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Mobility restrictions and their implications on the rental housing market during the COVID-19 pandemic in China's large cities

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ABSTRACT

The COVID-19 pandemic has caused significant mobility restrictions and generated profound impacts on global socio-economic development. Mobility restrictions can generate significant impacts on the demand and supply sides of the rental housing market. By taking 77 large Chinese cities as cases, this research establishes a stepwise mediation effect test to evaluate the impacts of the pandemic on the rental housing market during Q1 2020. The results show that the confirmed cases were negatively associated with rental unit transactions, and the inter-city and intra-city movement played a significant role of mediating effects. Meanwhile, the impact of pandemic on rents lagged behind rental transaction in China's large cities, and the strict mobility controls caused the high vacancy rate of rental housing, leading to the bankruptcy of many housing rental agencies. Our research add to the burgeoning literature examining the mediating effect of mobility control between confirmed case and housing rental market. It demonstrates that the change of housing rental market induced by pandemic in China is the short-term influence on rental unit transaction, which is different from western countries. In China, a country with the most strict mobility control, the challenges come from the impact of pandemic on housing rental agencies.

1. Introduction

During the COVID-19 pandemic, thousands of cities were locked down to prevent the spread of coronavirus cases. The pandemic has led to drastic changes in mobility. Social distancing, self-isolation and travel restrictions have brought about fears of economic crisis and recession, and the decrease in workforces across all economic sectors has caused dramatic job losses (Nicola et al., 2020). Over the last year, many studies on the social-economic impact of COVID-19 have emerged (Canals et al., 2020; Jay et al., 2020; Nicola et al., 2020), and studies on the influence of COVID-19 on the housing market have also been published worldwide (O'Toole et al., 2020; Janson & Verbrugge, 2020; Huang et al., 2020; Yilmazkuday, 2020; Gupta et al., 2021; Kuk et al., 2021). Much of this research has discussed the impact of the pandemic on migrants in the rental market. Because of the threat facing the housing market due to the pandemic, governments in many countries, such as the United States, Germany, and England, are looking for ways to lessen the impact of the pandemic on housing affordability. It is reported that four protective measures: protection of tenants from eviction, mortgage relief, rent freezes, and rent subsidies, have been or are being used in order to relieve the hardship on tenants (Khulodilin, 2020).

Compared with the rental housing market in western countries, the rental housing market in China is much less developed, and has no specific regulations. Although the pandemic brought about dramatic impacts on tenants, landlords and real estate agents, the Chinese government has not adopted any measure to cope with the problems in the

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rental housing market. In 2018, there were more than 241 million migrants in China, of those, around 160 million were rural-to-urban labour migrants, and most of them were located in the developed coastal area and the Beijing-Tianjin region. Yuan (2017) stated that migrants contributed 20%–30% to China's 40 years of economic growth since the opening reform. The outbreak of COVID-19 in Wuhan happened during the Festival travel season, and it was reported that around 5 million people left Wuhan before its lockdown at the end of January, leading to the spread of COVID-19 throughout China. The lock-down measures were maintained through February and March, leading to a GDP contraction of 6.8% in Q1 2020 compared with Q1 2019. The differences between cities in the severity and duration of the mobility restriction measures imposed during the first quarter have been reflected in the decline of GDP. This relationship between mobility restrictions and economic activity can be clearly observed in Chinese cities.

Beginning in April 2020, confirmed cases started to decline dramatically due to the stringent lock-down in China, and domestic travel gradually returned to normal. However, the impact of COVID-19 on the rental housing market has continued. According to the statistics of RealData, housing rent decreased more than 7% in large Chinese cities in 2020 compared with 2019. In 2020, there were around 40 rental agencies that filed for bankruptcy due to the high vacancy rate during the pandemic, as the influence of COVID-19 on the rental housing market was significant. By selecting 77 large cities as cases, this research establishes a framework to analyze the impact of the COVID-19 pandemic on mobility and its socio-economic consequences, in particular, its impact on the rental housing market in large Chinese cities.

Our research makes the following contributions. First, we add to the burgeoning literature examining the mediating effect of mobility control between confirmed case and housing rental market. Second, we demonstrate that the change of housing rental market induced by pandemic in China is the short-term influence on rental unit transaction, which is different from western countries where housing rent has been significantly affected, and racial and spatial impacts of pandemic have been uneven and verified. Third, in China, a country with the most strict mobility control, the challenges come from the impact of pandemic on housing rental agencies and the long-term impacts of pandemic on housing rental market is worthy of further research.

