

RESEARCH ARTICLE

The COVID-19 pandemic and residential mobility intentions in the United States: Evidence from Google Trends data

Lei Lei¹  | Xialu Liu²

¹Department of Sociology, Rutgers University, New Brunswick, New Jersey, USA

²Management Information Systems Department, Fowler College of Business, San Diego State University, San Diego, California, USA

Correspondence

Lei Lei, Department of Sociology, Rutgers University, 26 Nichol Ave, New Brunswick, NJ 08901, USA.

Email: llei@sociology.rutgers.edu

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Abstract

The COVID-19 pandemic has disrupted people's lives through economic challenges, closure of worksites and schools and increased health risks. These disruptions can trigger new residential needs and preferences, but little research has been done regarding the impact of the COVID-19 pandemic on moving intentions. We theorized how the pandemic could influence intentions of making different types of residential moves. Using Google Trends data, we conducted a time-series analysis to assess the transitory, short-term and long-lasting changes in various types of mobility intentions since the pandemic. Results show that thoughts about temporary relocation surged at the onset of the COVID-19 epidemic and then experienced a long-term decrease. Intentions to move through housing purchases and rentals briefly declined at the beginning of the pandemic but then surpassed their normal levels in the following months. Thoughts about moving in with family or parents increased by almost 50% during the pandemic. These trends were also reflected in Google searches for moving services, which exhibited an initial decline followed by a long-term increase. The results demonstrate that the COVID-19 pandemic has not only posed obstacles that lowered moving intentions but also has created new needs and desires for moving.

KEYWORDS

COVID-19, Google Trends, housing, migration, pandemic, residential mobility

1 | INTRODUCTION

The spread of COVID-19 and the lockdown policies have led to various economic, social and health consequences, drawing popular and scholarly attention. Recent research has documented the impact of the pandemic on work life, economic conditions (Béland et al., 2020), mental health (Brodeur et al., 2021) and domestic violence (Leslie & Wilson, 2020). These dramatic changes in economic and family lives would create discrepancies between households' needs and their current housing and community environments. However, little research has been done on whether people consider residential moves as an adaptation to the changes caused by the pandemic. A study in Spain reported that approximately 10% of the population moved during the lockdown and

analysed the triggers and motivations of these moves (Duque-Calvache et al., 2020), but this study did not compare mobility intentions or behaviours before and after the COVID-19 outbreak. To fill the gap in the literature, we examine how mobility intentions have changed before and during the COVID-19 pandemic in the United States.

It is crucial to understand residential mobility because it enables families and individuals to achieve better housing quality, residential environments and economic opportunities. Residential mobility also has wide-ranging implications for the broader society because it affects the growth of communities and drives changes in the demographic compositions of communities, cities and regions (Clark, 2017). There has been a steady decline in residential mobility and migration in the past 30 years in the United States (Frey, 2014;

Kaplan & Schulhofer-Wohl, 2017). Scholars were concerned about this declining residential mobility because it may signal a lack of fluidity in the labour market and have negative repercussions on the macroeconomy and workers' social mobility (Molloy et al., 2017; Winship, 2015). It remains unclear what effect the COVID-19 pandemic has imposed on the declining secular trend in residential mobility.

The process of decision-making about mobility begins well before the actual moves. Scholars viewed residential mobility as a multi-stage process, including considering, planning for and realizing mobility (Coulter, 2013; Kley, 2017), though the actual process could be nonlinear and much messier. Thinking about moving leads to desires or intentions to move, and intentions are translated into moving plans, which may eventually result in moving, or not. Previous studies showed that mobility thoughts and intentions are key determinants of residential mobility and to some extent mediate the relationship between structural variables and mobility behaviours (Landale & Guest, 1985; B. A. Lee et al., 1994; Lu, 1998). Although not all mobility intentions result in actual moves, considering and planning for moving are important preparatory stages that deserve attention. Scholars strived to understand mobility decision-making by examining the factors making people consider moving and factors influencing people's ability to translate moving intentions to actual moves (Kley, 2017; Lu, 1998). Neighbourhood contexts, life course stage/events, socioeconomic status and families and social ties have all been considered predictors of moving thoughts and intentions (Duque-Calvache et al., 2018; B. A. Lee et al., 1994). The COVID-19 pandemic has changed many objective and subjective factors influencing people's evaluation of current and alternative residential locations, but no research has investigated how the pandemic has changed people's considerations about making different types of residential mobility.

In the current study, drawing on migration theories and the literature on hazards and migration, we theorize how the COVID-19 pandemic can influence mobility intentions in its initial and subsequent stages. We use the terms that people search on Google to measure intentions of making different types of residential moves and analyse search data from Google Trends from January 2011 to February 2021 to examine the changes in mobility-related searches before and during the COVID-19 pandemic. Using the monthly search data and time-series models with intervention, we specifically explore the transitory, short-term and long-term effects of the pandemic on people's moving thoughts and intentions.

2 | THEORY AND LITERATURE

Early neoclassical economic theories consider migration a rational behaviour resulting from decision-making based on cost-benefit calculations (Sjaastad, 1962; Todaro, 1969). Individuals tend to move to maximize economic utility by purposing higher earnings in the destinations relative to their origins. Later, scholars have incorporated noneconomic factors to explain migration. Wolpert's (1966)

stress-response model views migration response to the stress experienced in the current residential neighbourhoods, with environmental stressors, including pollution, congestion, noise and crime. Along the same line, Speare (1974) argues that except for the migrations forced or necessitated by events like disasters, job change or divorce, other migrations are motivated by dissatisfaction with the current residence. His dissatisfaction model emphasizes the importance of individuals' attachment to other individuals, a housing unit, a job and neighbourhood organisations in determining their levels of residential satisfaction. Dissatisfaction can result from changes in the needs of a household, social and physical amenities offered by a particular location, or the standards used to evaluate these factors (Speare, 1974). In response to the dissatisfaction, people first seek ways to adjust to the local community. When a local adjustment has failed and a threshold of dissatisfaction has been passed, people will search for alternatives and make a decision by comparing the alternatives to their current location. Finally, objective factors such as the housing market, the job market and the cost of moving will enter the migration decision-making process (E. S. Lee, 1966; Speare, 1974).

Scholars interested in the relationship between environment and population have drawn on classic migration theories and developed conceptual models of how environmental hazards influence migration. They consider migration an adaptive response to climate change or environmental hazards (McLeman & Smit, 2006). It is assumed that climate change stimulates some form of change in the environmental or social-economic conditions that threaten the well-being of families or communities. The families will consider migration when they cannot make adjustments through other ways in the current location.

While most theories about environment and migration focused on how individuals make migration decisions when facing hazards, the framework outlined by Black et al. (2011) emphasized macro-level drivers of the existing migration process and the interaction between the environmental driver and other drivers of migration. They contend that environmental change can influence migration directly or indirectly through changes in the existing social, demographic and economic drivers of migration. This theory provides us with a valuable framework to analyse how the COVID-19 pandemic influences migration intentions directly and indirectly by altering various migration drivers at the macro and micro levels.

In the following section, we elaborate on how the pandemic can influence migration intentions directly by exposing people to health risks and indirectly by changing the amenities offered by a specific location, the needs of households, evaluation standards held by families and obstacles to migration (see Figure 1).

2.1 | Direct influence of the pandemic

The hazard and migration literature has documented cases of population displacement by hazards/disasters and temporary escape at the rapid onset of a hazard (Hunter et al., 2015). As a biological hazard—a highly contagious disease—the coronavirus imposes health

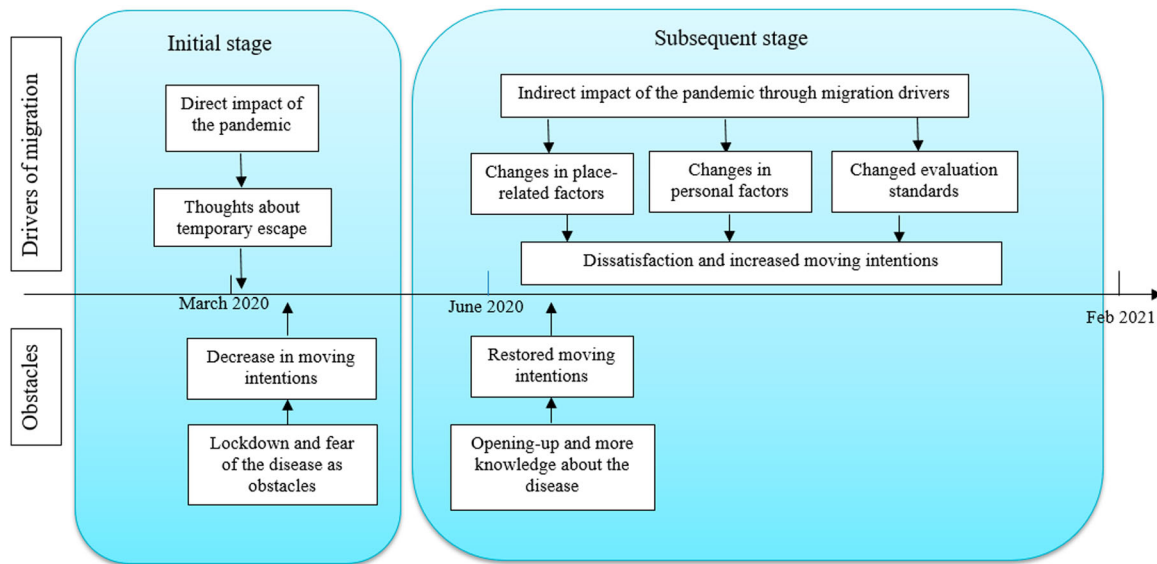


FIGURE 1 Theoretical outline for the impact of the COVID-19 pandemic on mobility intentions.

