such as shopping and doctor visits. While lower density may reduce the communicable spread of COVID-19, it limits the degree that rural residents can reduce daily movements to slow a virus' spread. Also, rural counties depend on agriculture and manufacturing more than other areas (Low, 2017; Vias and Nelson, 2006). Agriculture and manufacturing jobs require employees to travel to work sites, so work-from-home mandates are less likely to reduce mobility of rural workers. Inadequate broadband infrastructure makes it more difficult for rural workers with jobs that could be done remotely to effectively work from home. Holding other variables constant, nonmetro farms are 15 percent less likely to have high-speed internet access compared to metro farms (Basu and Chakraborty, 2011), and the lack of broadband access affects the potential for remote work across all sectors (Dobis et al., 2021).

Lack of other services more readily available in urban environments also reduces how effectively rural residents can shelter in place and lessen their mobility. Many rural areas lack grocery and meal delivery services. Grocery gaps and food deserts further compound rural residents' abilities to restrict their day-to-day movements within their communities. According to the USDA, Economic Research Service Food Desert Atlas, about 8 percent of rural residents (approximately 6 million people) live more than 10 miles from the nearest grocery store, forcing them to travel to larger urban centers for basic needs. Such increased travel and interaction with people from different areas potentially increases the risk of exposure to COVID-19.

Given that mobility reduction was one of the only mechanisms available to reduce community spread of COVID-19, the authors hypothesize that COVID-19 infection rates were lower for counties able to constrain their mobility to a greater degree. The analysis that follows highlights two key county characteristics, degree of rurality and economic type, that differentiate counties' abilities to limit day-to-day movements. This information has the potential to help policy makers focus on rural counties at greater risk of community spread of future COVID-19 and other communicable viruses.

Data and Methods

For the analysis, the authors reviewed data sources through 2020. Johns Hopkins University provides county-level data, reporting daily counts of new COVID-19 cases, cumulative cases, and cumulative deaths. This database, updated daily, contains records dating back to January 2020 when the first COVID-19 cases were reported in the United States. Migration data is from the 2012–16 county-to-county migration flow files tabulated from the American Community Survey of the U.S. Bureau of the Census. We use the 2012–16 flow data for three primary reasons. First, these were the most recent data available at the start of the pandemic. Second, as the literature review indicates, migration flows tend to follow established paths that change very slowly over time, so the paths present in the 2012–16 migration flow data likely persisted until the onset of the pandemic. Third, migration rates in the United States overall are declining (Cooke, 2010; Johnson et al., 2017), so using slightly older data (i.e., documenting moves coming out of the Great Recession) enabled the authors to identify established migration paths when there was more movement. Using these data, the authors constructed a flow matrix for each nonmetro county, tabulating in-migration to and out-migration from the aggregation of all metro counties. Using these in- and out- migration flows, the authors computed a gross migration rate between nonmetro counties and the aggregation of all metro territory. The gross migration rate for a given nonmetro county is the sum of migration to and from metro counties divided by the county's population. Compared with other migration measures, gross migration best captures all the migration interaction between two areas.

Finally, the authors used mobility data provided by Google reporting the relative change in movement of mobile devices on any given day compared with a baseline measure derived from the period January 3–February 6, 2020. The data are reported at the county level and include movements related to places of work, recreation and retail establishments, transit centers, grocery stores, parks, and residences. The Google mobility data lack complete coverage due to insufficient numbers of mobile users in small counties or inadequate cell tower structures in remote locations. Nonetheless, the database covers 88 percent of rural counties, and those counties are home to 98 percent of the rural population and 98 percent of confirmed COVID-19 cases. The Google data are most complete for commuting to places of work, so the authors used this as their proxy for changes in day-to-day movement within counties.[1] The analysis focuses on cases reported through the end of July 2020.

The authors used descriptive statistical techniques to explore the relationships between migration, mobility, and the spread of COVID-19 into and across nonmetro counties. To assess the role of county-to-county migration, nonmetro counties were grouped into quartiles based on their gross migration rates with metro regions. These simple quartiles clearly identify those nonmetro counties with the strongest metro migration connections (fourth-quartile counties) and those with much weaker metropolitan connections (first-quartile counties). Second- and third-quartile counties have more moderate metropolitan linkages. The authors profiled key spatial and economic differences across these gross migration quartiles and examined the extent and timing of the spread of COVID-19 cases across these four groups of nonmetro counties.

The authors adopted a similar approach to address the role of relative change in local mobility in the spread of COVID-19 infections in nonmetro counties. All nonmetro counties were grouped into quartiles based on change in workplace mobility as of April 15, 2020, the date when workplace- related mobility was at its lowest compared to pre-pandemic levels. Given that change in workplace-related mobility measured decreasing levels of movement, the first-quartile counties are those demonstrating the greatest relative declines in mobility and the fourth-quartile counties demonstrate local mobility most like pre-pandemic levels. Again, the authors examined geographic and economic characteristics across the four local mobility quartiles to identify factors that differentiate those places able to reduce day to day mobility to the greatest extent. Last, the authors tracked COVID-19 infection rates for these four groups of counties during the first 6 months of the pandemic to highlight the ways infections lag in places with greater reductions in local mobility. These results can be particularly helpful in identifying areas at greater risk when similar public health crises occur in the future.

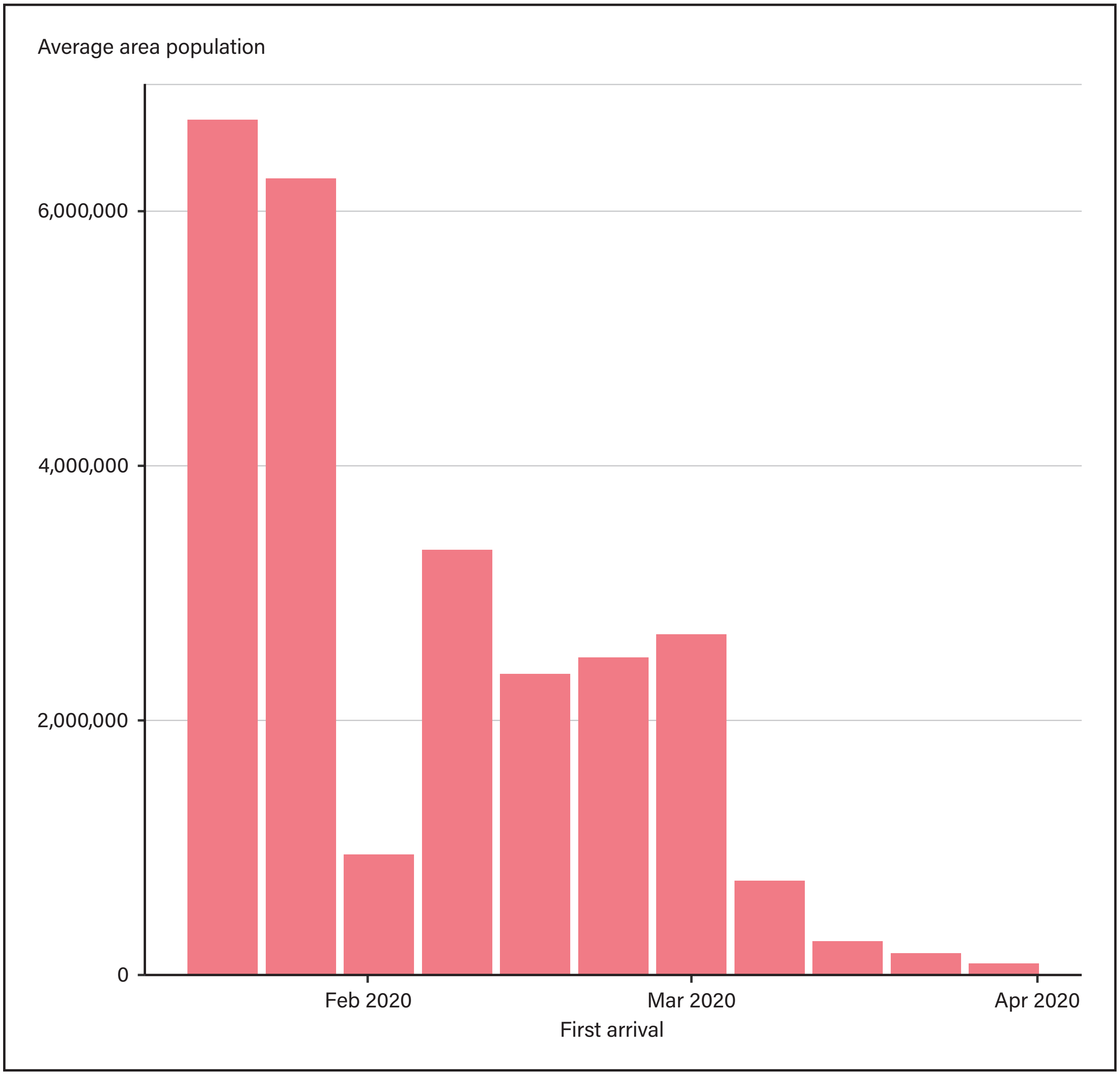
Results

After first appearing in the United States in early 2020, COVID-19 infections initially spread mainly among metro counties, then down the urban hierarchy into progressively smaller urban centers (figure 2).

