Adapting to Remote Work:

A study of Chinese Remote Workers during and after COVID-19

Economic Geography

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Abstract

This study examines the adaptation of telework in China during and after the COVID-19 pandemic, focusing on the mobility of Chinese teleworkers and the use of collaboration tools. Through questionnaires and data analysis, this study examines how telework affects employee mobility and how collaboration tools affect employee productivity. The findings suggest that telework greatly increases individual mobility, with personal preference and income level playing a key role, while family factors have a weaker influence. In the case of collaboration tools, optimal usage time was determined to be between 20 and 30 hours per week, beyond which productivity declined. User satisfaction with these tools is a key factor in maintaining high productivity. The study concluded that while telework gained traction during the pandemic, its long-term adoption in China remains uncertain, as many workers returned to traditional office environments after the pandemic. The implications of these findings suggest that while telework has the potential to reshape work dynamics, its future in China will depend on continued adaptation to technology and changing work patterns.

Keywords: Remote work, Mobility, Collaboration tools, Chinese Labour

Contents

Introduction

From 2019 to 2023, the world suffered the effects of COVID-19 for more than three years. Of all the aspects of the epidemic that have hit countries around the world, the one that will have an impact on the present and the future is the remote work that has been forced to begin as a result of the lockdown. Even though the current social order has largely recovered from the disruption caused by the epidemic, it is conceivable that remote work will remain an important topic in the future and will be discussed at deeper and more varied levels as society develops. Scholars in various countries have been conducting research on remote work during and after the epidemic based on regional data, questionnaires, interviews, and so on.

Brynjolfsson et al. (2020) explore the rapid shift to remote work in the United States during the early stages of the COVID-19 pandemic. It examines how this shift has affected the workforce, highlighting the role of occupation and industry in the feasibility of remote work. The study also discusses the potential long-term implications of this transition for work arrangements and the broader economy. This shift has led to significant changes in the demand for locally consumed services (LCS) in various neighbourhoods. The study identifies a large, heterogeneous impact across regions, with economic activities decreasing in city centres and increasing in residential suburbs. Gallacher and Hossain(2020) investigate the impact of COVID-19 on remote work trends and employment dynamics in Canada, concluding that 41% of jobs in Canada can be performed remotely, with notable variations across provinces, cities, and industries. It highlights that the feasibility of remote work correlates with worker characteristics, impacting income inequality, gender, age, and other factors. Moreover, the study finds that occupations less adaptable to remote work experienced more significant employment losses between March and April 2020, underscoring the pandemic's uneven impact on the labour market. Irawanto et al. (2021) emphasize that working from home during pandemics, especially in collectivist environments such as Indonesia, may have a positive impact on productivity and performance by improving work-life balance and reducing job stress, which can have a positive impact on job satisfaction.

In addition to studies based on specific countries or regions, researchers have also discussed remote working in a broader dimension. De Fraja et al.(2020) examine the geographical and labour market impacts of the increased prevalence of remote work, a phenomenon they discussed as "Zoomshock", which refers to the COVID-19 pandemic that led to the sudden and widespread adoption of online conferencing technologies such as Zoom and Microsoft Teams. This shift to remote working had significant geographic and labour market implications, such as a significant decrease in economic activity in productive city centres and an increase in residential suburbs. Zoomshock highlights the sudden and transformative nature

of the changes brought about by the pandemic, emphasizing the impact on traditional urban dynamics. Davis et al. (2021) use equilibrium modelling to analyze the impact of widespread adoption of work-from-home technologies and use data from various U.S. cities to calibrate and validate its model. They find that the shift to remote working triggered by the epidemic permanently affected incomes, income inequality, and urban structure, significantly increasing house prices. Galanti et al. (2021) showed that home-work conflict and social isolation had a negative impact on home-based work productivity, while self-leadership and increased autonomy had a positive impact. In addition, family-work conflict and social isolation have a negative effect on work-at-home stress. Hackney et al. (2022) showed that non-mandatory work-from-home arrangements have a positive impact on productivity and performance. However, when home working becomes a mandatory arrangement, or is driven by external factors such as pandemics, the overall impact may be less positive, and may even be detrimental.

China

There are parallels between the research on remote working conducted around the world and the subject of this paper: working from home in China. However, as a large and unique developing economy, remote work in China is similar to and different from that in the United States, Canada, or Europe, but may be more similar to Indonesia, which is also a developing country in Asia. The differences may lie in China's very different national context from the Western world and the relatively specific COVID-19 experiences of Chinese people. Of all the countries hit by the pandemic, China, as one of the last countries to come out of COVID-19 quarantine, did have some special experiences during the pandemic, with Chinese people experiencing stricter rules and longer periods of lockdowns throughout these three years. In 2022, when mobility has been restored in most countries, many cities in China were still experiencing months-long closures. Part of the work could not be done remotely, so the workers concerned had to stop working or even faced unemployment; while another part of the workers had to adapt to a new way of working under the sudden lockdown: remote working, which was not popular in China before the pandemic. (Bick et al., 2020)

In the case of China, the country had the initial potential to develop remote working before the pandemic, thanks to the rise of Internet-based videoconferencing tools, office collaboration tools, and the growth and popularity of remote working in countries around the world. (Bick et al., 2020) However, China's remote working industry and regulations were and are immature, and the number of workers who can work remotely remains a relatively small part of the Chinese workforce compared to the share of the workshare able to work from home in developed countries. Considering China's large population base, remote workers make up an even smaller percentage of the labour population. However, as a result of the outbreak, a large

number of workers had to switch to remote working as a last resort. In the case of China, this was a forced and rapid growth, as the monthly active users of Dingding, a remote collaboration platform that provides online organization, check-in, file sharing, conferencing and other functions, jumped by 66%, to more than 125 million. (Bick et al., 2020). It is curious to know what the situation is in China concerning remote work during and after COVID-19. What was the geographical distribution of remote workers in China during the sudden onset of the lockdown? Did the "Zoomshock" brought about by web-based tools also exist in China? How are Chinese remote workers faring themselves in the more barren remote work grounds relative to developed economies? What strategies did they adopt to adapt to their particular modes of work during the epidemic, and how did they choose to retain or discard forms of remote work after the epidemic? To what extent did remote working affect their working styles, efficiency and life-work balance? This paper aims to explore the above questions and to collect information that can be analysed qualitatively and quantitatively through questionnaires and interviews based on official data to synthesise China's remote working in the wake of COVID-19 and to provide a perspective on China for the ongoing remote working revolution around the globe.