risks on people in places with high infection risk. At the onset of the COVID epidemic, due to the lack of knowledge, feelings of uncertainty and fear of the disease, people may have had panic reactions to the epidemic and the upcoming lockdown. Stories have been reported in numerous places worldwide that migrant workers, visitors and people who were afraid of losing freedom fled from the cities before the lockdown took place (Bölinger, 2020; Parkin, 2021). In the United States, there is anecdotal evidence of an urban exodus during the pandemic (Dorsey, 2020) and the rich escaping New York City before it was locked down in March 2020 (Bellafante, 2020). Given the existing seasonal migration flows to warm places like Florida, people who already have a second home in the southern region had a convenient option of escaping the lockdown in their current cities. Thus, in the initial stage, we expect people to react to the epidemic by considering escaping densely populated cities and the upcoming lockdown and travelling to existing destinations of seasonal migration within the United States. But these migration intentions would soon be dampened by the stay-at-home order implemented in most states.

Unlike natural hazards or disasters, social distancing and lockdown are more effective and efficient adjustments to the epidemic than migration. Therefore, we do not expect the pandemic to generate continuous needs to escape. But the lockdown and social distancing policies led to profound changes in other aspects of people's lives, which could spur intentions to make a residential adjustment.

2.2 | Indirect influence through place-related factors

Migration theories have considered factors associated with places that attract people to or repel them from the area. While some

factors affect different people differently, other factors affect most people in the same fashion (E. S. Lee, 1966). For instance, a good climate, convenient transportation and various amenities are attractive to nearly everyone. Job opportunities and cultural diversity in large cities are attractive to young people. Features of an area, such as urban–rural location, traffic, crime and noise, are often cited as reasons for considering to move (Coulter & Scott, 2015).

The outbreak of COVID-19 has changed the amenities offered by specific locations and how people evaluate an area. The pandemic has significantly reduced the accessibility to urban amenities, such as restaurants, small businesses and cultural exhibits. Once may be associated with a vibrant culture, high population density and crowded neighbourhoods has become salient negative features that people wish to avoid due to the risk of COVID-19. Thus, more people preferred suburban residence and access to natural amenities over living in high-density urban settings. Meanwhile, a national poll showed that people reported a higher preference for walkability in the neighbourhoods (Shaw, 2020). The reduced attractiveness of urban locations is manifested in increasing net urban out-migration in the United States in 2020 compared with previous years (Whitaker, 2021). In sum, as posited in the dissatisfaction model (Speare, 1974), the lack of valued amenities in urban areas and re-evaluation of place-based characteristics according to the changed standards during the pandemic would generate dissatisfaction with the current residential locations and increased moving intentions.

In addition to environmental factors, such as changes in urban amenities, the diverse COVID-related policies across places can also motivate residential mobility. In the United States, states had the autonomy to implement policies, such as shutdowns, mask mandates, reopening, financial assistance and extensions of Medicare in response to the COVID pandemic (Zhang & Warner, 2020). The variations in these policies have increased diversity among areas in the country, providing reasons for people with different preferences

to move (E. S. Lee, 1966). For example, some people may consider moving to avoid the strict lockdown or obtain necessary medical care. Others may wish to find jobs in states that opened up earlier. Thus, we expect that policy variability across states may have created more thoughts about moving during the pandemic.

2.3 | Indirect influence through personal factors

Changes in professional and family lives tend to affect people's perceptions and evaluations of current housing and communities, thus shaping their thoughts about moving (E. S. Lee, 1966; Speare, 1974). Families desire to relocate because their current home conditions, location and environment do not meet their needs based on changes in family size, family composition and job location (Clark, 2017; Mulder & Hooimeijer, 1999; Rossi, 1955). Attachment to a job is one important reason people stay in certain places. During the pandemic, many workers were freed from commuting to their workplaces. Without needing to stay close to their workplaces, public transportation or highways, individuals can consider a broader array of alternative locations and housing options to meet other existing or arising household needs.

Major changes also happened to the household structure and the presence of household members. About 1/3 of children nationally began to study remotely at home due to school closure. The closure of college campuses in spring 2020 also drove millions of young adults to return to their parents' homes (Tompkins, 2020). These changes generated demands for larger spaces, home offices, study rooms and household amenities to meet the needs of families. The mismatch between the household needs and current residence can create dissatisfaction. If no sufficient adjustments can be made to address the dissatisfaction in the current location, the families would start to consider moving.

In addition, families and social ties outside of the households also affect the residential moves by shaping people's needs to move and reshaping their preferences about location (Gillespie & Mulder, 2020; Spring et al., 2017). Data from the Current Population Survey show that among people who moved between 2012 and 2013, 48% reported their main reason for moving to be housing-related, approximately 30% said they moved mainly for family-related reasons and fewer than 20% reported employment as their main reason (Ihrke, 2014). Researchers also found that the location of siblings, parents and friends can affect whether and where individuals move (Gillespie et al., 2022; Mulder et al., 2020). COVID-19 has taken a toll on individual physical and mental health and burdened the healthcare system. We expect that more individuals have had family members outside of the household who faced health problems and needed care during the pandemic than before. Thus, more individuals needed to move to receive care from or provide care to family members. A study in Spain during the pandemic suggests that 46% of movers cited the need to be near and care for loved ones as the reason for moving (Duque-Calvache et al., 2020). Media stories documented that people started to consider moving older parents

out of assisted living facilities or nursing homes due to the high risk of contracting COVID-19 in these facilities and the loneliness caused by social distancing (Graham, 2020). Moreover, given the loneliness and mental stress due to social distancing, people may consider moving closer to families during the pandemic even without family responsibilities.

Another important change happening to families is related to the household economic condition. Although the government has provided economic assistance to low- and middle-income families, many people have lost jobs or income during the pandemic (Coibion et al., 2020). Worse economic conditions make people question their ability to move. The economic losses and unemployment since the pandemic could render families less motivated to move even though they are unsatisfied with their current living conditions. On the other hand, economic shocks and unemployment can sometimes force people to move because they cannot afford existing housing. Fortunately, the Coronavirus Aid, Relief and Economic Security Act, the Emergency Rental Assistance (ERA) programme, the forbearance plan and the nationwide halt on evictions have helped families bear their current housing expenses and improve housing stability. These assistance programmes should have prevented many involuntary moves (i.e., evictions) and reduced intentions to move due to economic difficulties. Thus, we expect that the general economic downturn coupled with these assistance plans are counterforces that reduce the overall volume of residential mobility during the pandemic.

Related to the economic downturn, we expect fewer people to pursue new job opportunities during the pandemic, which reduces mobility intentions. Young people completing education may be less likely to move in search of job opportunities. This trend may partly counteract the increasing mobility motivations created by other changes in social and economic lives.

2.4 | Obstacles and facilitators

Factors that facilitate or prohibit mobility also enter the decision-making process. E. S. Lee (1966) emphasizes that for someone to decide to move, the perceived advantages of moving must be large enough to overcome the intervening obstacles. Distance between the origin and destination areas, moving costs, national borders, immigration policies, hiring agencies and existing social networks are some commonly considered factors (Black et al., 2011). These factors also affect the preparatory stage of migration decision-making. Unconquerable difficulties can make people think migration is not an option for them. During the pandemic, lockdown policies have been implemented in most states between March and May 2020 to reduce nonessential travel, which has been the most obvious obstacle to moves during the pandemic. By following the stay-at-home orders, people should not plan for house or apartment tours. Awareness of the COVID-19 infection risks also prevents people from considering moving during the pandemic because people would like to avoid contact with others during the home search process.

Thus, we expect that mobility intentions, in general, should have declined in the initial stage of the pandemic and resumed after the states gradually opened up.

Moving thoughts/intentions are critical preparatory stages leading to actual residential moves. In this study, we use Google search terms to capture the thoughts about a few types of mobility, including temporary moves, moves through a home purchase or rent and moves into family members' homes. According to the theories, we propose the following hypotheses.