[1] Assessment of the Google data in nonmetro counties with coverage across multiple mobility indicators shows change in place of work mobility to be highly correlated with other types of local movements.

Figure 2

Week of first arrival of COVID-19 in metro counties by size of metro area, January 19 – March 29, 2020



Notes: For each week from January 19–March 29, 2020, this graph shows the average size of all metro areas experiencing an initial outbreak of COVID-19 during that week. The average size dipped dramatically during the third week (starting Feb 2) because COVID-19 was detected for the first time in only one metro area, Worcester MA, with a population of 947,000.

Source: Peter Nelson, Middlebury College, using data from The Johns Hopkins University Coronavirus Resource Center.

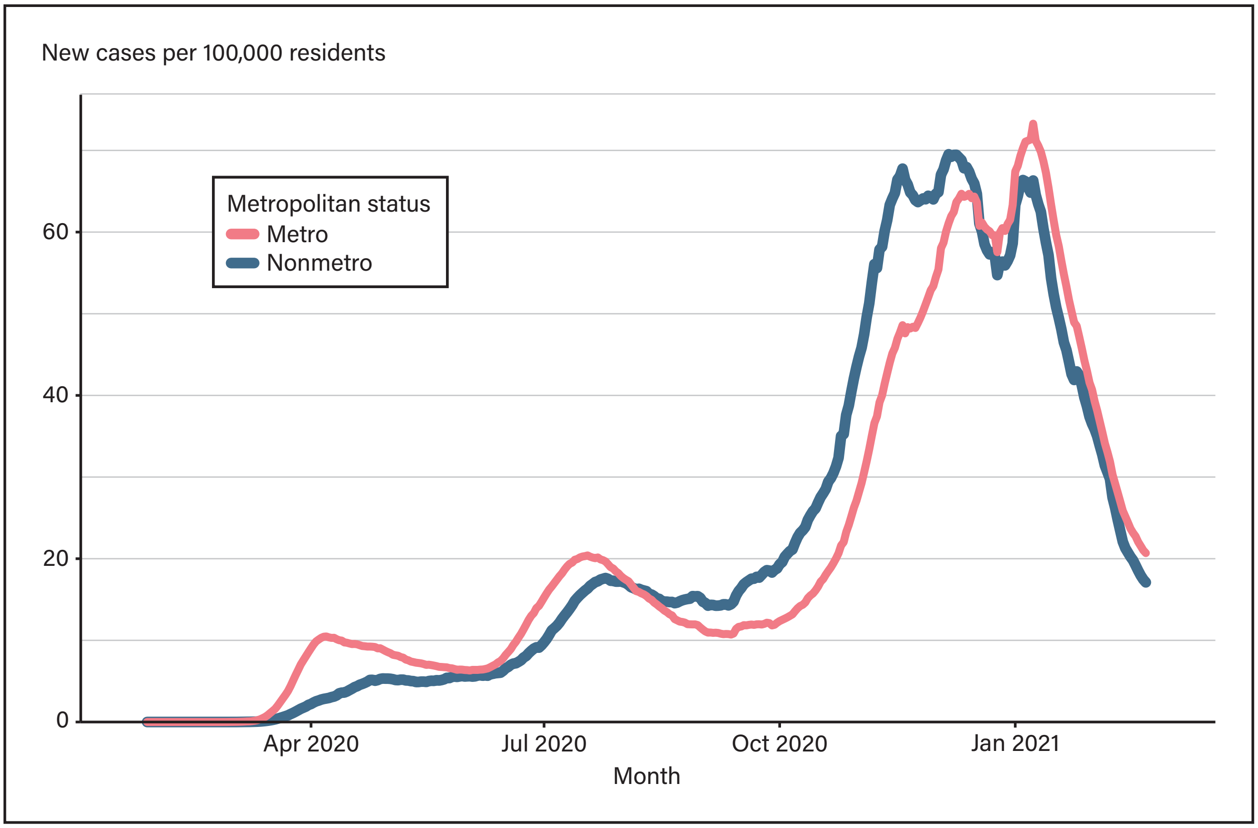
In mid-January 2020, the first two metro areas recording COVID-19 infections had an average population of over 6.6 million residents. One week later, the virus had spread to four more metro areas with a smaller average size of just over 6 million residents, and by March the virus was emerging in metro areas with fewer than 3 million residents on average. While this hierarchical diffusion shaped the primary geography of the pandemic during its early stages, nonmetro counties were not immune to COVID-19 infections (figure 3). The rolling mean[2] new case rate for metro and nonmetro areas shows that the earliest COVID-19 spikes

[2] When reporting new case rates, we use a 14-day rolling mean which for each date takes the average of values for the 7 days prior and the 7 days following each specific date. This technique smooths out variations caused by different reporting practices from place to place.

occurred in metro areas. In April 2020, metro case rates had their first spike, with average daily infections surpassing 10 new cases per 100,000 residents, more than triple the nonmetro new infection rate in the spring. The summer surge also arrived slightly earlier in metro areas, with case rates spiking once more in early July. The summer surge was also evident in nonmetro areas, though lagging the metro spike by a few weeks. By late summer, however, nonmetro new infection rates surpassed metro rates for the first time and continued to do so for the remainder of the year.

Figure 3

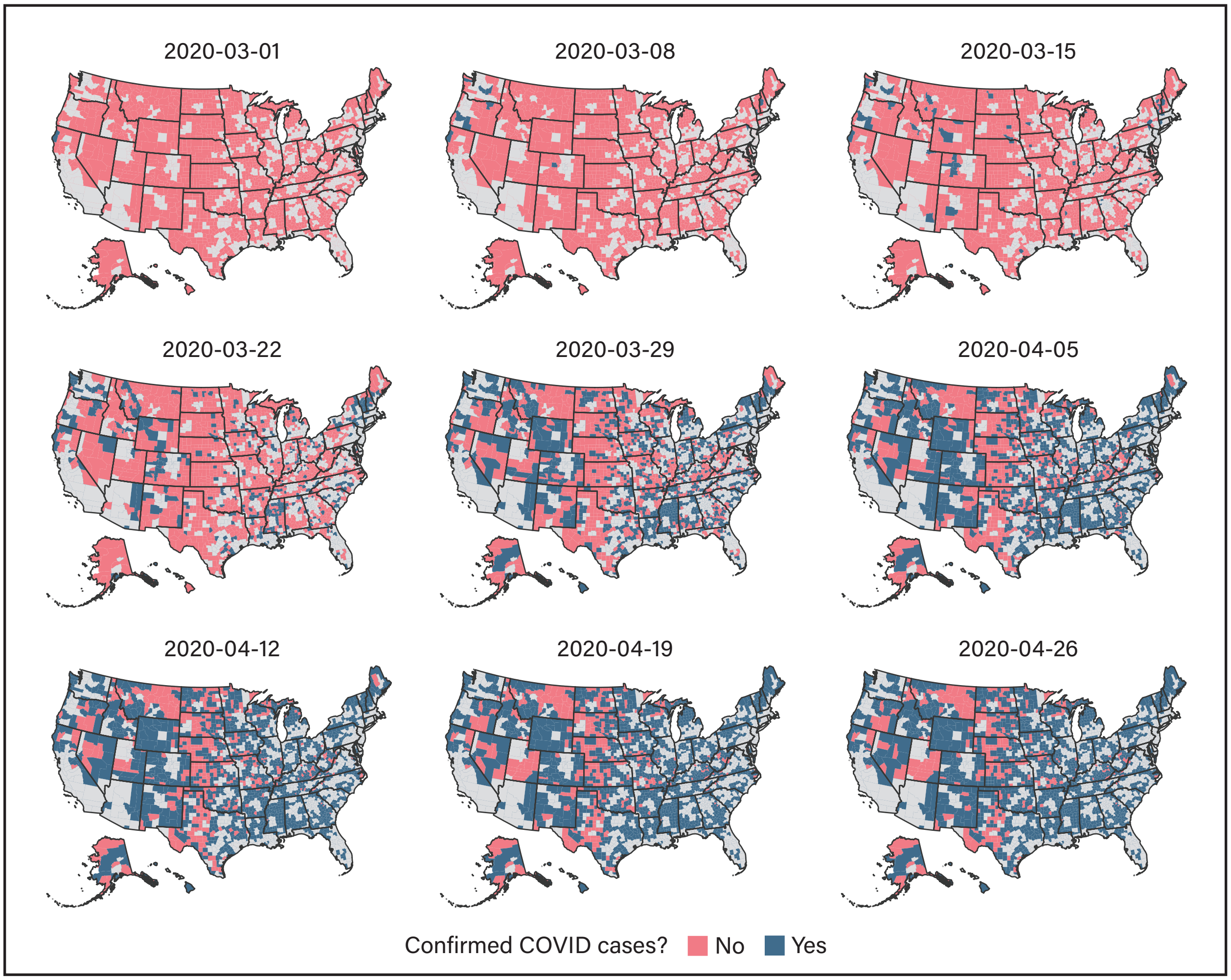
New COVID-19 cases per 100,000 residents by metro and nonmetro status, March 2020–January 2021



Source: Peter Nelson, Middlebury College, using data from The Johns Hopkins University Coronavirus Resource Center.