Taking the foregoing questions as a basis, we can summarize a main question: what was the geographic distribution, adoption and impact of remote work in China during and after the COVID-19 pandemic? In turn, three sub-questions can be asked under the core question: 1) What is the impact of remote work on the mobility of remote workers in China, do remote workers prefer to stay in their local area to spend time with their families, or do they travel more for activities such as travelling? 2) How are the life and work rhythms of remote workers through the study of telecollaboration tools; how did Chinese workers' choice of telecollaboration tools, frequency/length of use, and satisfaction with their efficiency and work change during and after the COVID-19 epidemic? Were remote workers able to adapt to the convenience and inconvenience of these tools?

Based on the research questions, this paper will be divided into the following sections: Section 2 is the theoretical framework which ends in a conceptual model with accompanying hypotheses. Section 3 discusses the data and the methodology, section 4 elaborates on the results and section 5 is the conclusion and discussion.

theoretical framework

Literature review

As far back as the early 1900s, researchers were already looking at remote working as the work situation of the future. Bailey and Kurland (2002) reviewed more than 80 empirical studies focusing on work-related factors, motivations and outcomes of remote working and found that remote working at the time was characterised by gender and occupational polarisation, with a predominance of male professionals and female clerical workers, and that this trend was also influenced by factors such as job suitability and managers' willingness to allow remote working. The authors emphasise that although remote working is seen as a modern work practice, its adoption is often constrained by managerial reluctance and organisational structures that prioritise control and supervision.

However, interest in remote work has not waned. Herrera et al. (2022) conducted a bibliometric analysis of publications from three time periods (1984-2009, 2010-2016, 2017-2021). The study drew on 539 publications from the Web of Science database and found that the number of publications on remote work has consistently increased during this period. In particular, there has been a significant increase in remote working-related publications since 2020 due to the COVID-19 pandemic. The rapid rise in interest is attributed to the demand for remote work solutions during the global embargo. Of the three periods of publications, early studies focused on work-life balance, work-family conflicts, and management strategies, while more recent studies emphasize the importance of flexibility policies and the role of technology in facilitating telecommuting. The consistent theme across the periods emphasizes the impact of telecommuting on the integration of personal and professional life.

The report by Alexander et al. (2021) highlights a significant shift towards hybrid work patterns, based on a survey of 5,043 full-time employees, in which the authors identified clarity of communication, work pattern preference and burnout as key variables. Their survey found that the majority of employees strongly prefer flexible working arrangements that combine remote and office work. The report highlights the positive impact of clear communication on employee well-being and productivity. However, a lack of communication can lead to anxiety and burnout, which affects job satisfaction. This trend highlights the growing need for work-life balance and the ability to work from home, at least some of the time. The move to remote working is not only a response to the health crisis but also reflects changing employee expectations and technological advances that enable seamless virtual collaboration. The pursuit of work-life balance is reflected in family life, prompting people to find a balance between work, spending time with

family and personal leisure, while the advancement of collaborative technology is reflected in the continuous introduction of online collaboration platforms and video conferencing tools in recent years.

Family and Personal Choices

Family factors influence remote workers' decision-making on many levels. For families with children, there is a lot to consider when working from home. Skórska (2021) analyzes Eurostat data for 2019 and 2020, focusing on employment and remote working trends among Polish parents aged 20-49. The study shows that the epidemic has exacerbated existing challenges in achieving work-family balance, especially for women who have traditionally been more involved in caregiving roles. Increased female labour force participation and the shift to dual-earner households complicate balancing work and family responsibilities. As Skórska points out, this conflict is particularly pronounced in families with small children, as the need for childcare can significantly reduce mobility. Research suggests that families with children experience higher levels of work-family conflict, which may influence mobility decisions (Dex & Bond, 2005; Skórska, 2021). For example, telecommuters with children may travel less frequently due to childcare responsibilities or choose more flexible travel arrangements to meet family needs.

The presence of young children makes it often necessary for guardians to reduce work-related travel, as parents prioritize childcare over commuting (Nomaguchi, 2009). This is particularly evident in families where one parent takes a more active role in household chores, often leading to reduced mobility for working parents. In contrast, families without young children may not be constrained to the same extent, making greater mobility possible.

In gender-specific studies, women are all relatively more affected by their families. Parents, especially mothers, tend to face more responsibilities, leading to greater stress and potentially increased non-work travel related to family needs. In telecommuting scenarios, the gender division of labour tends to be exacerbated, affecting female mobility and remote work participation (Toscano et al., 2022). Using data from 313 respondents, this study highlights gender and age differences in remote work experiences. Female employees experienced higher levels of stress and engagement, while older employees had less positive experiences. Araújo and Lua (2021) explored the widespread implementation of remote work during the COVID-19 pandemic. Drawing on official data and literature, the study explores the impact of remote work on work-life balance, gender roles and occupational health. It reveals significant gender differences, with women bearing the brunt of increased family responsibilities and facing greater challenges in balancing work and family life.

de Laat (2023) explores how remote work affects overwork and gender dedication to work and family. Interviews with 84 IT employees in North America suggest that flexible work arrangements facilitate dual commitment, allowing employees to integrate work and family life in spite of overwork. Men utilize remote work to become more involved in childcare, while women increase productivity and work longer hours. Despite the double dedication, traditional gender roles persist, with women taking on more family responsibilities.