Hypothesis 1 – *The intention to temporarily escape increased at the onset of the pandemic and declined in the following stages of the pandemic.*

Hypothesis 2 – *In the initial stage, the pandemic led to a decline in the intentions to move through a home purchase and renting.*

Hypothesis 3 – *In later stages, the pandemic increased the intentions to move through a home purchase and renting.*

Hypothesis 4 – *The pandemic has increased the thoughts about moving into family members' homes.*

3 | DATA AND METHODS

3.1 | Data

It is necessary to use data from before and during the pandemic to understand the population's behaviour changes. Although some national social surveys ask questions about residential mobility, most of the data for survey waves since the outbreak of COVID-19 are not yet available. We analyse data from Google Trends, a representative sample of trillions of search requests made to Google in a given geographic area. The data provide a unique perspective on what Google users are currently interested in and curious about (Rogers, 2016).

The normalized Google Trends data reflect trends in relative search interest in searched term(s) over a time period and in a geographic area. We extracted monthly search interest data for 14 mobility-related terms in the United States between January 2011 and February 2021. Each data point is the number of monthly searches for one term divided by the maximum number of monthly searches for this term during the entire sampling period in the geographic area. Google scaled the data points from 0 to 100, where 100 corresponded with the month with the highest search volume for the term, and 0 meant there were not enough searches in that month to generate meaningful values. When there are single and plural forms of a term, we submit them together to Google Trends. Thus, the scores for each term are calculated relative to the maximum monthly searches for both terms under examination. We then added the scores for each term together, so when multiple terms are examined together, the scores can exceed 100.

Google Trends data have several advantages compared with survey data: First, it provides access to real-time data and up-to-date information, which is crucial for policymakers to respond promptly.

Second, Google Trends helps us better capture the short-term changes during a fast-evolving pandemic since it collects users' requests continually on a weekly or monthly basis, whereas most survey data usually is released annually or semi-annually. Third, it minimizes response bias. Respondents may not remember or not feel comfortable reporting accurate and honest answers in surveys, but they leave traces on the search engines. In addition, Google search data shows aggregate measures of trillions of search activities, making it less vulnerable to small-sample bias (Baker & Fradkin, 2017; Brodeur et al., 2021). It is also more affordable and accessible than survey data.

Previous work has shown that Google Trends data serve as an effective predictor for users' behaviours. For example, it successfully predicts disease outbreaks (Carneiro & Mylonakis, 2009), retail sales (Bughin, 2014) and tourism flows (Siliverstovs & Wochner, 2018). Another study demonstrated that Google searches related to real estate correlate well with established business conditions and sentiment measures in the construction sector (OECD, 2020). Following Brodeur et al. (2021) and Della Penna and Huang (2010), we assume that Google search data can provide accurate and representative information about users' decisions. Moreover, we selected search terms to reveal people's mobility thoughts and intentions. Given its easy accessibility and timeliness, Google Trends data can show the temporal changes in mobility intentions during the COVID pandemic.

Nevertheless, we have to acknowledge the limitations of Google Trends data. The demographic profile of Google search users may not represent the general public. Google users tend to be younger, wealthier and with higher levels of education. While search frequencies can reflect moving thoughts and intentions, they could also be driven by pure curiosity or fantasy.

3.2 | Search terms

To find the relevant terms reflecting Google users' searches related to moving, we first brainstormed the terms people may search for when considering moving for various reasons. We then used Google's autocomplete feature to choose other relevant and frequently searched terms Google suggested. After identifying a list of terms and phrases, we tested each term in Google Trends to check its popularity and discover any other related terms. These procedures ensured that we were not missing any popular search terms relevant to our topic or including any rarely searched terms.

For this project, we decided on 14 mobility-related search terms and submitted them to Google Trends. We measured intentions of movement through three different routes, including moves related to a home purchase, moves related to a home rental, and moves into family members' homes. For searches related to purchase or rental, we further distinguished the types of home structures and selected search terms measuring house purchase, apartment purchase, house rental and apartment rental. The corresponding search terms are 'house for sale', 'condo', 'house for rent' and 'apartment(s)'. We

further included the terms 'real estate agent' and 'house inspection' to measure more serious behaviours of finding a realtor and conducting a house inspection before the transaction. One point to note is that the data returned by Google Trends contains any searches that include the submitted word(s). For instance, searches of 'apartments near me', 'two-bedroom apartments', 'one-bedroom apartments' and 'apartments for rent' are all included in the data for the term 'apartments'.

We also measured intentions to move into family members' homes using the terms 'move in with family' and 'move in with parents' because people may move by joining their families. Anecdotal stories indicate that during the early stages of the pandemic, many college students or young adults moved back home after campuses and dorms were closed.

Regardless of the form of the moves, planning for moving is further captured by the terms 'moving company(ies)', 'movers' and 'car shipping' since many people search for these services when planning a move. The trends in these terms are less likely to be driven by changes in people's interest in housing prices or real estate market investments.

Finally, we measured intentions to make temporary moves (possibly to a vacation home) using 'flight(s) to Florida', 'flight(s) to Miami' and 'flight(s) to Hawaii'. Although these are not considered residential moves in the demography literature, we included them because short-term escape in reaction to the pandemic is one important type of movement.

For search terms that are nouns, including 'apartment(s)', 'moving company(ies)', 'flight(s) to Florida', 'flight(s) to Miami' and 'flight(s) to Hawaii', singular and plural versions are both popular among Google users. We submitted the singular and plural versions together to Google Trends and added the numbers for the analysis.

3.3 | Analytical methods

Because Google Trends data are time-dependent and nonstationary (i.e., with changing mean and variance over time), analysis procedures for independent data cannot be used. Specifically, as people become more dependent on search engines to collect information, Google Trends data often exhibit an upward trend and exponential growth. Moreover, Google searches related to residential mobility demonstrate strong seasonality. Search interest peaks and valleys always appear in summers and winters, respectively. To eliminate the impact of unwanted fluctuations and focus exclusively on the changes caused by the pandemic, we first used seasonal autoregressive integrated moving average (ARIMA) models to describe the trends and seasonal patterns before the pandemic. We then used intervention analysis to assess the changes due to the COVID-19 pandemic. Intervention time series models have been successfully applied to study the impact of various external events, such as air pollution control and economic policies (Box & Tiao, 1975), natural disasters (Worthington & Valadkhani, 2004) and antiterrorism policies (Enders & Sandler, 1993). We adopted the intervention models to examine the impact of the pandemic on mobility-related Google searches.

3.3.1 | Seasonal ARIMA models

We first use seasonal ARIMA models $(p, d, q) \times (P, D, Q)_s$ with the period of $s = 12$ (months) to describe the underlying dynamics of mobility-related searches over time and model the stochastic trends in the data. More specifically, the autoregressive (AR) component measures the impact of previous observations on current observations. The order p refers to the number of previous monthly observations that influence the current observation. The moving average (MA) component captures the impact of previous error terms (or shocks) on the current value. It reflects the short-term memory of a series, that is, a random shock enters the system and persists for no more than q months before vanishing entirely. The integrated component (I) represents the time-varying mean resulting from a stochastic trend in the series. The order d refers to the number of times the monthly data need to be differenced to quantify the trend fully. In addition, the seasonal component of the model describes the periodic dynamic pattern that repeats every 12 months. Similarly, we use the orders P , D and Q for the seasonal component to capture the time series processes of how the observations of years ago affect the current observation.

Relying on data between January 2011 and February 2020, we select seasonal ARIMA models that fit the data best for each search term using Box-Jenkins methods (Pankratz, 2009) and the Akaike information criterion (AIC) (Shumway & Stoffer, 2000). Then, we use the selected models to predict the relative search interests for each search term from March 2020 to February 2021 and compare the predicted and observed values for this period. The deviation of observed values from the values predicted using seasonal ARIMA models and data in previous years are then modelled by intervention variables.

3.3.2 | Intervention variables

Flexible intervention functions are used to model the discrepancies between the observed and predicted values of search interests of each term, reflecting the impact of the pandemic on people's mobility-related searches. Two basic indicator variables can be used to describe the impact of an intervention (i.e., the pandemic).