The spread of COVID-19 into and through nonmetro regions was quite rapid (figure 4). After first arriving on the West Coast, cases next appeared in counties in the Rockies, home to destination ski areas such as Vail in Colorado and Sun Valley in Idaho. Pockets were also appearing by the third week in March throughout the rural Great Plains, primarily in counties with meatpacking plants, and in the Northeast. In the fourth week of March, significant clusters of cases appeared in high-poverty areas of the rural South, especially Mississippi. Within 7 weeks of first arriving in Humboldt County, California, more than 75 percent of all nonmetro counties had at least 1 confirmed case.

Figure 4
Nonmetro counties with one or more confirmed COVID-19 cases



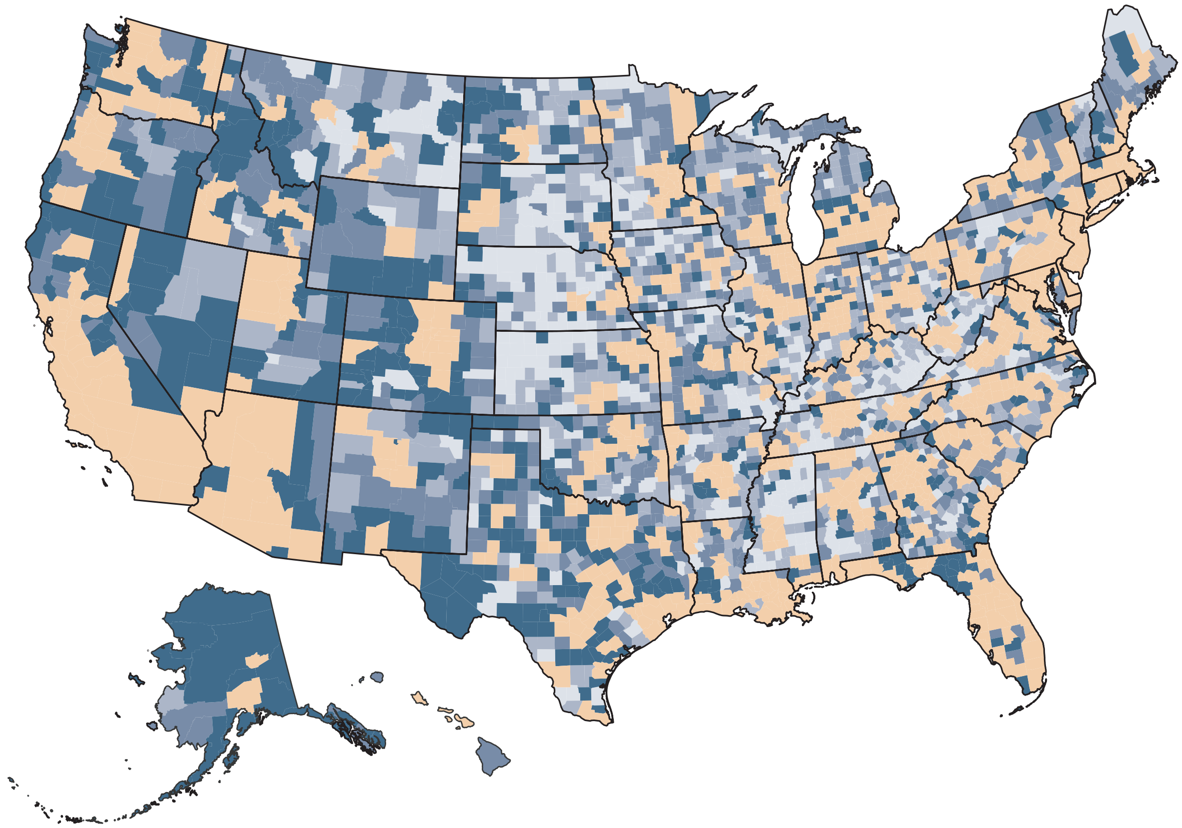
Source: Peter Nelson, Middlebury College, using data from The Johns Hopkins University Coronavirus Resource Center.

Movement of infected individuals between places is the primary mechanism contributing to the spread of COVID-19 infections across space, and gross migration rates are one measure reflecting such movement. They measure the relative size of established migration paths with metro origins and destinations. Nonmetro counties are grouped into quartiles based on their metro gross migration rate (figure 5). Proximity to metro regions explains much of the spatial variation in these gross migration rates. Remote counties far from any metro region, such as in the central and northern Great Plains, fall in the lowest gross migration quartile, indicating weak migration connections with metro regions. Conversely, counties falling in the fourth quartile indicating the strongest migration connectivity are typically adjacent to metro centers. This is evident in southern New Hampshire, along the Front Range in Colorado, and in parts of Texas adjacent to Houston, Dallas-Fort Worth, and San Antonio.

Proximity alone, however, cannot fully explain the spatial distribution of these migration quartiles. Counties with the highest metro migration connections can be found in remote regions of Wyoming, Idaho, and North Dakota. There are also adjacent nonmetro counties in Mississippi and West Virginia that fall in the lowest migration quartile. Thus, factors beyond simple proximity help shape these levels of connectivity with metro areas. These factors include unique economic conditions in places like western North Dakota, with its burgeoning energy sector, as well as established amenity destinations in places like the Colorado Rockies, Sun Valley Idaho, Jackson Wyoming, and along the Washington and Oregon coasts.

Figure 5

Nonmetro counties by level of migration with metro counties (gross migration rate)



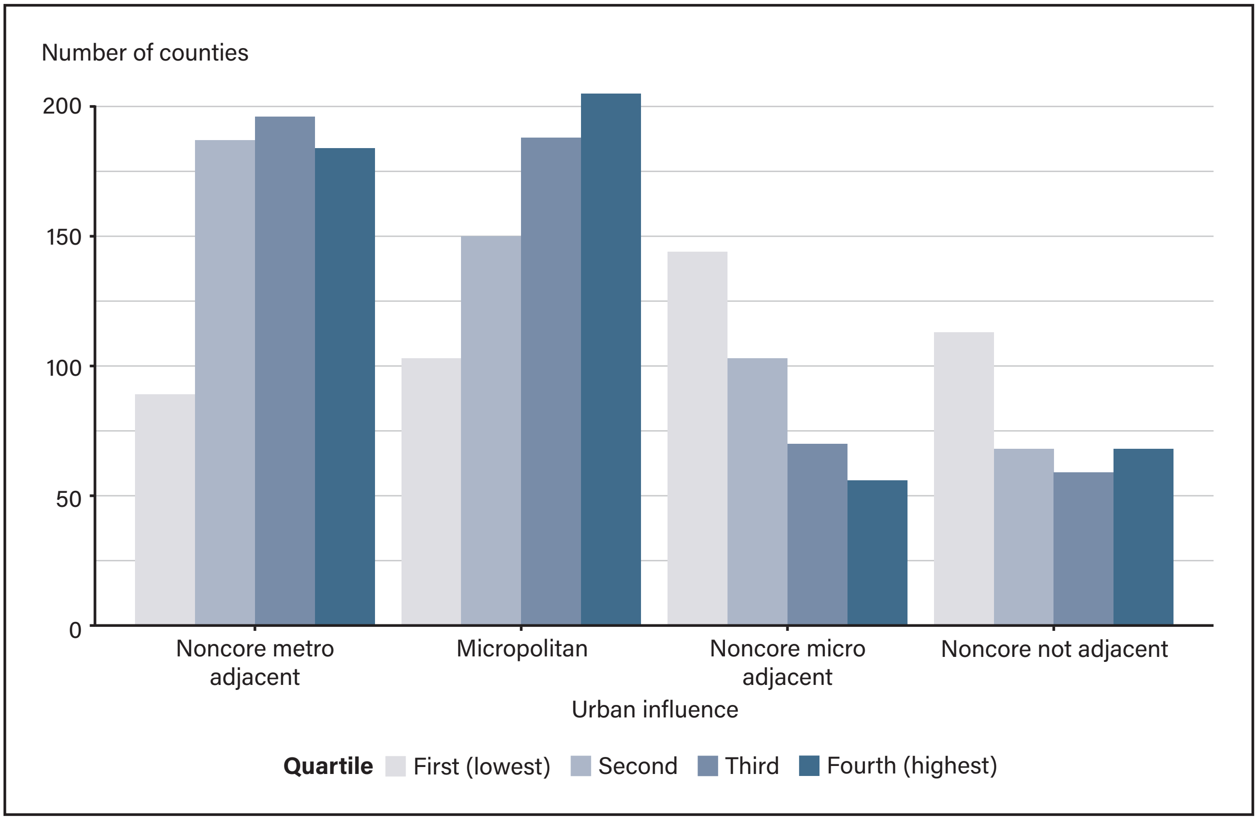
Notes: The gross migration rate for a given nonmetro county is the sum of all its migration flows to and from metro areas, as a percentage of the county's population. Counties are sorted from lowest to highest gross migration rate and divided into four equal quartiles. Western states have the highest gross migration rate.