Support from family members can enhance mobility by reducing the stress associated with balancing work and family responsibilities. Skórska (2021) noted that telecommuters are more likely to travel without interfering with family obligations in households where family members share household responsibilities. A supportive family environment can increase telecommuters' satisfaction and productivity, while a lack of support may lead to increased stress and work-family conflict (Toscano et al., 2022).

The impact of the family on remote workers can be multilayered. Family members can both share stress and cause conflict. In the case of telecommuting, the predominantly family-oriented nature of the workplace often blurs the boundaries between work and family life and leads to conflict, which affects job performance and satisfaction. Mothers, in particular, often face additional family responsibilities, which can increase stress levels and require additional non-work travel for family-related activities (Toscano et al., 2022). The level of work-family conflict is influenced by the composition of the family, with the more complex the family structure (e.g., families with young children or elderly dependents), the higher the level of conflict. This is consistent with the findings of Gajendran and Harrison (2022), who observed that mothers who worked remotely reported more work-family conflict than their male counterparts.

It is worth mentioning that due to traditional Chinese culture and family structure, parents also still have some say in the roles of their adult children. Children are to some extent expected to follow their parents' decisions or fulfil their obligations to support their elderly parents, a culture known as "filial piety" in China. Liu's (2020) study points out that the concept of filial piety still plays an important role in the decision-making processes of family travel. While the younger generation is becoming increasingly independent and taking a leading role in decision-making, filial piety ensures that parents still have considerable influence over the choices made by their adult children. This influence is mediated through two forms of filial piety: reciprocal piety and authoritative piety. Reciprocal filial piety emphasizes mutual concern and support, which directly affects the satisfaction and well-being that result from family decisions. In contrast, authoritative piety indirectly influences decision-making through the quality of parent-child communication. Effective and open communication moderates these influences, balances intergenerational expectations, and increases overall decision-making satisfaction. Thus, even as adult children increasingly dominate decision-making, deep-rooted cultural values of filial piety ensure that parental preferences and expectations continue to largely influence these decisions.

Waldrep et al. (2024) investigated U.S. workers' preferences for remote and hybrid work during the COVID-19 pandemic. In-depth interviews with 52 participants from dual-earner households elucidated the strong desire for remote work due to increased productivity, flexibility, and work-life balance. A large proportion of respondents favoured hybrid work arrangements, combining remote work with regular face-to-face interactions. Some participants were willing to change jobs in order to maintain remote work, despite childcare issues and the fact that their jobs were not suitable for remote work.

From the perspective of the remote workers themselves, remote working reduces commuting because employees no longer need to travel to a physical workplace on a daily basis (Wöhner, 2022). This reduction is more pronounced among those who work exclusively from home than among hybrid employees who occasionally visit the office. Despite the reduction in commuting, the rebound effect of increased non-work-related trips sometimes offsets the reduction in trips made by telecommuting that does not require commuting (Wöhner, 2022). This includes increased trips for shopping, leisure, and family visits, as remote workers may have more flexible schedules that allow them to engage in these activities. Wöhner (2022) used data from the 2015 Swiss Travel and Transportation Microcensus to examine how telecommuting and flexible work schedules affect travel behaviour. The study found that hybrid employees had a 21% reduction in commuting time, but an increase in non-work trips, which had a neutral overall impact on total travel distance. Full-time remote workers had the most significant reduction in travel.

Individual dispositions, such as personal preferences for work scheduling and levels of work engagement, can significantly affect telecommuter mobility. Individuals with high levels of work engagement are more likely to exhibit greater work-related mobility because they are motivated to pursue work-related opportunities that require travel. Conversely, individuals who prefer work-life balance may travel less and spend more time with their families. This preference may lead to decreased mobility as telecommuters choose to work from home rather than travel for work-related purposes. Individual preferences for flexible work arrangements may lead to different mobility patterns as remote workers balance remote work with occasional office visits or professional travel. (Toscano et al., 2022)

Caldarola and Sorrell (2022) analysed the impact of telecommuting on travel patterns using data from the UK National Travel Survey (2005-2019). The study shows that while telecommuting reduces the number of commute trips, it is associated with longer commute distances and an increase in non-work and business travel. Medium-frequency telecommuters increased their weekly commute distance by 32.5 miles, while high-frequency telecommuters travelled 21.5% more for non-work purposes.

Technological Influence

Among the publications related to remote work counted by Herrera et al. (2022), emerging topics related to remote work in recent years are related to technological advancements. Technological advancements have not only streamlined workflows but also given remote working more possibilities. Collaboration tools are the product of technological advancement. Collaboration tools can also be effectively used in offline working scenarios, but in the context of remote working, collaboration tools will provide more efficiency.

Karis et al. (2016) conducted a comprehensive study on the impact of videoconferencing (VC) and video portals on remote collaboration within Google, which initially confirmed the effectiveness of remote collaboration tools in maintaining productivity and employee satisfaction. The study involved interviews, surveys, meeting observations, and log analysis to assess the effectiveness of these technologies. The study found that ubiquitous and easy-to-use VC systems significantly enhance remote collaboration, making it nearly as effective as coworking. vC improves the quality of remote interactions by providing visual cues and reducing the behavioural costs of communication. Video portals are particularly effective in facilitating ongoing communication and building trust among remote team members. Of course, initial face-to-face meetings remain critical to building trust and improving subsequent remote interactions. Despite successes, challenges such as technical reliability and managing large meetings remain. Benavides et al. (2021) conducted a study on satisfaction with virtual interaction platforms and their impact on telecommuting performance during the COVID-19 pandemic. The researchers surveyed 384 teleworkers in Guayaquil, Ecuador, and found that respondents were highly satisfied with the virtual interaction platform, with less than 6% of respondents expressing dissatisfaction. Voice calls and video conferencing were rated highest for smooth and effective communication, while instant messaging was preferred for coworker conversations. Email and video conferencing were found to be the most effective tools for improving job performance, with both showing a significant positive correlation on job performance, however instant messaging and voice calls did not show a significant direct impact. This study also identifies challenges faced by remote workers when using virtual interaction platforms, including Internet connectivity issues, family interruptions, and the potential inability to maintain a normal work schedule.