This paper is organized as follows: Section 1 reviews literature on mobility and the housing market during the pandemic, and Section 2 explains the research data and methods. Section 3 examines the mediating effect of mobility between confirmed cases and the rental housing market in China's large cities, and the final section discusses rent changes post-pandemic, impacts of the pandemic on demand and supply sides of the rental housing market, and policy implications for rental housing market development in China.

2. Literature review: mobility and housing market during the pandemic

Previous studies have shown that mobility has both positive and negative impacts on the rental housing market. Saiz (2003) found that in the United States when immigration inflows are equal to 1% of a city's population, housing rents increase by about 1%. However, Si (2015) stated that immigration inflow has a negative effect on the U.K. housing market as immigration generates a negative income effect on housing demand by driving out natives who are relatively high wage earners. Saiz and Wachter (2011) concluded that the departure of native residents in response to immigration results in slower housing appreciation in immigrant neighborhoods.

Historically, pandemics have generated significant impacts on housing markets. For instance, Ambrus et al. (2020) examined the impact of a cholera epidemic on housing prices in one neighborhood in 19th century London. Francke and Korevaar (2020) investigated the effects of historical outbreaks of the plague on housing markets in the 17th century. Wong (2008) studied the impact of SARS on housing transaction volume in Hong Kong in 2003 and found that SARS led to a significant decline in transaction volume, but only caused a slight decrease of 1.6% in average housing prices for all estates. These existing studies have shown a significant negative correlation between pandemics and housing prices and transactions. However, to what extent this negative impact exists and whether it is a long-term or short-term impact varies greatly in different regions.

Since the outbreak of COVID-19 is only a little more than two years old as of this writing, the studies on its impacts on housing markets are insufficient. Limited studies include the research of Huang et al. (2020), Yrük (2020) and Huang et al. (2020) who constructed the weekly house price index of 64 cities in China from January 1, 2019 to May 31, 2020 by using the hedonic regression model. The results showed that housing prices fell by about 2% in the four weeks after the outbreak of COVID-19. More confirmed COVID-19 cases in a city significantly reduced housing prices and transaction volume. In particular, the negative impact on transaction volume is more significant than that on housing prices. In the United States, the pandemic has left low-and-moderate income tenants unable to pay rent. This non-payment of rent has led to more problems as landlords have gone without income to make necessary repairs and pay mortgages (Airgood-Obrycki, 2020a; Airgood-Obrycki, 2020b). By identifying metropolitan areas with existing economic vulnerabilities, Weeden (2020) showed that the unfolding crisis and resulting job losses may have the largest impact on rental markets. In the United Kingdom, there are more than 8 million tenants, and more than 4.5 million tenants living in private housing. It is reported that the income of 42% of private renters decreased during coronavirus lockdowns (The Guardian, 04/06/2020). Yrük (2020) found that a 10% increase in the alternative indicators of COVID-19 related cases or deaths is associated with a 0.1 to 0.03 percentage point decrease in housing market activity in the United States, while Yilmazkuday's estimation results (2020) suggested that 1000 additional COVID-19 cases (deaths) result in about $20 reduction in housing prices. Williams (2020) found that the UK housing market experienced a double slump in housing prices and transaction volume in March and April due to the government's restrictive actions.

Research concerning on examining the impact of pandemic on housing market has increased since 2021. By taking 49 largest metropolitan areas in the United States as samples and using online rental listing data set from Craigslist, Kuk et al. (2021) found that local spread of COVID-19 was followed by reduced median and mean rent from mid-March to early June. Tomal and Marona (2021) pointed out that the pandemic outbreak significantly lowered rents before and during the pandemic in Cracow, Poland. They also revealed that the emergence of the coronavirus reshaped the residential rental market in three ways: rents were decreased, the underlying rental price-determining factors changed, and the spatiotemporal submarket structure was altered. Trojanek et al. (2021) estimated that housing rents in Warsaw fell by 7.7% between March and December 2020. The research of Liu and Su (2021) revealed that the pandemic has led to a shift in housing demand away from neighborhoods with high population density in the US, and COVID-19 has re-introduced disease transmission as a dispersion force in the urban spatial equilibrium in the short run. According to America's Rental Housing 2022 report, rental housing demand came roaring back in the second year of the pandemic. The vacancy rate was reducing and driving up rents (Airgood-Obrycki, 2022).