Source: Peter Nelson, Middlebury College, using data from U.S. Bureau of the Census American Community Survey, 2012–16 County-to County migration flows.

Despite exceptions for counties in scenic locations, the map suggests that gross migration for nonmetro counties decreases as the level of rurality increases. If the distribution by level of rurality did not vary, we would expect to see bars of relatively equal height for each subgroup in figure 6. For example, there are 308 non-core, not-adjacent counties across the nonmetro United States, so if gross migration was not shaped by level of rurality, we would expect there to be 77 counties in each of the gross migration quartiles for the non-core not-adjacent subset. There are in fact more than 100 non-core not-adjacent counties in the lowest migration quartile, and the remaining such counties are equally distributed across the higher migration quartiles. Both metro-adjacent and micropolitan counties have much stronger migration connections with metro regions. Communities in these counties are likely more prone to early exposure to new viruses as they spread from metro areas and are therefore prime candidates for early intervention and monitoring.

Figure 6

Level of migration with metro counties (gross migration rate) for nonmetro counties by level of rurality

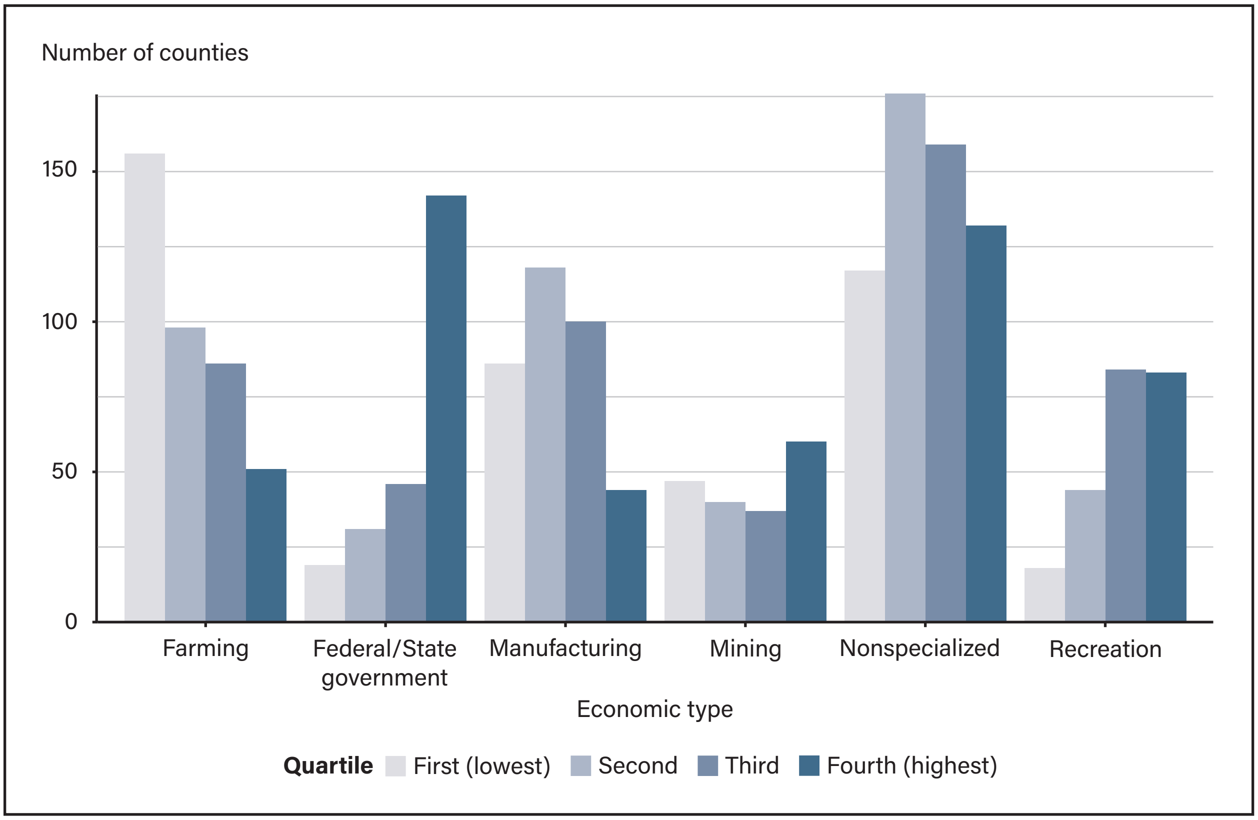


Notes: The gross migration rate for a given nonmetro county is the sum of all its migration flows to and from metro areas, as a percentage of the county's population. Counties are sorted from lowest to highest gross migration rate and divided into four equal quartiles. Level of rurality is measured using a modified version of the USDA, Economic Research Service (ERS), Urban Influence Codes. See the USDA, ERS Urban Influence Codes topic page for details.

Source: Peter Nelson, Middlebury College, using data from U.S. Bureau of the Census American Community Survey, 2012–v16 County-to County migration flows, and The Johns Hopkins Coronavirus Resource Center.

Economic factors influence these metro migration connections (figure 7). While there are roughly equal numbers of mining-dependent counties across the four quartiles, the other county types show much more variation in degree of metro migration connectivity. Farming-dependent regions show weaker migration connections with metro regions, as more than 150 (nearly 40 percent) of these counties fall in the lowest gross migration quartile. In contrast, Government- and recreation-dependent counties display much stronger migration connections with metro regions as disproportionate numbers of these counties fall in the higher migration quartiles. The tendency for recreation-dependent counties to display strong migration links with metro regions is consistent with the literature discussed above highlighting the ways nonmetro migration pathways develop over time, and increased movement along these established migration pathways likely brought the COVID-19 virus from urban to rural regions.

Figure 7
Level of migration with metro counties (gross migration rate) for nonmetro counties by economic type