Ilag (2021), on the other hand, examines the role of Unified Communications and Collaboration (UCC) tools, specifically Microsoft Teams, in enhancing remote work. The study concluded that Microsoft Teams improves productivity by integrating communication and collaboration features such as chat, audio/video calls, and file sharing, integrating with Office 365 applications, and providing robust security features. The study found that Microsoft Teams led to a 48% reduction in email volume, a 25% reduction in physical meetings, and a 32% increase in overall productivity. When it comes to collaboration, Microsoft Teams promotes real-time interaction, reduces isolation and improves team morale and trust. It also addresses the

challenges of working remotely, such as isolation and time zone differences, enabling efficient communication and engagement among team members.

While it is true that teleworking tools can be beneficial for efficiency, they can also bring about technological fatigue and even technological stress, which can expose the user to negative emotions. Martin et al. (2022) examined the impact of digital tool use on job satisfaction, stress, and productivity among teleworkers during the COVID-19 embargo. Using data from 438 employees in Luxembourg, they identified five scenarios of digital tool use, ranging from stable daily use to an intensive increase in the use of limited tools. The study found that increased tool use, especially intensive daily use, leads to increased job stress and decreased satisfaction, while limited and stable use scenarios maintain a better sense of well-being. Increases in productivity were observed with moderate tool use. These findings highlight the need to balance the integration of digital tools to avoid information overload and stress. Fernández-Fernández et al. (2023) also conducted a study to explore the effects of telecommuting technology stress on satisfaction, anxiety and performance. They collected data from 451 teleworkers and students in Madrid using an online questionnaire and PLS software. The study found that higher technological stress increases anxiety levels, which also negatively affects satisfaction, thus higher technological stress leads to lower satisfaction. Furthermore, higher levels of satisfaction with digital platforms can improve job performance. However, despite the presence of technological stress, no direct negative effects on performance were observed, suggesting that there are both positive and negative effects of technological stress (technological good stress and technological distress).

Model

Based on the literature, in the mobility section (Q1), the thesis will focus on the respondents' household composition and inclinations, as well as the respondents' personal inclinations. Respondents' mobility is then expressed in terms of the number of trips they actually take in one recent year. The specific variables are as follows:

1. Remote Worker Mobility (M_i): indicates the frequency of movement of remote workers within a certain period, and the data is collected through questionnaires.
2. Impact of remote work (IRM_i): indicates the level of favourable or unfavourable impact of remote work on travel as assessed by the respondents.
3. Family Factors (F_i): covers family-related variables such as the number of family members, family members' needs, etc., which may affect remote workers' mobility decisions.

4. Personal Preferences (P_i): personal preferences of remote workers for travelling or other activities.

Therefore, remote worker mobility can be expressed as a function of the proportion of remote working, family factors and personal preferences:

$$M_i = \alpha_1 + \beta_1 IRM_i + \gamma_1 Fi + \delta_1 P_i + \epsilon_{1i} \quad (1)$$

Where α_1 is the constant term, β_1, γ_1 and δ_1 are the parameters, and ϵ_{1i} is the error term.

In the Collaboration Tools section (Q2), the adaptation of remote workers to the convenience and inconvenience of these tools will be addressed as part of the qualitative analysis. In this section, the length and frequency of use of the collaboration tool will be considered, as well as respondents' satisfaction with the tool and their subjective perceived changes in efficiency.

1. Hours of Use (UL_i): represents the hours of use of the collaboration tool by a remote worker respectively. In the questionnaire, the hours of use were categorised into 6 levels at the level of 10 hours. In the model, the median of each level will be taken.
2. Satisfaction (S_i): the remote worker (i)'s evaluation of the satisfaction of the collaboration tool. Respondents were asked to score satisfaction with each tool from -2 to 2, while their reasons for choosing the collaboration tool were calculated, with each reason counting as 1 point, weighted as satisfaction, and totalled.
3. Impact of tools (IT_i): The overall impact of collaboration tools on the work of teleworkers. The questionnaire asked teleworkers to assess the impact of collaboration tools on their work in terms of efficiency and hours worked. The model is calculated by adding up the effects on efficiency and labour hours.

Consider the relationship between the choice of remote collaboration tools, frequency/length of use and satisfaction, and analyse the adaptation of remote workers to these tools:

$$IT_i = \alpha_2 + \beta_2 UL_i + \gamma_2 S_i + \epsilon_{2i} \quad (2)$$

Where α_2 is the constant term, β_2 and $\gamma_2$are parameters to be estimated, ϵ_{2i} is the error term.

Questionnaire design

In accordance with the aforementioned research questions and models, the questionnaire addresses the

following areas and questions.

1) Geographic distribution of remote workers: This section of the questionnaire investigates the provincial geographic location of the respondents in order to gain insight into the regional distribution of the respondents.
2) Mobility of remote workers: This section of the questionnaire focuses on the respondents' tendency to travel and stay at home while remote working, as well as on the respondents' family composition and the level of family support for travelling or staying at home.
3) Utilisation of telecollaboration tools: This section of the questionnaire sought to ascertain the attitudes of remote workers towards the selection and utilisation of telecollaboration tools. This included an investigation of the rationale behind the choice of telecollaboration tools, the frequency of their usage, and an evaluation of overall satisfaction with these tools.
4) Personal information: the final section of the questionnaire investigated the respondents' age, gender identity, education level, income level, and work industry.