The COVID-19 pandemic raises the importance of housing for everyone to protect themselves from the disease and against other similar airborne pandemics (Khaled Moustafa, 2020). Existing literature pointed out that tenants are more vulnerable to COVID-19 than homeowners. Byrne et al. (2020) estimated that in Ireland, 44% of households working in the economic sectors most severely affected by the pandemic were renters. O'Toole et al. (2020) emphasized that the overall decline in income and the high level of unemployment during the pandemic made life more difficult for rental households. Nearly one-third of renter families, after paying rent, did not have enough money to meet the
minimum basic living standard. In the United States, the CARES Act even imposed a 120-day moratorium on evictions for most renters who could not afford rent (Janson & Verbrugge, 2020). According to the International Organization for Migration (IOM), migrants’ vulnerability to COVID-19 was reflected in five aspects, contracting COVID-19, not accessing appropriate care, showing severe symptoms, suffering psychosocial impacts, livelihood and income insecurity (Guadagno, 2020). Kholodilin (2020) argued that the risk of large numbers of tenants and homeowners being evicted is very high during the pandemic period, and governments in many countries adopted various approaches to protect tenants. Eviction bans remained effective in the US, UK and several other countries well into 2021.

Meanwhile, scholars realized that in the coming years, the impact of COVID-19 on housing markets remains to be observed. Far more research is needed to understand the consequences of the ongoing pandemic. In the western countries, many studies highlight the importance of studying the rental market broadly and testing for socioeconomic, in particular, racial disparities within the rental market. In China, however, there have been few studies on the impact of the pandemic on the rental housing market. It is thus worthy further research.

3. Study area, methodology and data source

3.1. Study area

During the 2019 Spring Festival, the return to hometowns and holiday travel for Chinese residents reached 2.98 billion during its 40 day time span. The 2020 Spring Festival migrations decreased to 1.48 billion, a decrease of 50.3% during its 40 days (CINIC, 2020). Even so, a large amount of migrants returned to their homes for family reunions before the Spring Festival. For instance, more than 5 million people left Wuhan city before its lockdown (China Net Culture, 2020), increasing the risk of a significant spread of the virus.

Based on available data, this study selects 77 large cities, including 3 cities in Hubei province, 4 provincial level municipalities, 16 provincial capital cities and other large cities such as Shenzhen, Wuxi, Suzhou, Dalian, Qingdao, Yantai, and Xiamen as case studies (Fig. 1). These 77 large cities are home to a large number of migrants, and their economy has been active. The selection is based on the following reasons: (1) these cities cover more than 80% of cities with population inflow in China, and they are more susceptible to the mobility control compared with other cities with smaller migrant populations; (2) Three prefecture-level cities in Hubei province are selected because Hubei is the first province which was hit by the pandemic, and mobility control was very strict in these cities.

3.2. Analytical framework and research methods

The outbreak of COVID-19 generated dramatic impacts on mobility in China. With an increasing number of confirmed cases, the entire country adopted stringent measures to restrict mobility, including reduced travel and 14-days of self-isolation in arrival cities, such as Beijing. Many migrants found it difficult to return to the cities where they worked and lived. Meanwhile, intra-city movement was dramatically restricted due to social distancing rules, forcing millions of people to work and socialize from home — only venturing out for essential trips. Therefore, both inter-city and intra-city movement was stringently restricted.

Moreover, considering the great uncertainty due to COVID-19, some cities restricted open houses, a key part of the housing market transaction process, causing change of the plans of both owners and tenants. Increasingly, owners were requiring reassurance regarding the health of potential tenants desiring to view properties. Some cities, such as Beijing, required brokers to offer at most viewings of two properties a day with potential tenants in February and March, dramatically affecting rental transactions. Lianjia, the largest housing rental agency in China, reported a 30% vacancy rate for their rental units in Beijing during February and March.

In China, the central government adopted a strategy of “coordinating all the activities of the nation like moves in a chess game” (quanguo yipangui) to prevent the spread of the virus. In general, the more confirmed cases, the more stringent the control on mobility. Moreover, population size is a key index of city scale, and is selected as a control variable in our model. Theoretically, household income changes and employment have substantial influence on the rental housing market; however, these types of impacts are lagging indicators. Unfortunately, the quarterly data of household income and employment at the city level is unavailable, and thus we select GDP change as the surrogate for income and employment, another control variable. Moreover, existing housing stock is a key indicator of the rental housing market. However, we cannot collect data on the housing stock, instead, we use the net loss of rental housing market during the pre-pandemic and post-pandemic periods as dependent variables. The analytical framework is presented in Fig. 2.

We aim to analyze the relationship between the pandemic and its implications on the rental housing market with a mediating effect of mobility. Mobility has both the meaning of ability to move physically and socially. In other words, the ability to change one’s social or socioeconomic position within a community. In this research, we use the data of physical mobility as the mediator, and the purposes of mobility include commuting, business, shopping, recreation, transportation, and others. During Q1 of 2020, the schools, Karaoke TV houses, restaurants and recreational places were closed, and recreation, shopping and other activities were largely restrained. Therefore, mobility mainly included necessary activities such as commuting, business and transportation during the pandemic. Moreover, activities such as viewing properties were restricted due to the closing of residential quarters, and many tenants not being able to return to the cities where they work. As the result, inter-city and intra-city movement was significantly less than normal. Therefore, mobility can be used as the proxy of activities and a mediator between the pandemic and the rental housing market.