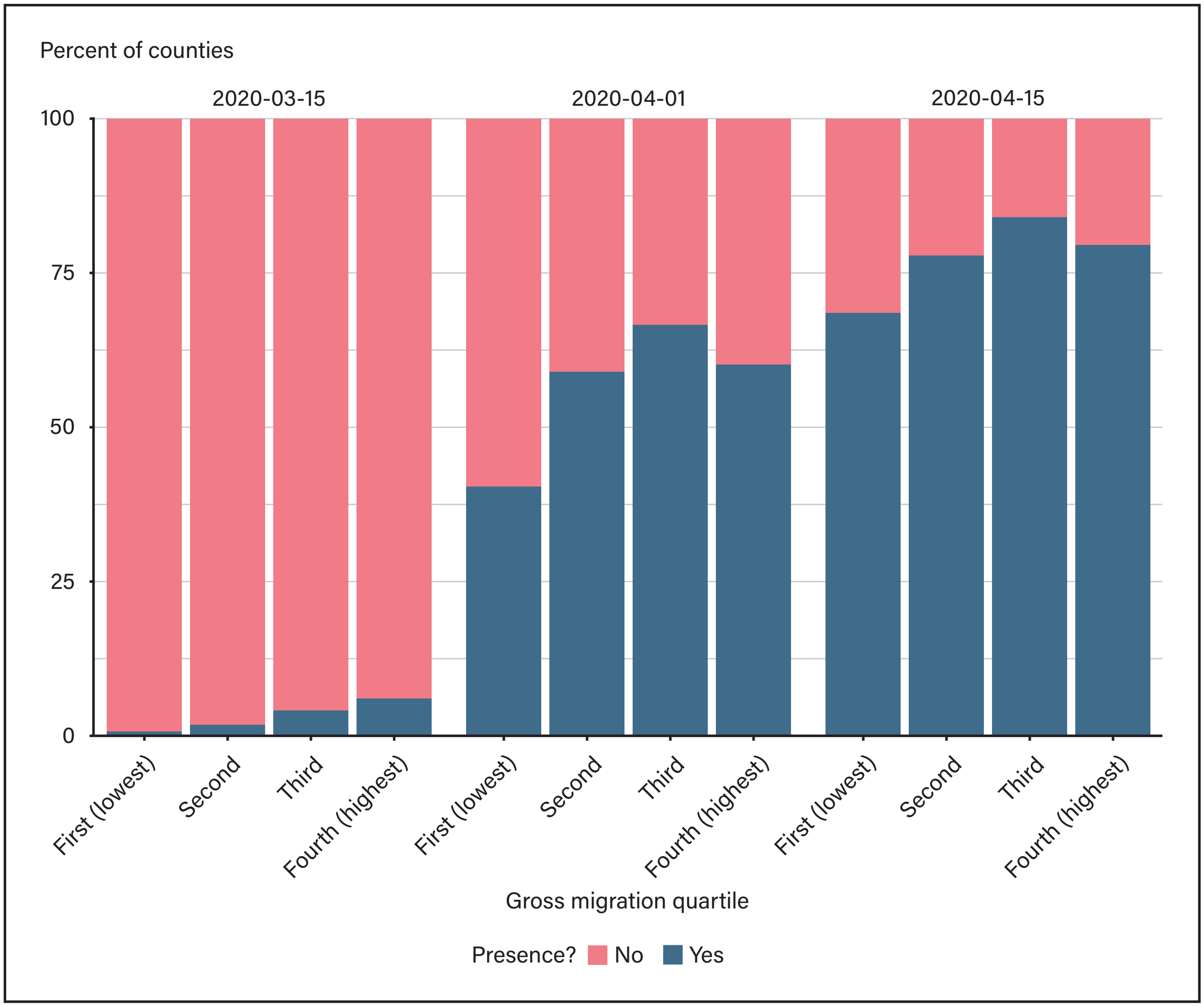
Notes: The gross migration rate for a given nonmetro county is the sum of all its migration flows to and from metro areas, as a percentage of the county's population. Counties are sorted from lowest to highest gross migration rate and divided into four equal quartiles. Economic type is determined using the USDA, Economic Research Service County Typology Codes. Counties with no dominant economic sector are classified as nonspecialized. See the USDA, ERS County Typology Codes topic page for more details.

Source: Peter Nelson, Middlebury College, using data from U.S. Bureau of the Census American Community Survey, 2012–16 County-to County migration flows.

The relationship between established rural-urban migration paths and the spread of COVID-19 into nonmetro counties was evident during the first weeks of the pandemic (figure 8). The first nonmetro counties with confirmed cases were disproportionately those in the highest migration quartile. On April 1 and April 15, a statistically significant smaller share of counties in the lowest migration quartile remained COVID free, 60 percent and 30 percent respectively.

Figure 8

Proportion of nonmetro counties with confirmed COVID-19 cases by level of migration with metro counties (gross migration rate), March 15, 2020–April 15, 2020

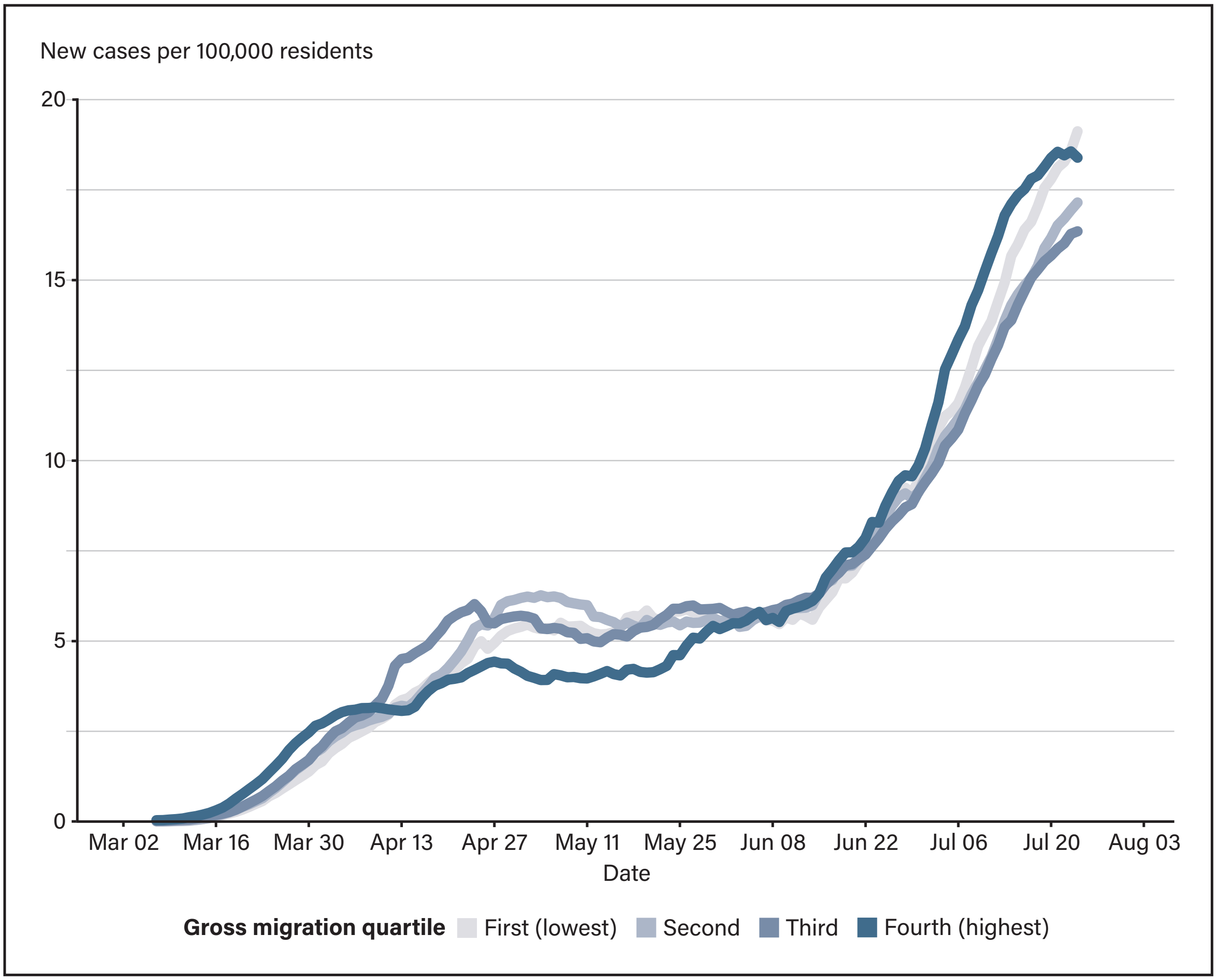


Notes: The gross migration rate for a given nonmetro county is the sum of all its migration flows to and from metro areas, as a percentage of the county's population. Counties are sorted from lowest to highest gross migration rate and divided into four equal quartiles.

Source: Peter Nelson, Middlebury College, using data from U.S. Bureau of the Census American Community Survey, 2012–16 County-to-County migration flows, and The Johns Hopkins University Coronavirus Resource Center.

Analysis of a 2-week rolling mean of new cases (to smooth out variations in reporting practices) during 2020 shows similar differences by gross migration quartile (figure 9). Nonmetro counties in the fourth quartile (those with the strongest historical connection to metro regions) were the first nonmetro counties to report Coronavirus cases. Case levels in the first quartile counties (those with the weakest metro ties) lagged the fourth quartile counties by 1 to 2 weeks through the beginning of April. Fourth quartile counties surpassed 2 cases per 100,000 residents before March 23rd, while first quartile counties did not reach this rate of infection until April 4.

Figure 9
New COVID-19 cases in nonmetro counties by level of migration with metro counties (gross migration rate), March–July 2020



Notes: The gross migration rate for a given nonmetro county is the sum of all its migration flows to and from metro areas, as a percentage of the county's population. Counties are sorted from lowest to highest gross migration rate and divided into four equal quartiles.

Source: Peter Nelson, Middlebury College, using data from U.S. Bureau of the Census American Community Survey, 2012–16 County-to-County migration flows, and The Johns Hopkins University Coronavirus Resource Center.