Specifically, the questionnaire first addresses respondents' telework time periods, categorising them into 2019 and before (pre-epidemic), 2020-2022 (during the epidemic), and 2023 and beyond (post-epidemic). This was a multiple-choice question that respondents answered and will address their telework experience during or after the epidemic separately in the follow-up questionnaire.

In the impact and mobility section, the questionnaire specifically investigated whether respondents are more likely to travel (adopt a digital nomad lifestyle) after switching to remote work or whether they are more likely to spend time with their family after switching to remote work. Further, respondents were asked to answer how many times they travelled in a year when working remotely and whether that frequency was higher than when working offline. Respondents were also asked to choose between the benefits and drawbacks of teleworking on mobility, with options including disposable money, disposable time, and impacts at the mental health level. Respondents were also asked to provide the composition of their family, including the age group and number of their children, whether they lived with a partner, parents or other elders. Finally coming to the family and personal disposition section, the questionnaire asked respondents about their family's attitudes towards home companionship and travel, about whether they support or need these options. Also, respondents were asked to assess their personal preferences for disposable time: whether they preferred to spend time at home or travelling.

In the Collaboration Tools section, respondents were categorised into two response groups based on the questions at the beginning of the questionnaire: those who worked remotely during the epidemic and those

who worked remotely after the epidemic. The fact that these two could co-exist meant that some respondents were required to fill in both groups of questions based on their experiences at different times. Considering the mainstream of China and the prevalence during the epidemic, the main collaborative tools examined in the questionnaire were the following: Zoom, Microsoft Teams, Tencent Meeting, Dingding, Feishu (also translated as Lark), Enterprise WeChat and some instant messaging software which are still used in collaboration, such as QQ and WeChat. Respondents were asked to make interval choices for the average number of hours per week they work remotely, their reliance on remote collaboration tools (open frequency and usage time, as well as the degree of dependence of work content on collaboration tools, etc.), and for each collaboration tool in the candidate list, the reason they chose that tool. Reasons for selection include strong functionality, ease of use, team or employer requirements, etc.

Data Processing

According to equation (1), the questionnaire categorized the respondents' frequency of travel in the last year into five intervals, and I eventually took the median of the intervals for these five intervals as the data for respondents' mobility (M_i). Since the study looked at the mobility of remote workers, and remote workers were unable to travel during the outbreak due to the shutdown, only this subset of respondents who were still working remotely after the outbreak was retained, totalling 136 respondents. Respondents were also asked to make multiple choices regarding the favourable or unfavourable impacts of telework on travel, with options including monetary impacts, time impacts, health impacts, and others. Each of these positive impacts was counted as 1 point, while the negative impacts were counted as -1 point, and their sum was counted as the total impact of telework on travel (IRM_i).

In terms of family factors (F_i), according to what was discussed in the theoretical section, co-resident children and parents have an influence on family mobility decisions, especially the role of preschool children in reducing mobility. Therefore, for the calculation of family factors, children were divided into three age groups, 0-6 years (preschool), 6-18 years (school-age children and adolescents) and 18+ years (adults), and 1.5 times weight was assigned to preschool children and 1.2 times to school-age children for the calculation of the level of family support and need to stay at home. Correspondingly, children's voices in travelling increased with age, but always with the primary principle of obedience to parents. Therefore, in calculating children's support and need for travelling, 0.5 times weight was assigned to preschool children and 0.8 times weight was assigned to school-age children. Parents and other elders, on the other hand, have

a say in family mobility decisions, so 1.2 times the weight is given to this group for both home or travel preferences.

For personal preferences, no weights are considered and only the difference between personal travel preferences and home preferences is taken to obtain the respondents' total propensity for mobility. A value of 0 is retained as no preference.

In the collaboration tool section, the main independent variables studied included satisfaction with the tool and length of use. In the questionnaire, respondents were asked to make multiple choices regarding the reasons for choosing a particular collaboration tool. Each reason was counted as one point in the calculation, the sum of which was the weight of the tool. The final satisfaction was summed up by the product of the individual tool’s weight and the respondent's assessment of their satisfaction.

Data

Management and Ethics

In the management of data, to guarantee accuracy and integrity, rigorous standards are adhered to in this study. From an ethical standpoint, the dataset was primarily derived from an anonymous questionnaire, which was designed to safeguard individual privacy by not involving any content that could reveal specific personal information. Consequently, no further anonymisation was required for this study.

Data Analysis

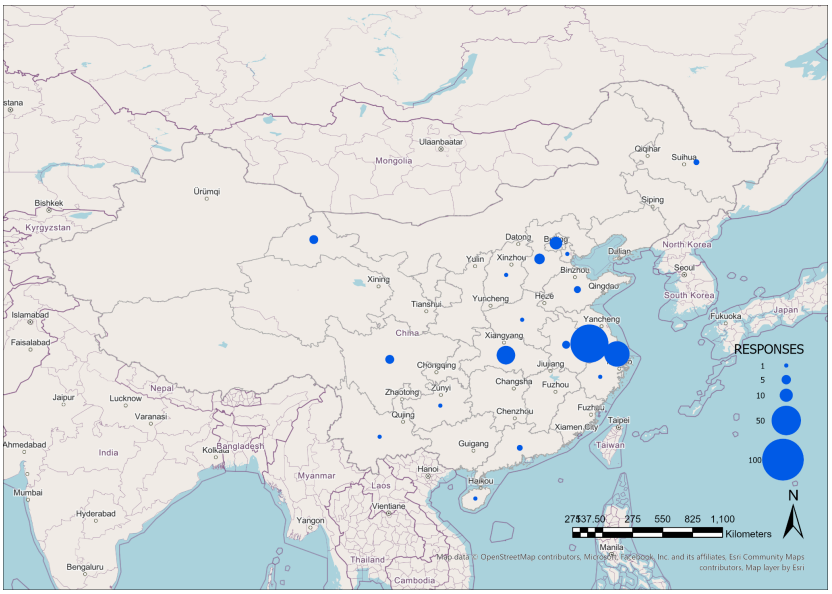


Figure 1. The overall distribution of respondents in China

A total of 203 respondents participated in the questionnaire survey. Before proceeding to further modelling, we can draw some clear conclusions from the results of the 203 questionnaires. Due to the limited form of dissemination of the questionnaire and the lack of response on the Internet, it was eventually adopted to disseminate and fill in the questionnaire through social networks. This form of dissemination ultimately resulted in 203 respondents mainly from Jiangsu Province and Shanghai, as shown in Figure 1. Jiangsu Province and Shanghai City are both located in the Yangtze River Delta region of China, which is one of the most economically developed regions in China. The samples from Jiangsu and Shanghai largely reflect the cutting-edge trend of remote workers in China.