The first one is a step function $S_t^{(T)}$ that describes the impact of an intervention occurring at time T and remaining in effect after that (Wei, 2006), as shown in panel (a) of Figure 2 and Equation (1).

$$S_t^{(T)} = \begin{cases} 0, & t < T \text{ prior to the event,} \\ 1, & t \geq T \text{ thereafter.} \end{cases} \quad (1)$$

The second is a pulse function $P_t^{(T)}$ representing a pulse effect of an intervention occurring at time T that only lasts one time period as in panel (b) of Figure 2 and Equation (2).

$$P_t^{(T)} = \begin{cases} 0, & t \neq T, \\ 1, & t = T, \text{ at the time of the event.} \end{cases} \quad (2)$$

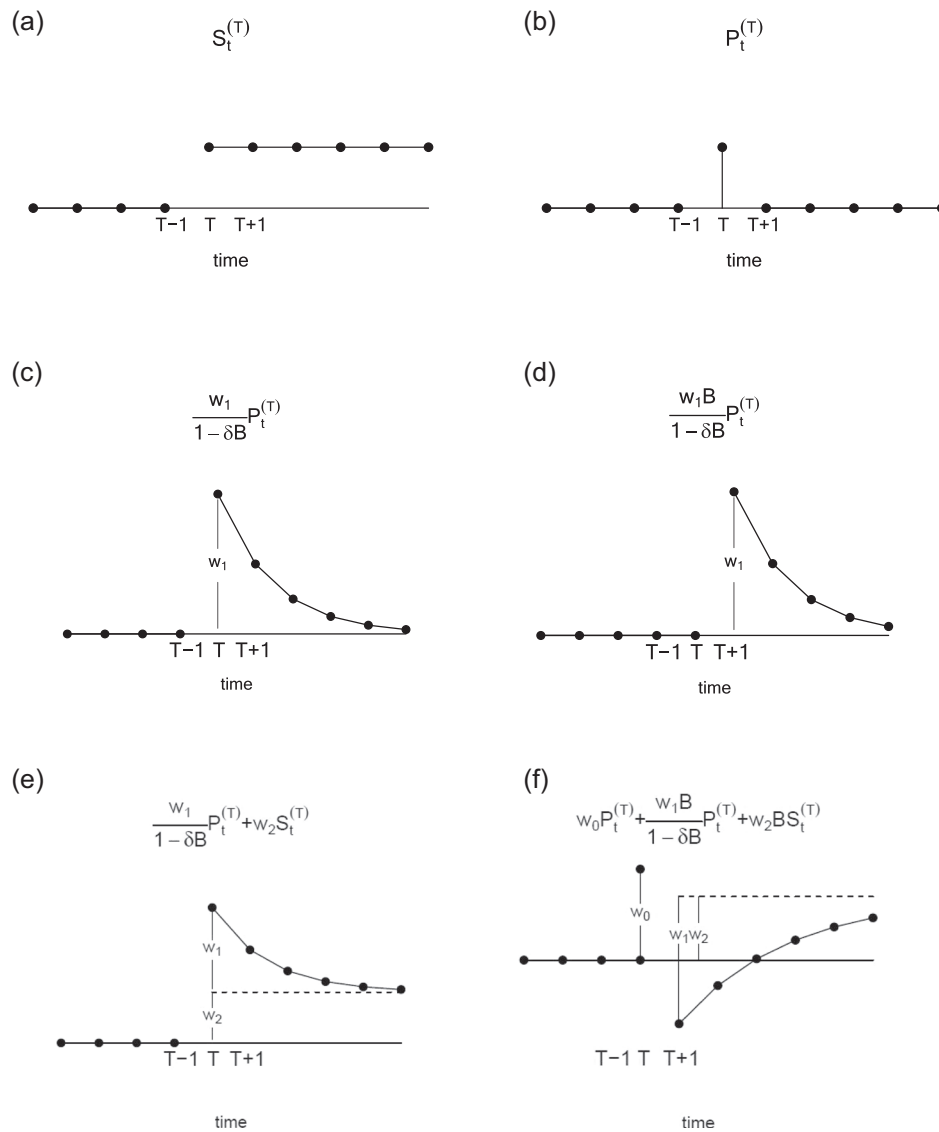


FIGURE 2 Examples of responses for intervention analysis.

Because the WHO declared COVID-19 a pandemic on March 11, 2020, and the U.S. president declared COVID-19 a national emergency on March 13, 2020, we assume the intervention occurred in March 2020. Thus, time T corresponds to March 2020 in our analysis.

3.3.3 | Seasonal ARIMA models with intervention

In the analysis, we combine the seasonal ARIMA model with the intervention function to model the observations in our data. Because most of the searches have grown exponentially with time, we take the natural logarithm of the relative search interest in each month for a selected search term (Z_t) and our dependent variable Y_t equals $\ln(Z_t)$. The logged search volume Y at time t is modelled as a sum of two components X_t and E_t .

$$Y_t = X_t + E_t, \quad (3)$$

where X_t follows a seasonal ARIMA $(p, d, q) \times (P, D, Q)_s$ process with period $s = 12$ (months) and E_t is the response quantifying the impact of the intervention:

$$E_t = \sum_{j=1}^k \frac{w_j(B)}{\delta_j(B)} I_{jt}, \quad (4)$$

where k is the number of intervention variables, I_{jt} is j -th intervention variable (either a step or a pulse function), and $\delta_j(B) = \delta_{j0} - \delta_{j1}B - \dots - \delta_{jr_j}B^{r_j}$ and $w_j(B) = w_{j0} + w_{j1}B + \dots + w_{jm_j}B^{m_j}$ are polynomials of the backshift operator B with degrees of r_j and m_j , respectively, for the intervention $j = 1, \dots, k$. The response function is a linear combination of several pulse, temporary, or long-lasting effects with different directions, sizes and decaying rates. In Equation (4), w_j indicates the direction and size of an effect and δ_j represents the rate of decay of an effect.

In Figure 2, we illustrate how different linear combinations of step functions and pulse functions in E_t can be used to model various forms of the impact that the pandemic has on mobility-related searches. In panel (c) of Figure 2, the impact of the intervention $\frac{w_1}{1-\delta B} P_t^{(T)}$ indicates that an abrupt change w_1 is felt at time T , and it exponentially declines to 0. Panel (d) of Figure 2 illustrates the case when the intervention does not take effect immediately when the event occurs but appears in the next period $T + 1$. Similarly, the change decays exponentially to 0 over time. In panel (e) of Figure 2, the impact $\frac{w_1}{1-\delta B} P_t^{(T)} + w_2 S_t^{(T)}$ indicates a lasting effect w_2 in addition to a temporary effect w_1 at time T . Panel (f) of Figure 2 illustrates the combination of a one-time pulse effect and a temporary effect in the opposite direction felt at $T + 1$, followed by a bounceback and possibly a residual effect. The impact can be written as $w_0 P_t^{(T)} + \frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 B S_t^{(T)}$, where w_0 measures the immediate pulse, w_1 is the short-term delaying effect, and w_2 is the long-lasting effect.

We consider 11 candidates for the response E_t in Equation (3) to formulate the impact of the pandemic on the relative interest in the search terms, using different combinations of a pulse effect, a short-term effect and a long-lasting effect with different starting times (see Appendix A). A pulse effect could capture people's immediate reactions to the quick onset of the pandemic, such as a surge of thoughts about temporary escape as proposed in Hypothesis 1. A short-term (decaying) effect could model an initially strong negative effect of lockdown policies on mobility intentions whose influence is gradually tapering off. A long-lasting effect could reflect increased residential dissatisfaction and thoughts about moving throughout the entire period. Because these effects overlap with each other, it only makes sense to interpret the sum of all three components. Our models with a pulse effect all begin at time T (the onset of the pandemic) because the pulse effect captures immediate reactions. For models with only a short-term effect and/or a long-term effect, we tried starting time of T and $T + 1$ because thoughts about some type of mobility tend to change immediately, while thoughts about other mobility types are only affected after some time. After estimating models with all 11 different responses, we selected one appropriate response function for each search term based on two criteria: (i) the intervention terms are significant and the decay rate δ is positive and (ii) the AIC values are as small as possible.

To better illustrate the impact of the intervention, we calculate the percentage changes in the relative search interest for each term since the pandemic using $(e^{E_t} - 1) \times 100\%$ and present them in figures. Finally, we calculate predicted values for each term using the selected seasonal ARIMA model with intervention and plot them along with the observed values.

We chose the seasonal ARIMA model with intervention over alternative methods such as difference-in-difference (DID) models and interrupted time series analysis (ITS) for a few reasons. First, DID and ITS methods estimate time trends in a deterministic way as a fixed function of time, whereas the ARIMA model can capture stochastic trends (which is more likely to be true for social science time series). Second, DID and ITS only estimate a constant change in the outcome since the event or an effect that grows linearly with

time. A seasonal ARIMA model with intervention can estimate more flexible responses combining an impulse effect, an exponentially decreasing effect and a long-lasting (constant) effect. Third, seasonal ARIMA models can properly capture the stochastic time-series process happening seasonally, whereas research using DID and ITS often controls seasonality using fixed effects of months/days or Fourier terms (pairs of sine and cosine functions) (Bernal et al., 2017; Brodeur et al., 2021).

4 | RESULTS

4.1 | Selecting seasonal ARIMA models

Figure 3 plots the monthly Google Trends data for the search terms from January 2011 to February 2021. As we expected, the data show strong seasonality (except the trends for 'move in with family' and 'move in with parents'), and search interests for most terms grow exponentially with time. We first use the seasonal ARIMA model to describe time series processes in the logged search interests of each term based on data before March 2020.