To this end, we adopt the methods of stepwise mediation effect test (Baron & Kenny, 1986; Zhou et al., 2010) and bootstrap (Elgamal et al., 2007) to test the correlation and mediating effect. The stepwise test is used to estimate each path in our proposed analytical model. Following the suggestion of Baron and Kenny (1986), we conduct three regression equations—regressing the mediator on the independent variable, regressing the dependent variable on the independent variable and regressing the dependent variable on both the independent variable and on the mediator, with all other variables controlled—to test our hypotheses. First, in this test, when regressing the mediator mobility on the independent variable of confirmed cases, we define the coefficient of mediator variable mobility as $a$. Second, when regressing the dependent variable rental market on the independent variable of confirmed cases, the coefficient of the dependent variable rental market was $c$. Third, when regressing the dependent variable rental market on both the independent variable, confirmed cases, and on the mediator mobility, the coefficient of mediator variable mobility was $b$, and the independent variable of confirmed cases coefficient was $c\cdot a$.

3.3. Data sources

According to the analytical framework, we classify the data into four
Fig. 1. Location of 77 large cities in China.

Fig. 2. Analytical research framework.
types: confirmed cases, mobility, socio-economic variable, and rental housing market (Table 1). COVID-19 case data is collected from Harvard Dataverse, and the original source is from the National Health Commission of the People's Republic of China (http://www.nhc.gov.cn/) and publicly reported cases from the Dingxiangyuan platform (https://github.com/BlankerL/DXY-COVID-19-Data). Mobility data is gathered from Baidu Huiyan (https://qianxi.baidu.com/), and is calculated on the basis of cellular signaling data. The monthly accumulated mobility data in Q1 2020 is based on the daily reported move-in and move-out index from Harvard Dataverse: COVID-19 Data Collection (https://dataverse.harvard.edu/). Socio-economic data comes from the National and the 77 large cities' local statistical official websites. Rental housing market data is collected from the Creprice database platform (https://www.creprice.cn) and RealData platform (https://research.ke.com/data/) which provides comprehensive rental market information based on the real estate market platform of “city house” (http://www.cityhouse.cn/city.html), “Lianjia” (https://lianjia.com/) and supplemented by other real estate websites and offline intermediary agent data. We select two types of key index data, rental unit transaction and average rent during both the pre-pandemic and pandemic periods.

4. Research results

In order to understand the impact of the COVID-19 pandemic on mobility and the rental market in the 77 large cities of China, this model assumes two time periods: a benchmark period from January to March 2019 (Q1) before the Covid-19 pandemic and a crisis period of Q1 2020 during which mobility was significantly reduced.

4.1. Spatial characteristics of mobility and the rental market during the pandemic

(1) Confirmed cases

Fig. 3 shows that in the 77 large cities, there were a total of 63,023 confirmed cases during Q1 of 2020, among which, cities outside Hubei province accounted for 8530 confirmed cases, averaging 115 cases in each city. The total number of confirmed cases in first-tier cities, such as

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Table 1

| Data type                      | Index               | Time period         | Data source                                      |
|--------------------------------|---------------------|---------------------|-------------------------------------------------|
| COVID-19                       | Confirmed cases     | Monthly data in Q1  | Harvard Dataverse: COVID-19 Data Collection     |
| (Independent variable)         |                     | of 2020             |                                                 |
| Mobility                       |                     | Daily data in Q1    | Baidu Mobility Data website                     |
| (Mediator)                     | Inter-city migration| of 2019 and 2020    |                                                 |
|                                | Intra-city movement | Feb. to Mar. of 2019| Harvard Dataverse: COVID-19 Data Collection     |
|                                | index               | 2019 and 2020       |                                                 |
| Control variable               | GDP contraction     | Data in Q1 of 2019  | National and local statistical official websites|
|                                | Population size     | and 2020            |                                                 |
| Rental housing market (Dependent variable) | Rental unit transactions | Data in Q1 of 2019 and 2020 | Creprice and RealData database platforms |
|                                |                     | Data in Q4 of 2019  |                                                 |

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The mobility index is calculated based on individual movement. If an individual leaves the city where s/he lives for more than one day, s/he is regarded as a move-out individual, and the city where s/he lives is regarded as a departure city. If s/he travels to another city for more than four hours, this city is regarded as an arrival city, and the individual is regarded as a move-in individual. The sum of all individuals is then indexed.
Beijing, Shanghai, Shenzhen, Guangzhou, were higher than that in other mega-cities. Beijing, with 580 cases, was the city with the largest number of confirmed cases outside Hubei province.