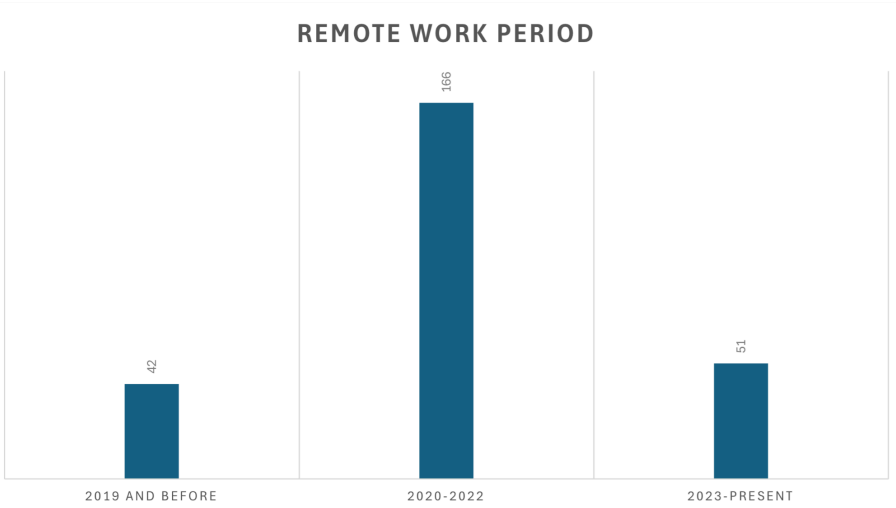


Figure 2. The number of remote workers in 3 periods

Figure 2 reflects the period distribution of remote work among respondents. It can be seen that less than 25% of respondents worked remotely in 2019 and before. Even in the relatively economically developed eastern part of China, remote working is not popular due to various restrictions. In contrast, due to the impact of COVID-19, the number of remote workers increases significantly to 166 in the period 2020 to 2022. After the blockade restrictions in China were fully lifted, the number of remote workers decreased again from 2023 to the present to 51, essentially the same level as before the outbreak. remote working in China did not become the new normal in the context of the epidemic, but the number of people taking up remote working forms did increase.

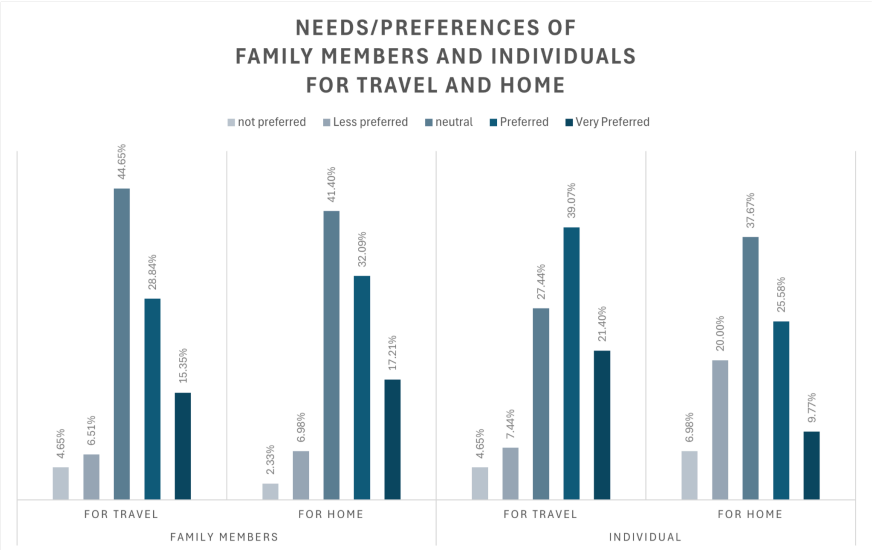


Figure 3. Needs/preferences of family members and individuals for travel and home

Figure 3 shows the tendency of respondents to increase their travel or spend more time with their families. The questionnaire categorized the likelihoods into five categories: "not preferred", "less preferred", "neutral", "preferred" and "very preferred", and surveyed the attitudes of the respondents themselves and their families about travelling and staying at home, respectively. The overall trends were similar as there was no requirement for either/or in terms of travelling and staying at home. For respondents' families, the need for travel and companionship was more pronounced, with a slightly higher percentage requesting companionship at home than for travel. Still, nearly half of the respondents' families were neutral. For the respondents themselves, there is a significant decrease in the number of people who favour neutrality when it comes to travel. More respondents preferred travelling by a much larger percentage than preferring home, reflecting a preference for mobility.