Table 1 presents the best seasonal ARIMA models chosen for different search terms based on data before March 2020 and their AIC values. As an example, we interpret the selected seasonal ARIMA model for 'house for sale' $(1, 1, 0) \times (0, 1, 1)_{12}$. This model has an AR (1) component, meaning the current search interest depends on the search interest one period (month) before. It also has an integration component $I(1)$, indicating that we need to differentiate the data once to capture the stochastic trend. As for the seasonal part of the model $(0, 1, 1)_{12}$, we also need to subtract the observation in the previous year to capture the yearly stochastic trend and the seasonal MA(1) component means that random shocks entering the system persist for one period (year). Other models can be interpreted similarly.

The models presented in Table 1 are used to predict the relative search interests from March 2020 to February 2021. Figure 4 plots the fitted values using seasonal ARIMA models without intervention together with the observed values throughout the entire period. Before the pandemic, the fitted values were close to the actual observations and followed the trends for all search terms very well. The fitted values and observed values for the terms 'move in with family' and 'move in with parents' are not as close as those values for other terms because the two terms do not have clear seasonal patterns and the correlation between past and future is weaker compared to for the others. In Figure 4, the predictions for all the search terms for the period from March 2020 to February 2021 deviate from the actual observations, implying that the pandemic has changed people's search behaviours regarding these mobility-related terms.

4.2 | Identifying intervention effects

We then estimate seasonal ARIMA models with intervention, considering 11 different response functions for each term to capture

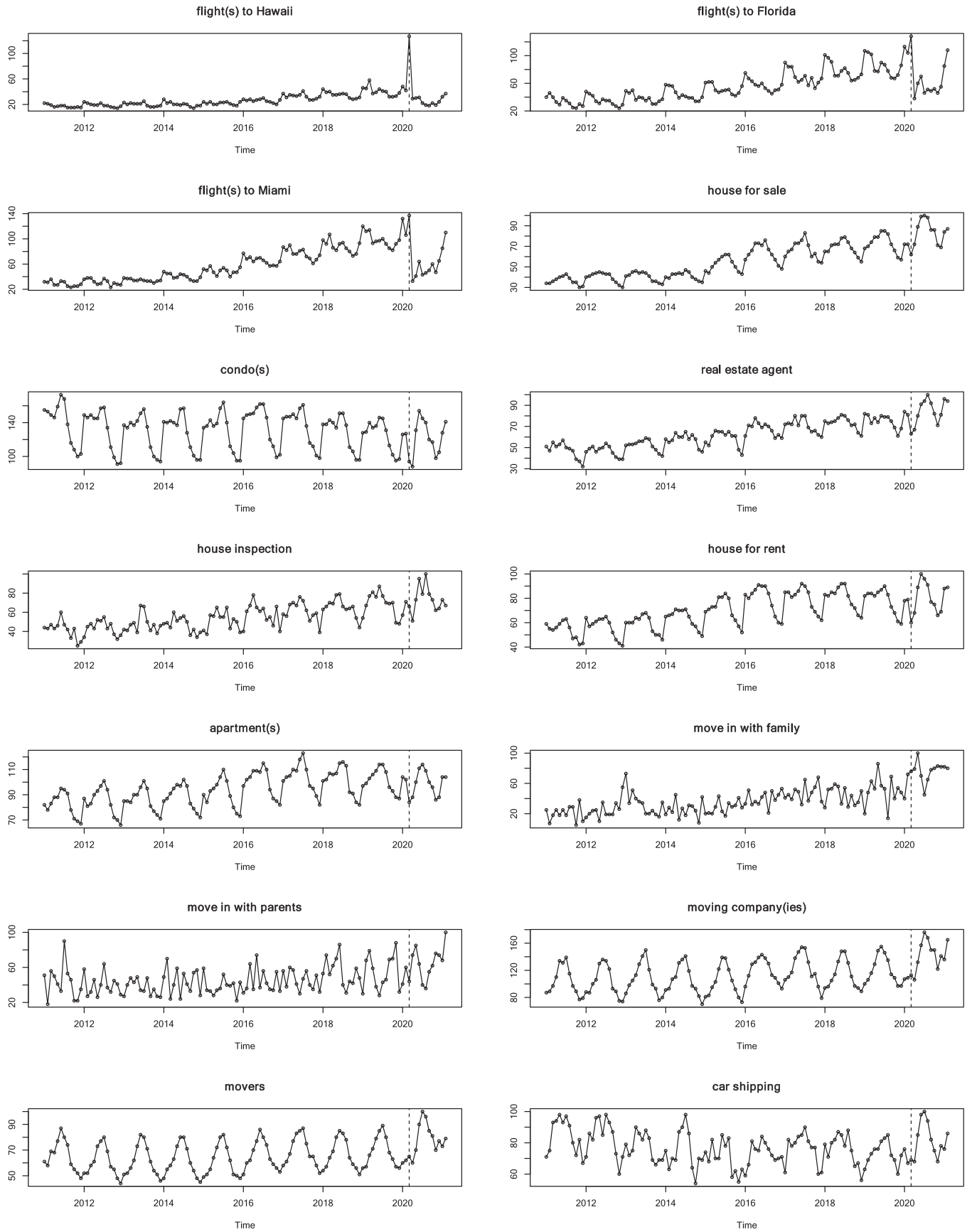


FIGURE 3 Time series plots of monthly relative interests on selected search terms from January 2011 to February 2021. The vertical dashed lines indicate March 2020.

| Category | Search term | Order $(p, d, q) \times (P, D, Q)_{12}$ | AIC |
|-----------------|--------------------------------|---|---------|
| Temporary leave | Flight(s) to Hawaii | $(0, 1, 1) \times (0, 1, 1)_{12}$ | -185.71 |
| | Flight(s) to Florida | $(2, 1, 3) \times (0, 1, 1)_{12}$ | -202.64 |
| | Flight(s) to Miami | $(2, 1, 0) \times (2, 1, 0)_{12}$ | -226.13 |
| Purchase | House for sale ^a | $(1, 1, 0) \times (0, 1, 1)_{12}$ | -328.24 |
| | Condo(s) ^a | $(0, 1, 2) \times (0, 1, 1)_{12}$ | -387.9 |
| | Real estate agent ^a | $(0, 1, 1) \times (0, 1, 1)_{12}$ | -234.36 |
| | House inspection ^a | $(3, 1, 0) \times (0, 1, 1)_{12}$ | -83.71 |
| Rental | House for rent | $(0, 1, 1) \times (0, 1, 1)_{12}$ | -346.69 |
| | Apartment(s) | $(0, 1, 1) \times (0, 1, 1)_{12}$ | -390.02 |
| Family | Move in with family | $(0, 1, 1) \times (0, 0, 0)_{12}$ | 131.44 |
| | Move in with parents | $(0, 0, 1) \times (0, 0, 0)_{12}$ | 75.15 |
| Moving services | Moving company(ies) | $(0, 1, 4) \times (0, 1, 1)_{12}$ | -278.12 |
| | Movers | $(0, 1, 1) \times (0, 1, 3)_{12}$ | -334.37 |
| | Car shipping | $(0, 1, 1) \times (0, 1, 1)_{12}$ | -166.56 |

^aThe log-transformed 30-year fixed mortgage rate was considered an exogenous variable in the ARIMA models. However, it is not statistically significant. Hence, they are not included in the selected models.

the impact of the pandemic since March 2020. The AIC values of the 11 models for each search term are presented in Appendix B, and the selected models are in bold.

The estimated parameters in the response E_t for the model selected for each term are presented in Table 2. The coefficients show the direction, size and decaying rate of the different components of the intervention impact. Still taking the response for 'House for sale' as an example, we can use a negative pulse effect of -0.225 in March 2020, a decaying negative effect of -0.295 since April 2020 (decaying with a rate of 0.301) and a long-lasting positive effect of 0.17 since April 2020 to describe the overall effect of the pandemic. Because these effects overlap in time domain, it only makes sense to combine all three components for interpretation.

To better illustrate the overall intervention effects, we plot the percentage changes in the relative search interest for each term since the pandemic in Figure 5. For terms indicating thoughts about temporary relocations, searches of the term 'flight(s) to Hawaii' immediately increased in March 2020 but started a long-lasting decline during the pandemic period. For 'flight(s) to Florida', we detected a long-lasting negative effect since April 2020. For 'flight(s) to Miami', there has been a slowly decaying negative effect of the pandemic since April 2020. One thing to note is that the searches for flights to Florida and Miami surged in the week of March 8 to 14, 2020 and declined quickly in the second half of March 2020. This fluctuation is masked by the monthly aggregation of data. The weekly dynamics in these two terms can be seen more clearly in Appendix C. The surge in searches for flights to these seasonal migration destinations is consistent with Hypothesis 1 about people's

TABLE 1 Selected ARIMA models without intervention for 14 search terms using data before March 2020 and their AIC values

immediate panic response at the onset of the pandemic. Many people thought about leaving their current residence to escape lockdown, which aligned with media reports about people fleeing from cities (Bellafante, 2020; Bölinger, 2020), similar to the impact of an acute environmental disaster (Hunter et al., 2015). In the long term (in a relative sense), however, intentions for a temporary escape¹ have been reduced significantly, as shown by the 30%–50% fewer searches of these flight-related terms since April 2020 [40.13% for 'flights to Florida' with a 95% confidence interval (CI) (34.77%, 45.49%) and 44.44% for 'flights to Hawaii' with a 95% CI (34.37%, 54.52%)].