(2) Inter-city and intra-city mobility

Fig. 4 reveals the change in mobility from Q1 2019 to Q1 2020. Due to the pandemic, population mobility was severely restricted during Q1 2020 when compared with the same period of 2019. In particular, in February 2020 the total move-in index for the 77 large cities decreased 75% compared to the same period of 2019. In March, the rate of decrease was 36%. The average move-in index of cities in Hubei province decreased 93% in February 2020 compared to February 2019, and 78% in March. The move-in indices of provincial-level municipalities and provincial capital cities was relatively higher than other large cities and they decreased faster in February 2020. In March 2020 all large cities’ inflow gradually recovered, but the move-in gap between March 2019 and March 2020 in provincial-level cities and provincial capital cities was larger than in other cities.

Meanwhile, the move-out flow was significantly reduced in large Chinese cities due to the pandemic. Compared with February 2019, the move-out index of the 77 large cities dropped 78% during February 2020, and dropped 40% in March 2020 compared with March 2019. In the three Hubei cities, the move-out flow decreased 93% in February 2020 and 71% in March 2020 over the same periods in 2019. Cities outside Hubei province showed a clear recovery trend in March 2020 when compared to February 2020. During the same time period, the move-out index of provincial-level municipalities and 16 provincial capital cities was in a fairly slow recovery process. The move-out drop in Beijing was highest among all cities at 89% in February 2020, and 82% in March 2020.

Inter-city mobility is composed of both move-ins and move-outs, and after calculating the move-in and move-out indices of each city, we found that the total mobility index decreased 39% from Q1 2019 to Q1 2020. The biggest drop occurred in February 2020, reaching 76%, followed by 38% in March 2020, while it was only 6% in January 2020. Among all cities, the decrease of total mobility in the cities of Hubei province was most significant, decreasing 4% in January 2020, 93% in February and 74% in March. In February and March 2020, the mobility restrictions were significant in the four first-tier cities. Inter-city movement decreased 81% in Beijing, 68% in Shanghai, 57% in Guangzhou, and 54% in Shenzhen compared to the same period of 2019.

Besides inter-city movement, intra-city movement was also restricted to a large extent during the COVID-19 pandemic. Generally, intra-city movement decreased 44% in February 2020 compared with February 2019, and 7% in March 2020 compared with March 2019. In February 2020, the intra-city movement index in the cities of Hubei province decreased 68% compared with February 2019, and 32% in March 2020 compared to March 2019. When compared with the same period of 2019, total intra-city movement in the provincial-level municipalities and 16 provincial capital cities decreased 47% in February 2020, and 15% in March 2020. During the same period, it was 42% and 2% respectively in the other 54 cities. Therefore, the recovery of intra-city movement was slower in the larger cities.

(3) GDP contraction

In Q1 of 2020, China’s GDP dropped 6.8% compared with the same period in 2019. Cities in Hubei province declined most significantly in Q1 2020. The GDP of the three cities in Hubei province decreased 37.7%, and the drop in Wuhan reached 40.5%. GDP in cities outside Hubei province decreased by 5.5% in Q1. However, there was one city, Nanjing, whose GDP grew, bucking the national downward trend, at a rate of 1.7%. This increase was mainly because Nanjing gradually reopened businesses beginning on February 10th and also due to the huge investment in Nanjing’s electronic information industry over the previous several years (Ruiyu, 2020).

(4) Rental housing market

The rental housing market has been facing great uncertainty due to COVID-19. Rental unit transactions in cities outside Hubei decreased 32% in Q1 2020 compared with Q1 2019. During the same period, rental unit transactions in cities outside Hubei decreased 90%, and those in Wuhan decreased 92%. In contrast, rental unit transactions in cities outside Hubei decreased 57% in February and 16% in March 2020. In first-tier cities, Beijing’s rental unit transactions decreased at a higher rate than those in Shanghai, Guangzhou and Shenzhen. Due to severe mobility restrictions, transactions dropped 48% in Q1 2020 in Beijing. On the whole, compared with the same period in 2019, we find that rental unit transactions showed a downward trend in February 2020 and an upward trend in March 2020.