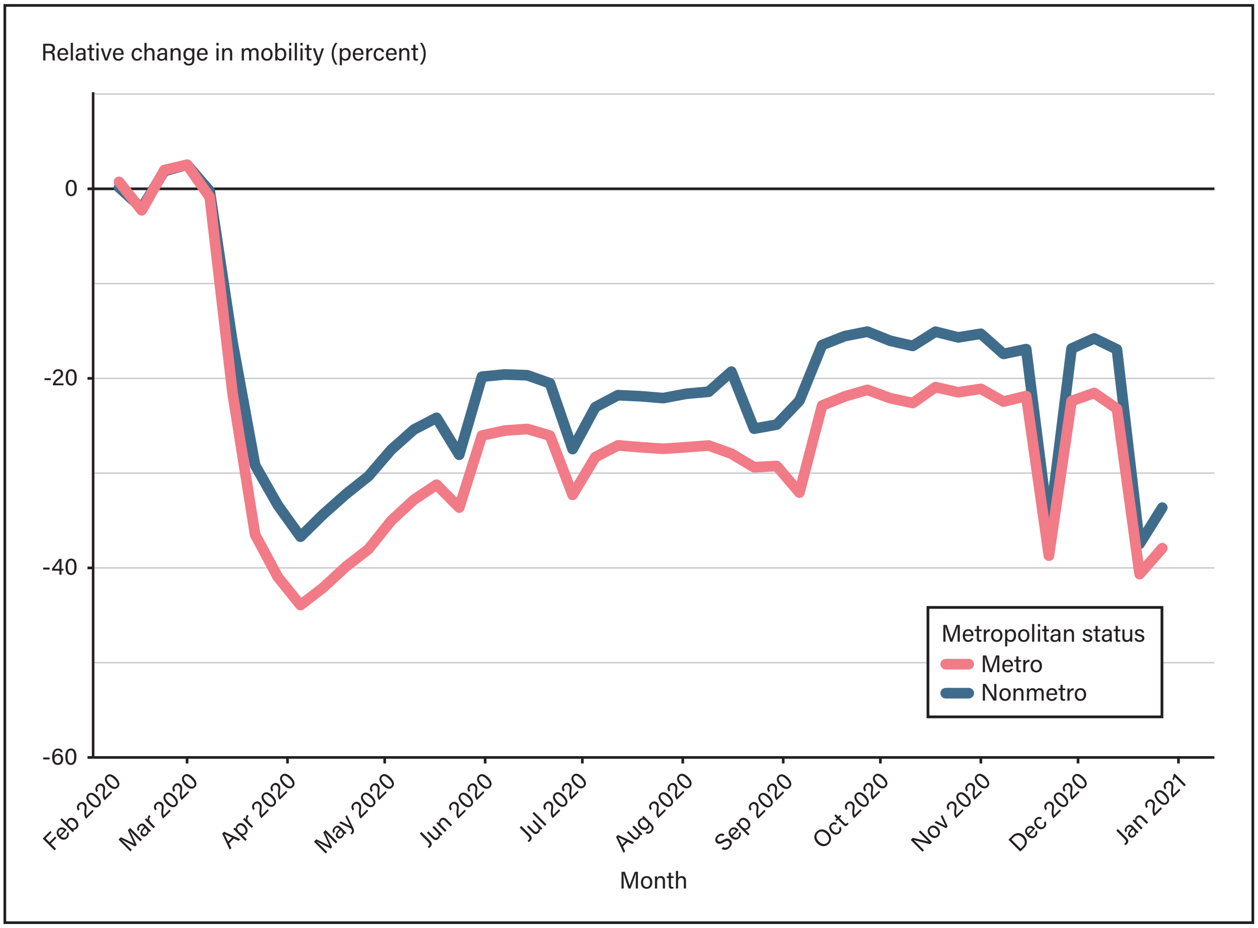
The rapid rise of COVID infections in March and April of 2020 led State officials to issue stay-at-home orders. As a result, new infection rates remained relatively flat through much of late April and May. Once governors began to relax restrictions on movement, case rates surged once more, and the surge started almost a month earlier in the highest migration quartile. By the end of June, these counties had the highest rates of new cases of all county groups, suggesting that the lifting of restrictions opened movement along the established urban-rural migration pathways, bringing more virus into nonmetro areas.

Local Mobility and the Spread of COVID-19 Within Rural Communities

While migration between places can introduce COVID-19 to a community, it is largely movement within places that contributes to community spread. With few medical treatments and no viable vaccine, by late March and early April 2020 local and State officials resorted to restricting day-to-day movements to limit the spread of COVID-19 within communities. While this was a reasonable course of action given the lack of other options, rural regions faced distinct challenges in limiting local mobility (figure 10). For both metro and nonmetro counties, steep declines in day-to-day mobility occurred in the early stages of the pandemic, followed by a slow increase in local movements as States began lifting stay-at-home orders in May. Changes in mobility stabilized through the summer and then rose once more at the end of summer, likely due to reopening of schools. There were also periodic drops in mobility coinciding with major holidays such as Thanksgiving and Christmas. While these temporal trends in mobility change are similar between metro and nonmetro counties, throughout the entire pandemic metro counties showed greater reductions in mobility than nonmetro counties. It appears that significant barriers existed, limiting the extent to which nonmetro regions could pull the one lever available to effectively slow community spread of COVID-19 until vaccines became more widely available in early 2021.

Figure 10

Relative week-to-week change in work-related mobility by metro status, February 2020–January 2021



Notes: Relative change in mobility is the change in movement for workplaces of mobile devices on any given day compared with a baseline measure derived from the period January 3–February 6, 2020. Here we report the average of county-level data. Short-term drops in workplace mobility coincide with holiday weekends.

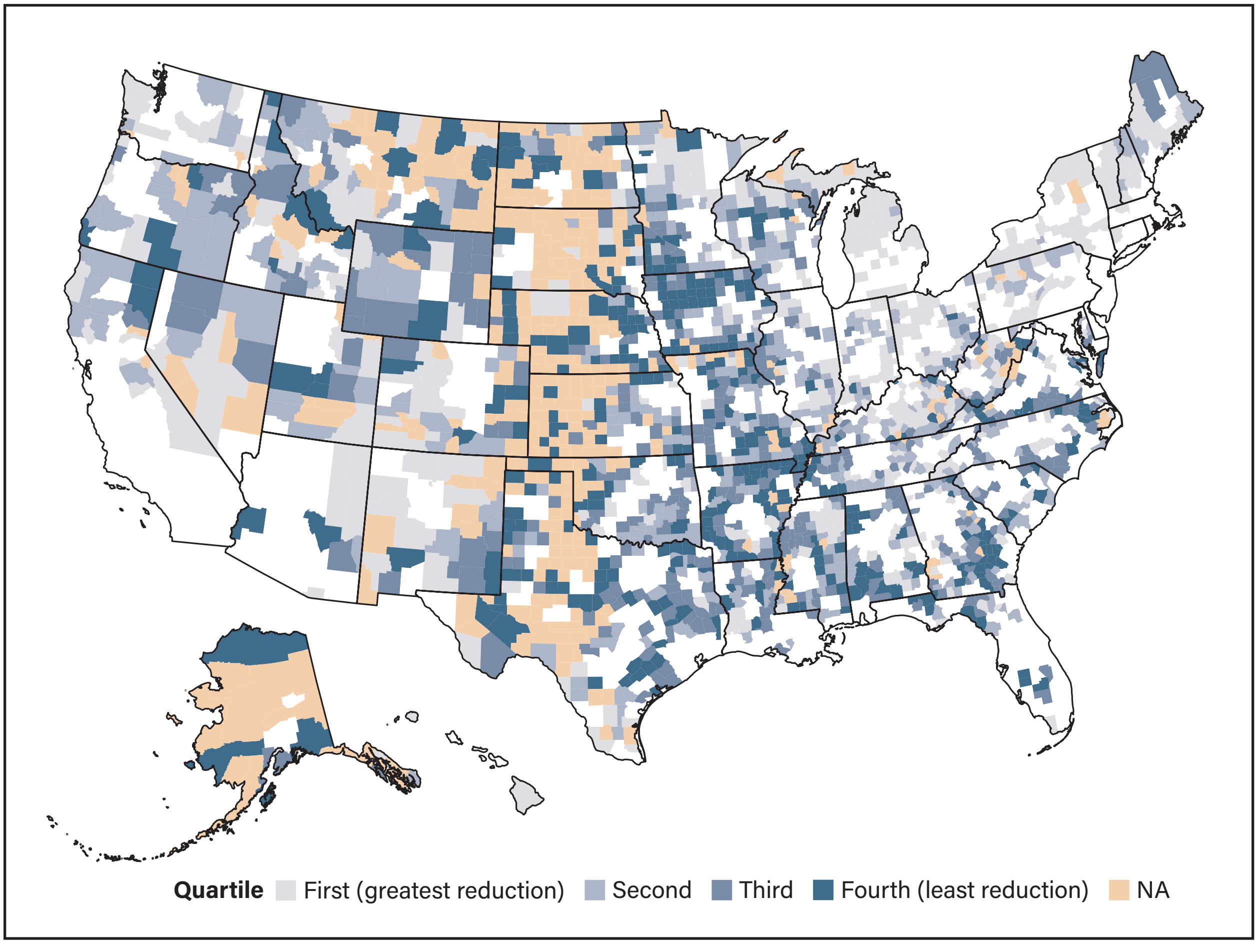
Source: Peter Nelson, Middlebury College, using data from Google's COVID-19 Community Mobility Reports.