For housing purchase-related searches, most of them experienced an initial decline and then a long-term increase. We estimated a decrease of approximately 20%–30% for the search interests in March 2020 [20.19% for 'house for sale' with a 95% CI (14.00%, 26.39%), 20.15% for 'condo(s)' with a 95% CI (13.97%, 26.33%), 21.76% for 'real estate agent' with a 95% CI (9.52%, 34.00%), and 29.62% for 'house inspection' with a 95% CI (23.70%, 35.54%)]. These declines are consistent with Hypothesis 2, which proposes a temporary decrease in thoughts about moves due to the obstacles presented by the pandemic. As argued in the migration theory by E. S. Lee (1966), people would avoid considering moving when the health risks outweigh the benefits of moving in this stage. In the following months, the search volumes returned to normal for 'house inspection'

¹The actual number of visitors in Hawaii has reduced even more, according to data by the Hawaii government. <https://www.hawaiitourismauthority.org/research/monthly-visitor-statistics/?year=2020>. The number of tourists was reduced by 99.5%, 98.9% and 98.2% in April, May and June 2020.

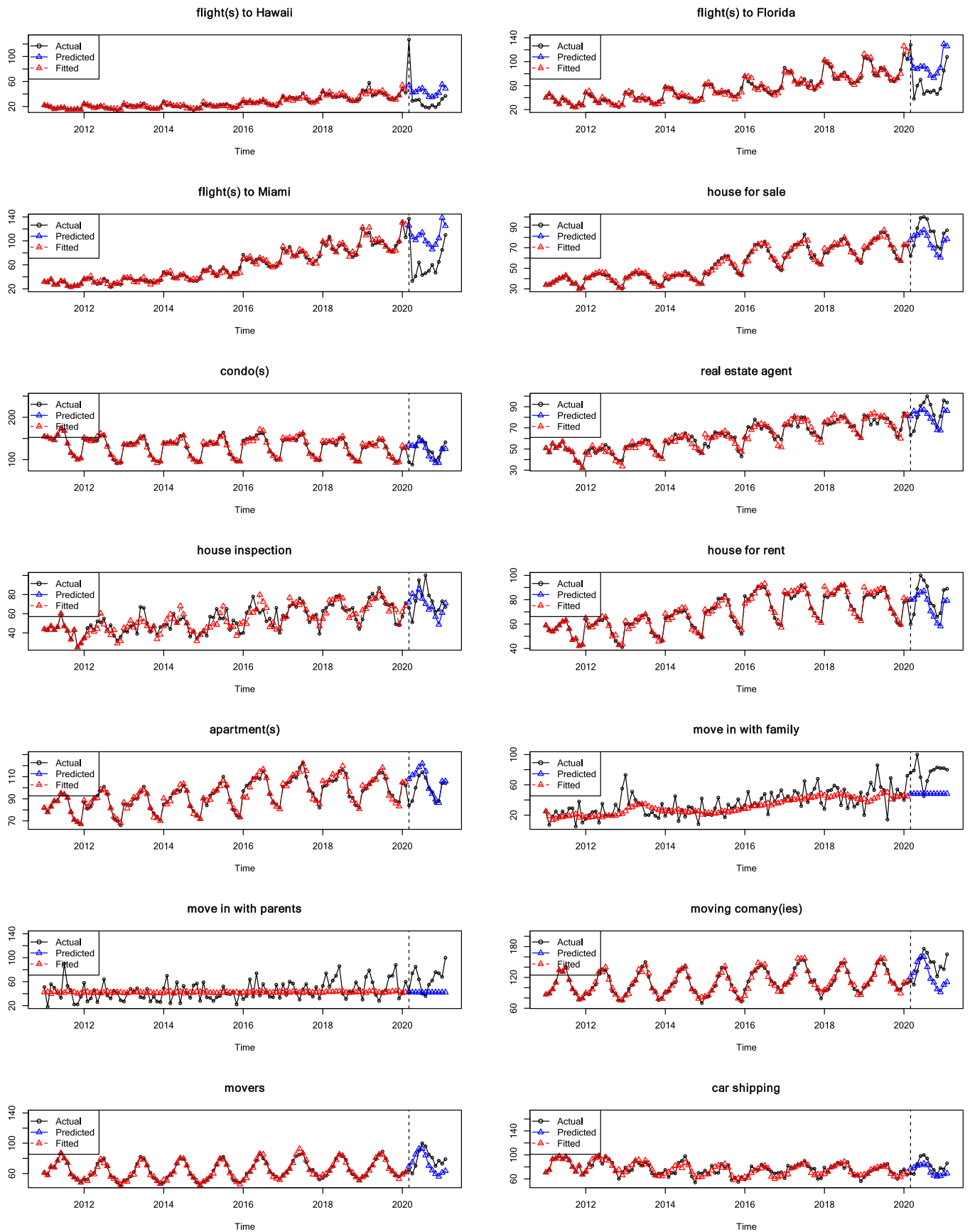


FIGURE 4 Plots of fitted and predicted values using seasonal ARIMA models without intervention (based on models Table 1). The vertical dashed lines indicate March 2020.

TABLE 2 Selected intervention models and estimation results for the 14 search terms

| Category | Search term | Response E_t | w_0 Pulse effect | w_1 Size of temporary effect | δ Rate of decay for temporary effect | w_2 Size of long-lasting effect | Impact starting time |
|-----------------|----------------------|---|--------------------|--------------------------------|---|-----------------------------------|----------------------|
| Temporary leave | Flight(s) to Hawaii | $w_0 P_t^{(T)} + \frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 BS_t^{(T)}$ | 0.939*** (0.109) | 0.383*** (0.1405) | 0.587*** (0.123) | -0.600*** (0.148) | March 2020 |
| | Flight(s) to Florida | $w_2 BS_t^{(T)}$ | -- | -- | -- | -0.513*** (0.053) | April 2020 |
| | Flight(s) to Miami | $\frac{w_1 B}{1-\delta B} P_t^{(T)}$ | -- | -1.041*** (0.077) | 0.903*** (0.028) | -- | April 2020 |
| Purchase | House for sale | $w_0 P_t^{(T)} + \frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 BS_t^{(T)}$ | -0.225*** (0.039) | -0.295*** (0.063) | 0.301*** (0.151) | 0.170*** (0.077) | March 2020 |
| | Condo(s) | $w_0 P_t^{(T)} + \frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 BS_t^{(T)}$ | -0.369*** (0.034) | -0.485*** (0.039) | 0.177*** (0.076) | 0.078*** (0.036) | March 2020 |
| | Real estate agent | $w_0 P_t^{(T)} + \frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 BS_t^{(T)}$ | -0.245*** (0.071) | -0.372*** (0.074) | 0.424*** (0.147) | 0.128*** (0.064) | March 2020 |
| | House inspection | $\frac{w_1 B}{1-\delta B} P_t^{(T)}$ | -- | -0.351*** (0.122) | 0.657*** (0.127) | -- | March 2020 |
| Rental | House for rent | $\frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 S_t^{(T)}$ | -- | -0.455*** (0.052) | 0.517*** (0.068) | 0.146*** (0.052) | March 2020 |
| | Apartment(s) | $w_0 P_t^{(T)} + \frac{w_1 B}{1-\delta B} P_t^{(T)}$ | -0.249*** (0.029) | -0.228*** (0.029) | 0.552*** (0.100) | -- | March 2020 |
| Family | Move in with family | $w_2 S_t^{(T)}$ | -- | -- | -- | 0.447*** (0.228) | March 2020 |
| | Move in with parents | $w_2 BS_t^{(T)}$ | -- | -- | -- | 0.423*** (0.114) | April 2020 |
| Moving services | Moving company(ies) | $\frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 BS_t^{(T)}$ | -- | -0.666*** (0.187) | 0.841*** (0.080) | 0.507*** (0.190) | April 2020 |
| | Movers | $\frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 BS_t^{(T)}$ | -- | -0.529*** (0.072) | 0.733*** (0.055) | 0.292*** (0.075) | April 2020 |
| | Car shipping | $\frac{w_1 B}{1-\delta B} P_t^{(T)} + w_2 S_t^{(T)}$ | -- | -0.320*** (0.099) | 0.633*** (0.158) | 0.166*** (0.068) | March 2020 |