Moreover, rents declined dramatically in provincial-level municipalities and provincial capital cities. In 90% of the provincial-level municipalities and provincial capital cities, average rent declined in 2020 compared with 2019. The average rent decreased 3.3% in four provincial-level municipalities and 3.6% in provincial capital cities in 2020 compared with 2019. This might be attributed to the fact that these cities have more migrants than others, and migrants had to delay their return to these cities due to mobility restrictions. Generally speaking, the cities which lost more migrants because of the pandemic experienced larger declines in rent. However, this requires more data on population change and rental housing supply. Generally, average rents fluctuated among the 77 M-cites in Q1 2020 compared to the same period in 2019 (Please see Fig. 5). For detailed cities, although transactions dramatically declined, rent in Wuhan witnessed a decrease from 32.5 Yuan/m² in Q1 2019 to 31.1 Yuan/m² in Q1 2020. In provincial level municipalities and provincial capital cities, average rents decreased 1.8% in Q1 2020. In the first-tier cities of, Shanghai and Shenzhen, rents increased slightly in Q2 of 2020, compared with that in both Q1 of 2019 and Q1 of 2020. Beijing’s Q1 rent decreased 3.3% and decreased 4.6% in Q2 2020 compared with the same periods in 2019. Among provincial municipalities and provincial capital cities in Q1 2020, Tianjin’s and Zhengzhou’s rents decreased more sharply than those in other cities.

In the whole year of 2020, the average rent in 77 cities decreased by 7.7% compared with 2019. Among 77 cities, the rent in 31 cities increased slightly and the other 46 cities experienced declining rents in 2020. Therefore, compared with rental unit transactions, the impacts of pandemic on rent change was lagging behind and the long-term effect of pandemic remains to be observed in the future.

4.2. Examining the impact of pandemic on mobility and rental housing market

The stepwise mediation effect test is a traditional method to identify and test mediating effects, and it has employed regression-derived techniques that rely on an underpinning general linear model in order to specify possible relationships among variables (Baron and Kenny, 1986). In this research, we use stepwise regression to test the mediating effects of inter-city and intra-city movement, respectively. We choose the confirmed COVID-19 cases in Q1 2020 as the independent variable, two rental market variables, including rental units and average rent as dependent variables, and population size in 2019 and GDP growth in Q1 2020 compared to Q1 2019 as control variables.

While selecting index of mobility, we identify the move-in index (see variable INTER1 in Table 2), and the sum of move-in and move-out index (see variable INTER2 in Table 2) as mediators. Since the lockdown of Wuhan began on January 23rd, the inter-city movement before that may lead to an increase of confirmed cases. In February and March, inter-city and intra-city movement was strictly controlled to prevent the mobility of potential patients.

We choose average rents and net loss of units between the pre-
Fig. 4. Mobility change from Q1 2019 to Q1 2020. a–c, Inter-city movement in Q1 2020 compared with Q1 2019. d, Intra-city movement from Feb. to March 2020 compared with the same period of 2019. y-axis shows the mobility change.
Fig. 5. Rent changes during the pandemic. Y-axis shows the change of rents in Q1 2020 compared with Q1 2019.
The test of the six path models (see Table 3 and Fig. 6). A one by one, we identified two mediating path models which are significant in the test of the six path models. A standardization and using stepwise regressions to test the mediating effects into INTER2 in Model 2, inter-city movement is still a mediator between confirmed cases and rental unit transactions. The weight of the mediating effect can be calculated through the value of \( \beta \) of path a, b, and c in model 1 (as shown in Fig. 6); which is \( (a \times b) / c = 0.233(23.3\%) \).

When the mediating variable is changed from INTER1 in Model 1 into INTER2 in Model 2, inter-city movement is still a mediator between confirmed cases and rental unit transactions. The difference between Model 1 and Model 2 is the mediating effect (Fig. 6). The weight of the mediating effect in model 2 was 18.4%. This shows that the mediating the pandemic and the post-pandemic periods (see variable RENT and UNIT in Table 2) to measure the change in the rental housing market during the pandemic. We use the average rents and units in Q4 of 2019 to describe the pre-pandemic rental housing market and in Q1 of 2020 to describe the post-pandemic rental housing market. After variable standardization and using stepwise regressions to test the mediating effects one by one, we identified two mediating path models which are significant in the test of the six path models (Please see Table 3 and Fig. 6). A Bootstrap test is used to test the other four correlation models and it further confirms that they are not correlated.

Generally, the results show that intra-city movement was not a mediator between confirmed cases and rental markets, while inter-city movement and intra-city movement were not the mediators between confirmed cases and average rents while inter-city movement was a mediator between confirmed cases and transaction units. In the two effective path models (Fig. 6), the independent variable is confirmed cases. In model 1, the mediating variable is INTER1. The dependent variable is UNIT. In Model 2, the mediating variable is INTER2, and the dependent variable is UNIT.