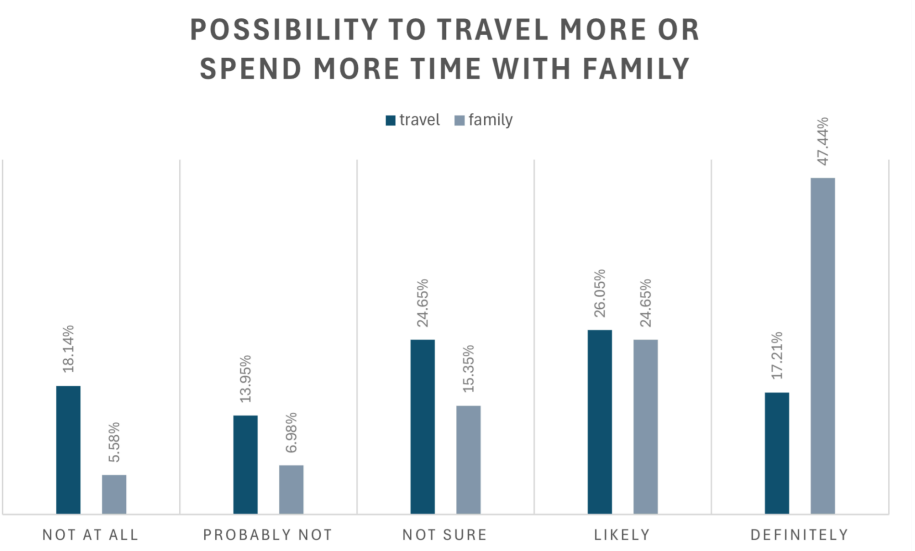
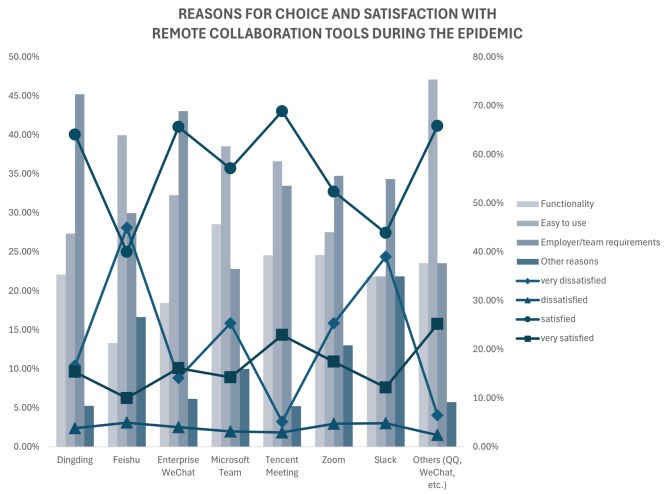


Figure 4. Possibility to travel more or spend more time with family

Figure 4 shows the likelihood that respondents would increase their likelihood of travelling or spending more time with their families, compared to the propensity, which implies more opportunities to travel or spend time with their families in real life. The results are again categorized into five categories according to the degree: "Not at all", "Probably not", "Not sure", "likely" and "definitely". The distribution of travel likelihoods is relatively even, but overall less than the average respondent feels that they have emerged as more likely to travel after working remotely. In contrast, the percentage of those who would definitely spend more time with their families is overwhelming. 47.44% of respondents believe they would spend more time with their families. Of course, working from home would provide more opportunities to spend time with family by nature. In contrast, based on current working conditions, combining travel and work does not seem realistic for most respondents.

In the section on collaboration tools, the questionnaire differentiated between remote workers during and after the epidemic. Reasons for choice and satisfaction of various remote collaboration tools. The questionnaire evaluated a total of several remote collaboration tools, among which Dingding and Feishu have similar functions and are both widely used multifunctional collaboration platforms on the Internet in China, providing functions such as file sharing, weekly and monthly reports, meeting records, etc. Enterprise WeChat is an employee communication platform for enterprises, and Tencent Meeting is an online meeting platform with the same functionality as Zoom. QQ and WeChat are chat software and are not specifically designed for remote workers, but because they have been operating in China for a long time, many companies have set up their communication groups in these software.

Respondents were asked to choose among four reasons for selecting a collaboration tool, including functionality, ease of use, employer/team requirements, and other reasons. In addition, respondents were asked to rate the collaboration tools according to their level of satisfaction. In the chart, "very dissatisfied" is represented by a diamond, "dissatisfied" is represented by a triangle, "satisfied" is represented by a circle, and "very satisfied " is represented by a square.



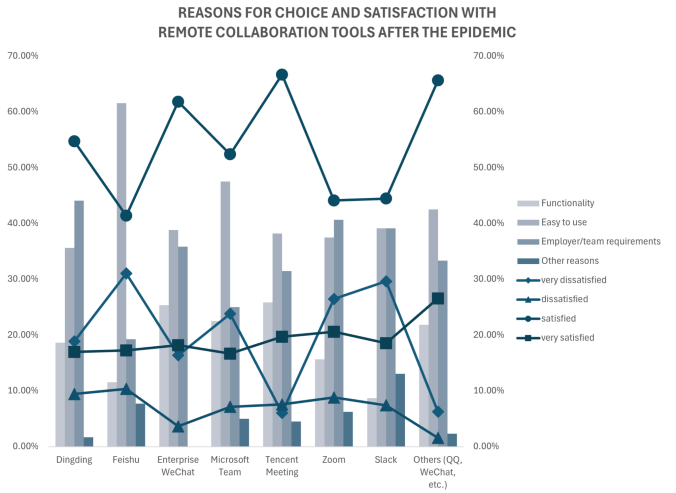


Figure 5. (left) Reasons for choice and satisfaction with remote collaboration tools during the epidemic
Figure 6. (right) Reasons for choice and satisfaction with remote collaboration tools after the epidemic

Since the number of users of each collaboration tool is different, Figure 5 and Figure 6 derive the percentage of each reason for use and satisfaction based on the number of users of each tool. As shown in Figure 5, Dingding and Feishu as competitors, most of the users of the former are employers or team requirements, while the latter is more concerned about its ease of use, which in a sense reflects the competitive strength of Feishu. As seen in Figure 6, the percentage of Feishu users focusing on ease of use increased after the epidemic, which may mean that Feishu successfully opened the market with its simplicity of operation and functionality. Microsoft Teams and Slack, on the other hand, have relatively few users because there are collaboration platforms in China that have similar features and are more in line with the needs of Chinese companies.