Nonmetro counties were divided into quartiles based on the reduction of mobility as of April 15, 2020, when local mobility was at its lowest nationally. While mobility levels have risen for all quartiles, the counties able to reduce their mobility to the greatest degree at the outset of the pandemic have maintained lower levels of mobility throughout.

There is a distinct geography to the distribution of these mobility-change quartiles (figure 11). Most of the counties in the nonmetro Northeast show the greatest reduction in local mobility, as does much of rural Michigan and the coast of Washington State. In contrast, a large share of nonmetro counties across the South and along the Great Plains display more modest reductions in mobility. Much of nonmetro Georgia, Alabama, Arkansas, Iowa, and eastern Nebraska fall in the fourth quartile. And while the data are more limited in the sparsely populated portions of western Kansas, west Texas, the Dakotas, and eastern Montana, those counties for which Google does provide data almost all fall in the fourth quartile, showing more limited reductions in local mobility.

Figure 11

Relative change in work-related mobility for nonmetro counties as of April 15, 2020



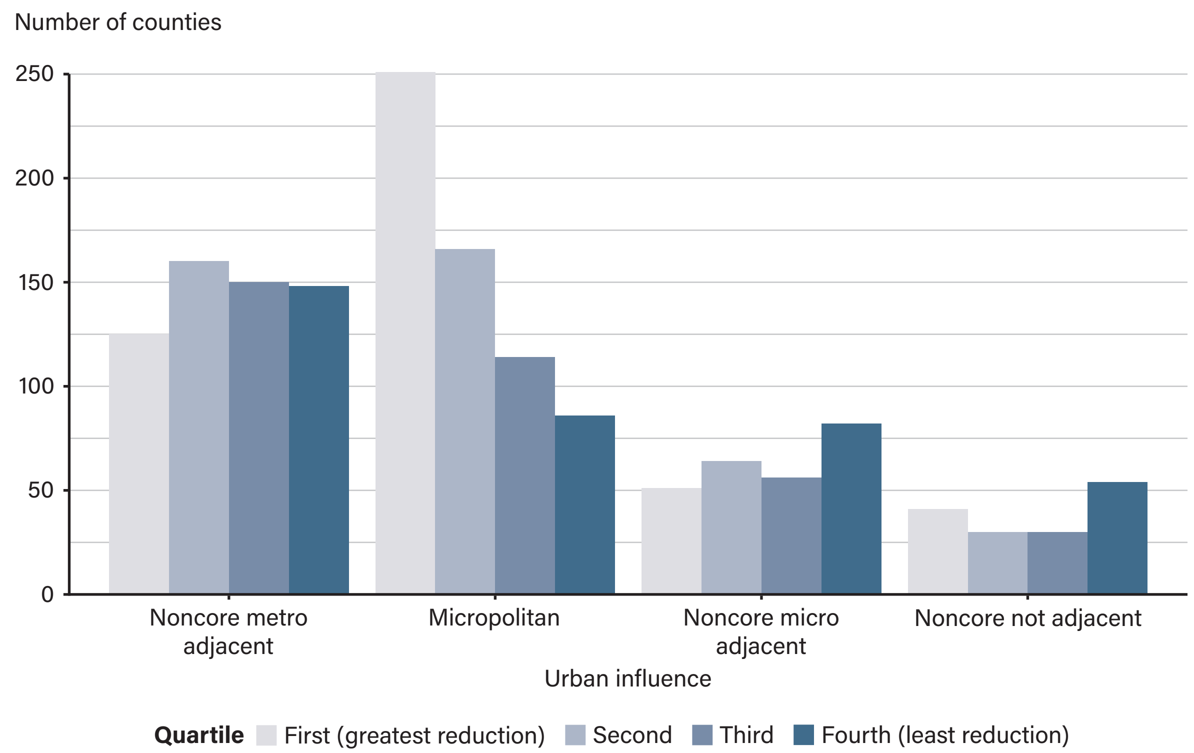
NA = Not Available.

Notes: The relative change in mobility is the change in movement of mobile devices at workplaces as of April 15, 2020, compared with a baseline measure derived from the period January 3–February 6, 2020. Counties are sorted from highest to lowest mobility change and divided into four equal quartiles.

Source: Peter Nelson, Middlebury College, using data from Google's COVID-19 Community Mobility Reports.

The position of counties along the urban-rural continuum further shapes the geographies of mobility reduction during the COVID-19 pandemic (figure 12). Metro-adjacent counties are relatively evenly distributed across the four quartiles, with only slightly fewer than expected of these adjacent counties showing the greatest reduction in mobility. In contrast, nonmetro counties containing larger urban populations (i.e., micropolitan counties) fall disproportionately in the first quartile with the greatest reduction in local-scale mobility, while those more rural in character (falling outside micropolitan areas) are more likely to be in the fourth quartile.

Figure 12
Relative change in work-related mobility for nonmetro counties by level of rurality

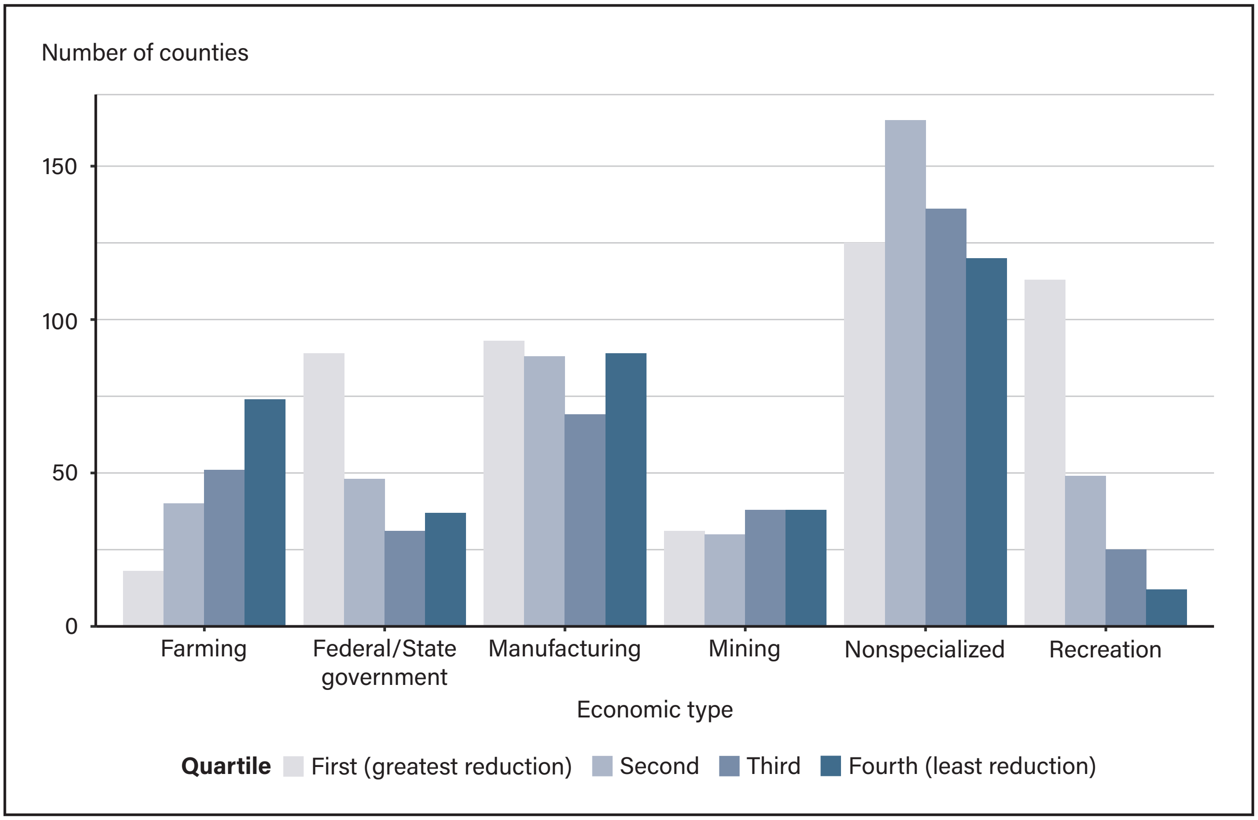


Notes: The relative change in mobility is the change in movement of mobile devices at workplaces as of April 15, 2020, compared with a baseline measure derived from the period January 3–February 6, 2020. Counties are sorted from highest to lowest mobility change and divided into four equal quartiles. Level of rurality is measured using a modified version of the USDA, Economic Research Service (ERS) Urban Influence Codes. See the USDA, ERS Urban Influence Codes topic page for details.