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

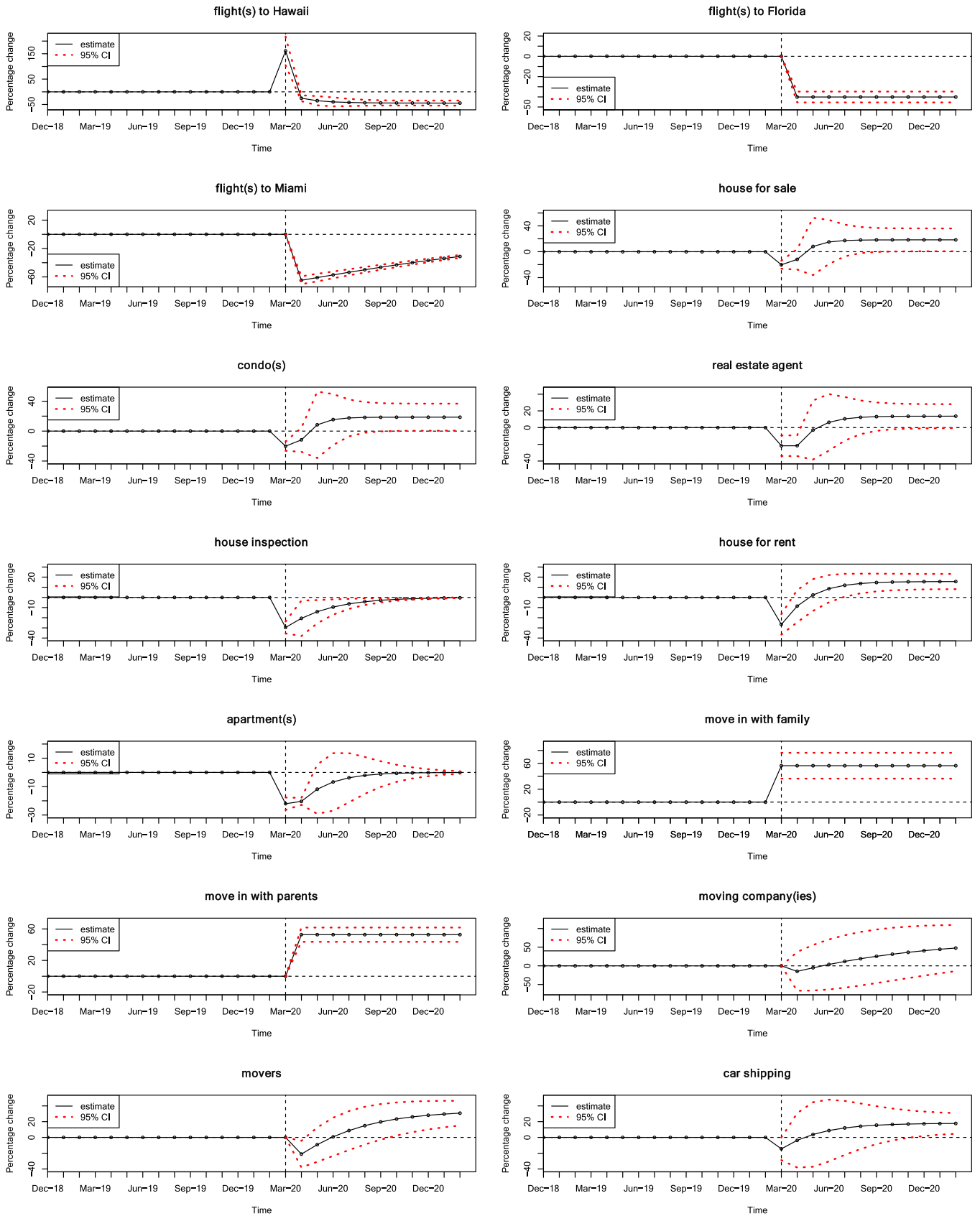


FIGURE 5 Plots of the percentage changes of relative interests of the search terms. The vertical dashed lines indicate March 2020. The horizontal dashed lines are 0, which means the search interest is not affected by the pandemic.

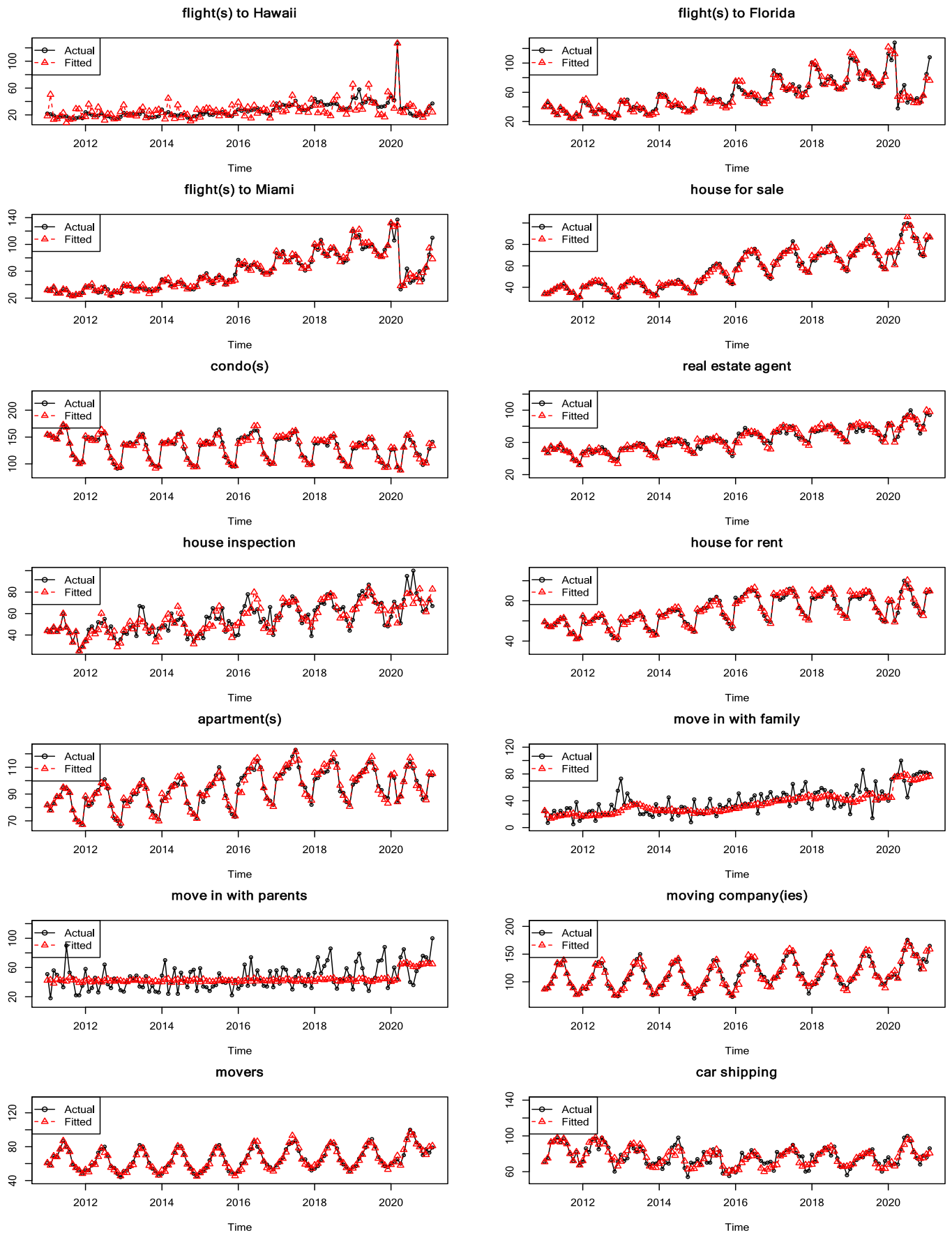


FIGURE 6 Plots of fitted values using seasonal ARIMA models with intervention (Table 2).

but surpassed the prepandemic levels for 'house for sale', 'condo (s)' and 'real estate agent'. The long-term positive impact of the pandemic on the house purchase-related terms reflects the dissatisfaction with the current residences and the newly generated needs for housing adjustment since the pandemic, which is consistent with Hypothesis 3. Families only search for 'house inspection' right before the transaction. The search volume for this term did not exceed the usual level, perhaps because families cannot successfully purchase a house due to the record low housing inventory. Although there were increased needs and desires for moving, many families did not win the bidding war on a house. Many homebuyers have even skipped home inspections in the recent hot market.

Rental-related searches have similar patterns to housing purchase-related searches. The initial decline in search interest was 26.59% for 'house for rent' with a 95% CI (16.48%, 36.70%) and 22.04% for 'apartment(s)' with a 95% CI (17.68%, 26.40%) in March 2020 (see Figure 5). The search for 'apartment(s)' gradually returned to normal in the following months, but the search for 'house for rent' increased to a level of 15.65% higher than the prepandemic level with a 95% CI (8.17%, 23.12%). The initial decline supports Hypothesis 2 about the short-term deterring effect of the pandemic, owing to the obstacles presented by the lockdown. We found a long-term increase in searches regarding rental houses but not in searches concerning apartments, which may be because people have come to desire more space during the pandemic as more family members have been working and studying at home. This result partially supports Hypothesis 3 regarding the increase in thoughts about residential mobility achieved via renting.