In Model 1 (Fig. 6), the results of our test show that when inter-city migration is added into the model, the absolute value of path c’s estimate (0.389) becomes smaller than that of the direct path c (0.508) and the p value is still found to be 0.000 (see Fig. 6). This indicates that inter-city movement is a mediator between confirmed cases and rental unit transactions. The weight of the mediating effect can be calculated through the value of \( \beta \) of path a, b, and c in model 1 (as shown in Fig. 6); which is \( (a \times b) / c = 0.233(23.3\%) \).

Table 3
Model test regression results.

| Variable | Coefficient in Model 1 | Coefficient in Model 2 | Coefficient in Model 3 | Coefficient in Model 4 |
|----------|------------------------|------------------------|------------------------|------------------------|
| RENT     | 0.414***               | 0.414***               | 0.401***               | 0.130***               |
| POP      | 0.139                  | 0.139                  | 0.014                  | 0.184                  |
| CASE     | 0.287**                | 0.287**                | 0.075                  | 0.317*                 |
| INTER1   | 0.485***               | 0.485***               | 0.200**                | 0.014                  |
| GDP      | 0.271                  | 0.271                  | 0.075                  | 0.014                  |
| UNIT     | △                      | △                      | △                      | △                      |

Table 4
Descriptive analysis of variables.

| Variable | Mean | SD  | Min  | Max  |
|----------|------|-----|------|------|
| GDP      | -6.85| 7.06| -40.5| 1.6  |
| POP      | 859.43| 431.81| 505.7| 3101.8 |
| CASE     | 840.04| 5766.76| 13   | 50,006 |
| INTER1   | -3.28| 2.98| -17.18| -0.93 |
| INTER2   | -6.54| 5.86| -33.29| -1.93 |
| GDP      | -2.31| 1.05| -6.20| 0.73 |
| UNIT     | -10,952.88| 17,413.45| -93,710| -264 |
| Obs.     | 75   |     |      |      |

* p < 0.1, **p < 0.05, *** p < 0.01, △ is the dependent variable in the regression model.
effect of the move-in index between confirmed cases and rental units was higher than the sum of the move-in and move-out flow. This is consistent with the observation that cities usually adopted mobility control, such as 14 days of self-isolation for those people who moved into the city instead of moving out of the city.

5. Discussion and conclusion

5.1. Impacts of pandemic on rental housing demand and supply

In large Chinese cities, tenants are mainly made up of migrants and newly graduated college students. Migrants are more vulnerable to the pandemic compared with urban hukou residents, and many of them have been left unemployed or facing impending job loss. Inevitably, this will have a significant impact on individuals’ abilities to pay rent, mortgages and other expenditures. The China National Statistics Bureau reports that the number of rural-to-urban migrant workers decreased from 170 million in December 2019 to 120 million in February 2020 due to stringent mobility restrictions, which led to a reduction in their income. The Tsinghua University report on 58 counties shows that 30.4% of migrants experienced income contraction in 2020 compared with 2019, among which 6% of migrants experienced significant income loss (China Business News, 01/17/2021). In Q1 2020, the available jobs for newly graduated college students decreased by 16.77% compared with Q1 2019, while job applicants increased by 69.82%. Although there is no detailed information on the change in rental housing demand, the decrease of demand on rental housing is clearly seen.

On the rental housing supply side, the high vacancy rate of rental housing has caused nearly 90% of home owners to lower their expectations on housing rental in large cities (Lianjia Research Institute, 2020). In around 70% of large cities, the gap between actual rent and asked rent raised to some extent, indicating that the bargaining power of tenants improved. Compared with individual home owners, rental housing agencies were more adversely affected by the pandemic. According to Lianjia Research Institute, more than 40 rental agencies filed for bankruptcy due to the high vacancy rates in 2020. Even the second largest rental agency of China, Phoenix Tree Holdings Limited, with more than 500,000 housing units, went into bankruptcy, and thousands of tenants lost their pre-paid seasonal or yearly rent. Many local governments, including Beijing, Shanghai, Shenzhen, Wuhan and Chengdu, have forbidden rental housing agencies from collecting rent of more than 3 months in order to prevent tenants from losing money, causing cash-flow challenges for rental housing agencies.

During the pandemic, the breadth and severity of the socio-economic impacts is spatially heterogeneous, and certain cities/people are more affected than others. In this research, we find that the confirmed cases were negatively associated with rental unit transactions through the mediating effects of inter-city movement and intra-city movement in Q1 2020. The impact of the pandemic on housing rent is lagging, and rents showed a descending trend in 2020 compared with 2019.