Source: Peter Nelson, Middlebury College, using data from Google's COVID-19 Community Mobility Reports.

County economic structure also influences patterns of mobility reduction to some extent (figure 13). Farming counties show more limited reductions in mobility, with more than four times as many counties falling in the fourth quartile than in the first. In contrast, Government- and recreation-dependent counties both displayed greater reductions in mobility, and this is particularly true for recreation-dependent counties. Over 110 recreation-dependent counties fall in the first quartile group showing the greatest reduction in mobility, with fewer than 12 falling in the fourth quartile.

Figure 13
Relative change in work-related mobility for nonmetro counties by economic dependence

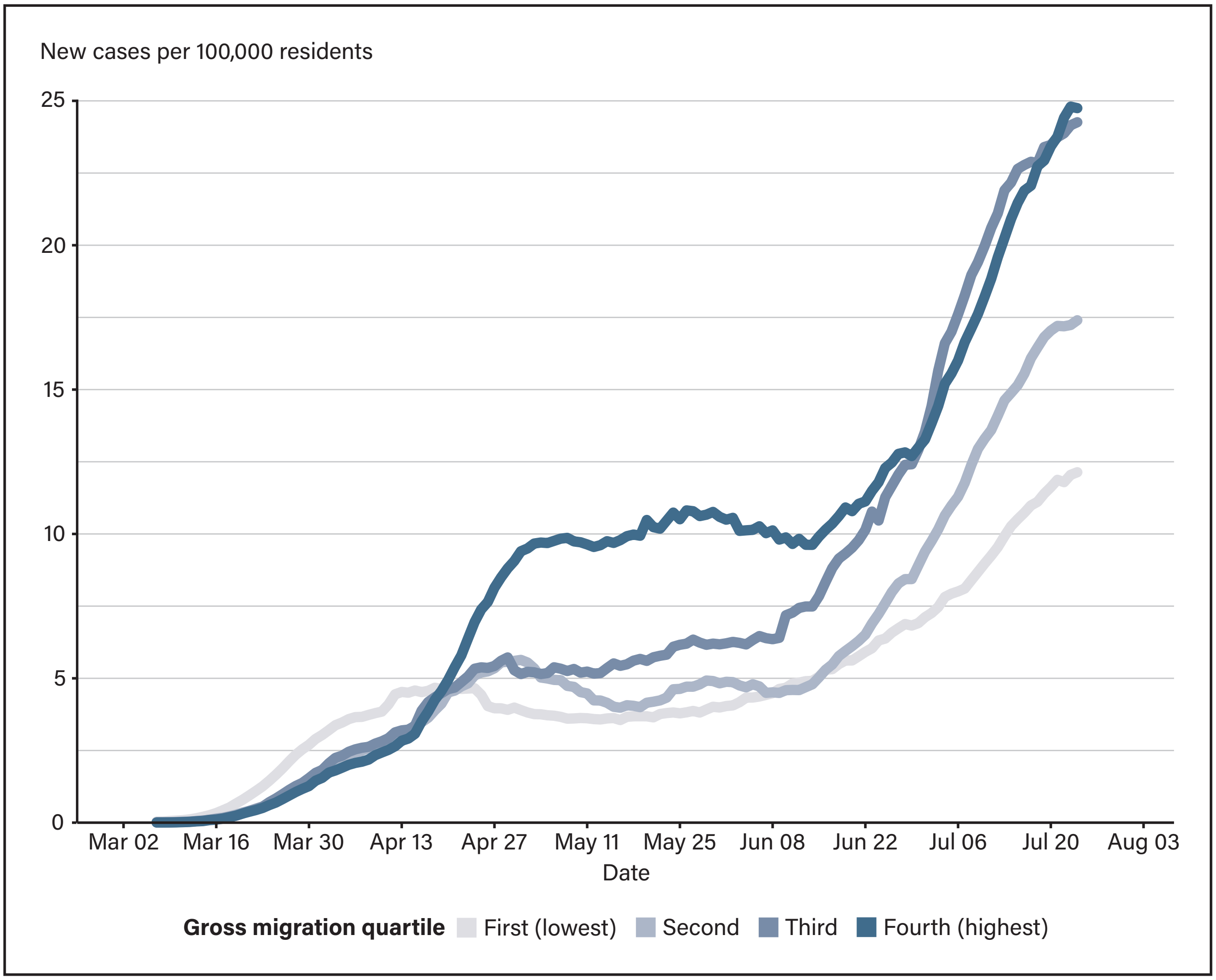


Notes: Here relative change in mobility is the change in movement of mobile devices at workplaces as of April 15, 2020, compared with a baseline measure derived from the period January 3–February 6, 2020. Counties are sorted from highest to lowest mobility change and divided into four equal quartiles. Economic type is determined using the USDA, Economic Research Service (ERS) County Economic Typology. Counties with no dominant economic sector are classified as nonspecialized. See the USDA, ERS County Typology Codes topic page for more details.

Source: Peter Nelson, Middlebury College, using data from Google's COVID-19 Community Mobility Reports.

Reducing mobility does appear to be an effective means to reduce community spread of COVID-19 within counties (figure 14). By the third week in April 2020, those counties with higher levels of local mobility (fourth-quartile counties) were experiencing infection rates nearly double those in counties with greater reductions in mobility. These higher rates of infection were persistent throughout the summer and fall surges of 2020. During the summer surge in Coronavirus cases in July, counties in the first quartile (greatest reduction in mobility) had infection rates 60 percent lower than counties in the third and fourth quartiles (12 new cases per 100,000 versus 25 cases per 100,000). And while infection rates have risen across all quartiles shown in figure 14, at any given time throughout the pandemic infection rates in the first quartile were substantially lower than rates in the other quartiles.

Figure 14
New COVID-19 cases in nonmetro counties by relative change in work-related mobility, March–August 2020



Notes: The relative change in mobility is the change in movement of mobile devices at workplaces as of April 15, 2020, compared with a baseline measure derived from the period January 3–February 6, 2020. Counties are sorted from highest to lowest mobility change and divided into four equal quartiles. Economic type is determined using the USDA, Economic Research Service County Economic Typology. Counties with no dominant economic sector are classified as nonspecialized.

Source: Peter Nelson, Middlebury College, using data from Google's COVID-19 Community Mobility Reports.

Conclusion

This analysis highlights how different forms of human movement affected the spread of COVID-19 as it was transmitted from metro centers into rural regions and then through rural communities upon arrival. The analysis supports the likelihood that COVID-19 moved into rural regions along established urban-rural migration paths. As expected, COVID-19 cases began to emerge earlier in those nonmetro counties with the highest degree of migration connectivity with metro regions. The virus' arrival in the top gross-migration quartile preceded its arrival in counties with weaker migration ties to urban areas by 2 to 3 weeks. Moreover, significantly larger shares of counties with the weakest migration ties with metro regions remained COVID-19 free much later into the pandemic. Finally, areas with more established migration pathways saw an earlier onset of the summer-2020 surge, with cases rising in the third and fourth quartile counties nearly 4 weeks before the surge hit other nonmetro areas.

As expected, nonmetro counties that were able to reduce their mobility to a greater extent showed lower COVID-19 infection rates and a slower spread. Not all places have the same capacity to reduce mobility, making some areas more vulnerable to community spread than others. Counties more remote from urban areas, and those more dependent on agriculture, appear less able to reduce local mobility. This understanding is potentially helpful in identifying areas at greater risk if facing similar public health crises in the future.

There is much still unknown about the COVID-19 pandemic and the lasting impact it is having on people and places in the rural United States. Our findings suggest that efforts aimed at limiting the movement of people between places can effectively contain public health crises to fewer places than would occur without such restrictions. Knowing which places are most vulnerable can enable more-directed public health interventions in the form of education, public service announcements, and targeted testing. Finally, these results suggest that vaccination efforts may be most beneficial in communities with the least capacity to reduce mobility, as these areas are most prone to community spread.

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