For moves into family members' homes, we observed a long-lasting positive effect of the pandemic on searches for 'move in with family' and 'move in with parents' starting in March 2020 and April 2020, respectively. As shown in Figure 5, searches for these two terms have increased by more than 50% compared with their prepandemic levels (56.37% for 'move in with family' with a 95% CI [36.38%, 76.36%] and 52.69% for 'move in with parents' with a 95% CI [43.64%, 61.74%]). The results support Hypothesis 4 that thoughts about moving into family members' homes have increased since the pandemic began.

The pattern of search interests in moving services can capture changes in plans of or actual moves via various routes. The results for moving services-related searches echo the pattern of an initial drop and a long-lasting increase for the purchase- and rental-related searches. Regarding searches for 'moving company(ies)' and 'movers', we observed a short-term decline since April 2020, followed by a long-lasting increase in the following months (see Figure 5). For 'car shipping', there was a short-term negative impact starting in March 2020 and a long-lasting positive impact later. These patterns are consistent with what we expected in Hypotheses 2 and 3. The effect of the pandemic was not felt until April, probably because families who had already signed purchase or rental contracts for new homes were obligated to complete their moves in March regardless of the COVID-19 pandemic. A negative impact on 'car shipping' was felt in March, probably because the

timing to ship a car is more flexible and thus more susceptible to external events like the pandemic.

Figure 6 plots the fitted values using seasonal ARIMA models with intervention. The red dashed lines are the fitted values that are close to the actual observed numbers. Compared to the seasonal ARIMA models without intervention shown in Figure 4, seasonal ARIMA models with intervention perform much better and capture the trends and dynamics of the data more precisely. The intervention response functions correctly capture the deviations of search volumes away from the prepandemic patterns since the outbreak of COVID-19.

5 | CONCLUSIONS AND DISCUSSION

In this study, we examined the impact of the COVID-19 pandemic on mobility intentions in the United States using monthly data from Google Trends. This article contributes to the literature in several ways. First, drawing on theories of migration decision-making and recent literature on hazards and migration, we explained how the COVID-19 pandemic could influence mobility intention directly and affect it indirectly through other migration drivers. In addition, we conducted a timely analysis of real-time search data to test our hypotheses about mobility thoughts. The monthly data over 11 years allowed us to examine the transitory, short-term, and long-lasting effects of the pandemic on mobility-related searches. Research using annual or biennial survey data may not reveal the granular scale fluctuations. Moreover, we examined temporary relocations, which are relevant reactions to the COVID-19 outbreak but are not typically asked about in household surveys. Finally, Google search data could capture people's intentions to move better than survey data because when the intentions were short-lived or unrealized, people may not remember to report them in surveys, but they leave traces on the internet.

The findings lead us to draw a few conclusions. First, regarding the direct effect of the pandemic on mobility intentions, we found a surge in searches related to short-term escape at the onset of the pandemic in the first week of March 2020. The people who intend to move to Hawaii or Florida may already have a vacation home there. They would like to avoid the risk of the disease and find a better environment to quarantine. As shown in a survey by Pew Research Center, among U.S. adults who moved due to the pandemic, 28% cited 'to reduce their risk of contracting the virus' as their main reason (Cohn, 2021). The increased thoughts about temporary escape are consistent with the dramatically increased temporary change-of-address requests sent to USPS in March and April 2020 (Bowman, 2021). However, in the long term, temporary relocation intentions have declined by 30%–50% due to restrictions on travel.

Second, COVID-19 had a short-term retarding effect on thoughts about residential moves via some but not all routes. Searches of housing purchase- or rental-related terms decreased significantly in March 2020, which may be attributable to people's fear of COVID-19 infection and the restrictions of the lockdown

policies. However, searches about moving in with family or parents did not decline at the time of the COVID-19 outbreak, as this type of move is not prevented by fear of disease transmission or lockdown. It is also noteworthy that the short-term decline was evident for both the terms capturing mobility thoughts (indicated by searches for listings and real estate agents) and more concrete moving plans or behaviours (as reflected by searches for moving services). Although most people who searched for moving services were sure to move, they delayed their moves in the early stages of the pandemic.

Third, although the pandemic dampened mobility intentions in the initial stage of the pandemic, since the summer of 2020, it increased searches related to most types of moving, including moves through purchases of houses or condos, house rental and moving in with family. The only exception is moving related to apartment rental. The long-term increases in searches on purchase-related and house rental-related terms reflect a discrepancy between household needs and current residential conditions during the pandemic. For example, working and studying from home may have created demands for larger spaces and better housing conditions. A recent survey showed that the share of Americans who are satisfied with the quality of life in their local community has dropped between 2018 and 2021 (Parker et al., 2021). The pandemic could have also changed people's evaluation of place characteristics. Features like high population density and closeness to highways and train/bus stations may be less valued than before. Fewer U.S. adults in 2021 expressed a preference for living in urban areas than in 2018 (Parker et al., 2021).

The slight difference between the patterns of the search terms may suggest heterogeneous effects of the pandemic across population groups. The long-lasting increases in searches for purchase-related terms and 'house for rent' could reflect the increased demands for more spaces and better conditions among larger families, owners and wealthier families. In contrast, the search volume of 'apartment(s)' has returned to normal, indicating a lack of long-lasting changes in the moving intentions among renters and people with fewer economic resources. This could also be attributable to the financial assistance programmes preventing many evictions and voluntary adjustment of housing conditions to save money.

The long-term increase in thoughts about moving via housing purchases and rentals is reflected in the increased number of searches for moving services. The surge in these searches since summer 2020 indicates an increase in planning for moving, not merely higher intentions to move. Moving service-related terms capture people planning moves via all routes who intended to use the specified moving services. One caveat is that small businesses may also use Google to search for moving services. The larger magnitude of the long-lasting positive effect relative to the size of the initial decline indicates that the increased plans for moves not only compensate for the moves postponed by the lockdown but also fulfil the newly created needs for housing adjustment.

Fourth, thoughts about moving in with family or parents have increased significantly (by approximately 50%) since the COVID-19 pandemic. Due to the health risks generated by the pandemic, the

need to provide care to or receive care from family members has increased. Another possible reason to move in with family is economic distress. Unemployment, financial loss and closure of college campuses during the pandemic have probably driven many young people back to their parent's or family members' homes. Our findings are consistent with a recent survey showing that 61% of American adults who moved due to the pandemic relocated to a family member's home, and one in five said they moved because they wanted to be with family (Cohn, 2021). This finding highlights the importance of family ties in decisions regarding residential moves, which was emphasized in recent literature (Gillespie & Mulder, 2020; Spring et al., 2017).

In sum, we find a short-term decline in thoughts about moving through rental or purchase in the initial stage of the pandemic and a long-lasting increase in thoughts about moving through house purchase/rental and to a family member's home since summer 2020. The growing interest in residential mobility is consistent with the increase in temporary and permanent moves reported in surveys and address change data (Bowman, 2021; Cohn, 2021; Parker et al., 2021). In contrast to our findings, data from the Current Population Survey (CPS) reveal that the migration rate in 2020 has declined to a record low. Between March 2020 and March 2021, only 8.4% of Americans (age 1 year and older) have changed residence (U.S. Census Bureau, 2021). There could be a few reasons for the differences in patterns revealed in CPS and our findings. First and foremost, the CPS only asked respondents whether they lived at the same address a year ago, discounting temporary mobility. Second, CPS captures mobility among a broader population than the adult population represented by Google users. Moreover, Census Bureau acknowledged that the pandemic-related survey operations and nonresponse changes may have influenced the estimates in 2021. It could also be because the mobility intentions revealed in our study have not been translated into actual moves yet. There could be 'catch-up' mobility in the following years. Therefore, researching mobility intentions and behaviours using different data sources is warranted.

Future research could contribute to this area of literature by addressing some limitations of the current study. First, our measures of mobility intentions could be inaccurate. Although 90% of home buyers search online (National Association of Realtors and Google, 2013), they may not necessarily search for information using Google. Second, by using Google Trends data, we can only analyse the overall level of mobility intentions, but we cannot distinguish moves by distance or destinations. Third, without data on the characteristics of Google users, we cannot analyse how socio-economic status, life course stage and other personal factors affect moving intentions and behaviours, which is a task for future research using survey or administrative data. Fourth, our study does not aim to parse out the effects of different macro factors, such as the disease outbreak, lockdown policies and financial assistance programmes, on moving intentions and actual moves. If interested, researchers could specifically evaluate the effectiveness of various financial assistance programmes in improving housing stability.

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ORCID

Lei Lei  <http://orcid.org/0000-0003-2161-1217>

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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