5.2. Policy implications for rental housing market development in China

Compared with international cities, the rental housing market has been less developed in Chinese cities. For instance, only 21% of residents lived in rental housing in China’s large cities in 2010 (Source: the 6th population census of China). Over the recent decades, soaring housing prices and housing shortages in large cities have made housing more and

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2 http://www.stats.gov.cn/tjsj/sjjd/202009/t20200928_1792070.html
more unaffordable for urban residents, and the housing price-income ratio was more than 20:1 in many Chinese large cities and 30:1 in mega-cities such as Shenzhen, Beijing, Shanghai and Xiamen, much higher than the international standard of 2–6. Since 2017, the Central government has proposed “a housing system promoting both tenancy and ownership” in order to solve the problems of unaffordable housing and the housing shortage. However, due to the high price-rent-ratio and low return, investors have shown much less interest in the rental housing market compared with the commodity housing market.

In China, rental housing agencies usually obtain rental units from individual home owners and renovate those houses for higher rent in order to capture the rent gap. However, China has established neither a financial nor a legislative system for the rental housing market. The lack of REITs or other similar financial tools has made financing difficult for rental housing agencies. In order to occupy a larger market share in the rental housing market and attract outside investments, some agencies pay higher prices to home owners above the rent they can collect from tenants. They also offer a yearly premium package to tenants to collect rent in advance to improve their financial liquidity. However, during the pandemic, many migrants could not return to the cities where they worked. On the other hand, the rental housing agencies could not return to the cities where they work, and the cash flow crisis finally led to the bankruptcy of these agencies.

So far, the Chinese government has adopted preferential policies, mainly tax reduction, to aid retail, catering, and tourism industries to get through the economic recession. The policies to assist housing rental enterprises and tenants, however, has not yet been issued. Moreover, more strict control policies have been imposed on housing rental agencies in many cities to prohibit these agencies from collecting pre-paid rents, causing great cash flow challenges for these agencies. This government policy of “Throwing the baby out with the bath water” has hampered prospective investors, preventing them from investing in rental housing. According to the Lianjia Research Institute (2020), only two developers among the top 100 developers added investments in the rental housing market during 2020, much less than the ten in 2018 and nine in 2019. The impact of the pandemic on the rental housing market has been long-lasting and its effects will remain in the near future.

In general, the pandemic has brought hardship on both tenants and housing rental agencies. On the one hand, the lock-down of communities caused great difficulties for tenants from applying for entry permits during the pandemic and delayed migrants from returning to the cities where they worked. On the other hand, the rental housing agencies experienced problems of cash flow due to the reduction of tenants, leading to the bankruptcy of many agencies. More stringent regulations from the government on rent collection and a lack of financial support may deteriorate many rental housing agencies. Generally speaking, housing rental agencies have played an essential role in increasing housing rental space, and investing in improving the quality of rental housing. Financial aid and tax subsidies could help them survive through this difficult period and would be beneficial for the sustainable development of the Chinese rental housing market which is still in its beginning stage. Immediate relief measures, such as supportive financial policies and regulation of protection of tenants’ rights, need to be implemented and adjusted for those that may fall through the cracks in order to achieve a sustainable development of the rental housing market in China.

5.3. Limitations and future research directions

Although this research has applied multi-source data to analyze the impact of pandemic on rental housing market, these results should be analyzed with caution due to the variety of mobility restrictions and the difficulty in obtaining accurate and sufficient information. Moreover, the impact of the pandemic on mobility and the rental housing market depends on many other factors, such as household income, activities and employment changes during the pandemic and the magnitude and variety of the economic policy responses taken by governments. However, due to the unavailability of these key data, this research has to adopt proxy indicators such as GDP and mobility. This could cause some bias in the research results.

The socio-economic impacts of pandemic will undoubtedly be long-lasting. In general, this model is a first step in quantifying the economic and housing impacts of COVID-19 at the city-level by using mobility as a mediator, and it can be extended to explore the impact of indirect socio-economic effects of the pandemic. Future research topics can explore why the rental market in some cities has been more or less affected by COVID-19 infection rates, what is the mechanism that the mobility has affected rental market. Moreover, more evidence from city-level cases is needed to understand the impacts of pandemic on tenants and rental agencies.

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CRediT authorship contribution statement

Li Tian was responsible for research design, and wrote the inclusion and conclusion part.

Jing Xia was responsible for collecting data and running the model.

Wei Ouyang made the research design and wrote paragraphs of data analysis.

Yinlong Liang wrote the part of literature review and prepared the data.

Jinxuan Liu wrote the part of literature review.

Yongfu Li helped the data analysis.

Li Wan helped the research design and method.

Yin Jin helped the research design and refined the manuscript.

Weipan Xu helped to prepare the data.

Yaoqian Ma helped to prepare the data.

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Declaration of competing interest

The author(s) declare no competing interests.

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