Zoom had been the first choice for online meetings for many companies at the beginning of COVID (Google Meet was difficult to access due to the presence of Great Firewall), but later Zoom introduced a payment policy (paid users could create meetings while free users could only join meetings) and subsequently stopped the account registration service in mainland China. Tencent Meeting has seized the opportunity of Zoom's exit from the mainland Chinese market to become the most commonly used video conferencing platform in China. Survey results show that Tencent Meeting users care about both ease of use and team requirements, indicating that the platform has done relatively well in terms of functionality and popularity.

Overall, there is a relatively high percentage of people who chose to use collaboration tools due to employer or team requirements for the mainstream products in the options, suggesting that respondents themselves may lack the subjective will to seek out tools to improve their remote work productivity, and are simply adapting to societal trends. Surprisingly, the percentage of people who choose a particular collaboration tool because of its functionality is consistently low. This could mean that the functionality of these tools is

moderate, only assisting in the workflow of remote workers, but not providing a qualitative change in productivity.

As for the satisfaction level, comparing the user evaluations during and after the epidemic, most of the respondents' ratings are more neutral, and the proportion of those who are very satisfied or very dissatisfied with the tools is relatively small. Most users were highly satisfied with the collaboration tools, especially for Tencent Meeting, which had the highest percentage of satisfaction and the lowest percentage of dissatisfaction among other tools. This may be related to its high ease of use and relatively single function. Due to the singularity, users only use it for specific functions, so it is easier to meet user expectations in terms of online meeting functionality compared to multi-functional platforms.

In addition, respondents also rated traditional instant messaging software such as QQ and WeChat highly, with a certain percentage of respondents choosing them for their ease of use. This means that collaboration tools still do not have a stable place in the workflow of these respondents, and many of the functions are redundant for remote workers, while the basic functions can be reached using traditional tools. The trend and proportion of collaboration tools completely replacing traditional communication tools is still not strong and big enough, and collaboration tools have not yet struck a balance between functionality and complexity in the workflow. With a relatively low percentage of functionality and ease of use, respondents chose a collaboration tool because their employer and team asked them to, more or less reflecting the fact that they are being held hostage to a new tool.

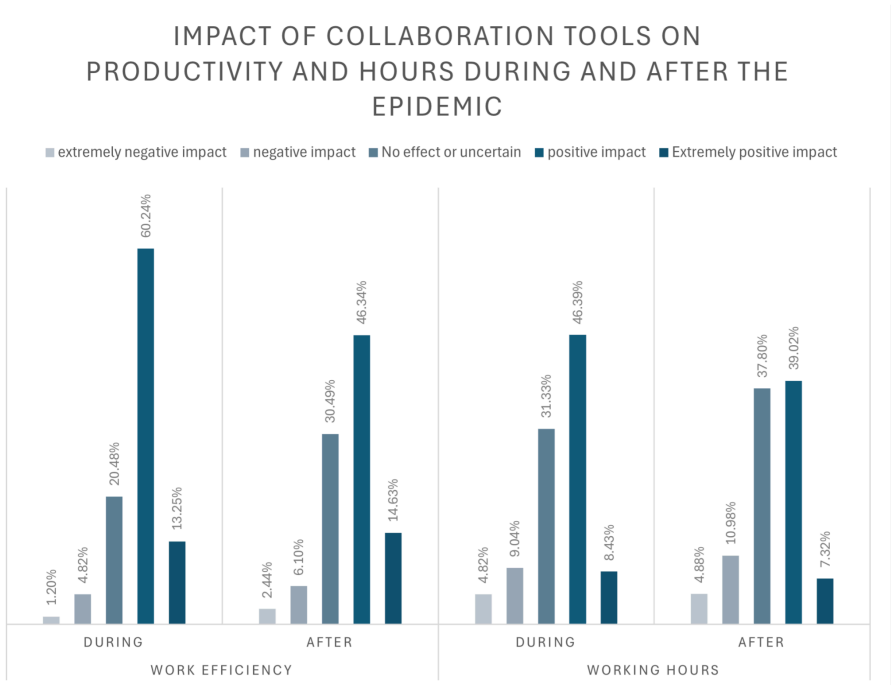


Figure 7. Impact of collaboration tools on productivity and hours during and after the epidemic

Figure 7 shows the impact of collaboration tools on productivity and hours worked, as assessed by respondents who worked remotely during and after the epidemic, respectively. Impacts are categorized into five levels: "extremely negative", "negative", "no effect or uncertain", "positive" and "extremely positive".

During the pandemic, collaboration tools had a significant positive impact on work productivity, with 60.24% of respondents reporting a positive impact and 13.25% reporting an extremely positive impact. After the epidemic, there was a slight decrease in the percentage of respondents who perceived a positive impact on work productivity. In addition to this, the proportion of neutral respondents and those who thought it had a negative impact increased somewhat, reflecting the fact that the impact of collaboration tools on efficiency has become multifaceted in the post-epidemic era.

In terms of working hours, the percentage of respondents who believe that collaboration tools have a positive impact on working hours is lower compared to the work efficiency part. People's Daily reported in early 2024 on a legal dispute over whether the use of WeChat to complete work-related tasks after official working hours should be considered overtime (Legal Daily WeChat Official Account, 2024). In China, even non-remote workers often face the problem of being asked to "work on WeChat" during off-duty hours. Some respondents also reported that the presence of collaboration tools sometimes lengthened their working hours because it was easier to delegate work tasks. Turning off their phones or turning on no-disturb mode after the allotted quitting time is not an escape from working overtime - remote workers who adopt this strategy are reprimanded by their leaders.

Overall, the figure suggests that while collaboration tools had a positive impact on productivity and work hours both during and after the epidemic, the extent of this positive impact diminished after the epidemic.

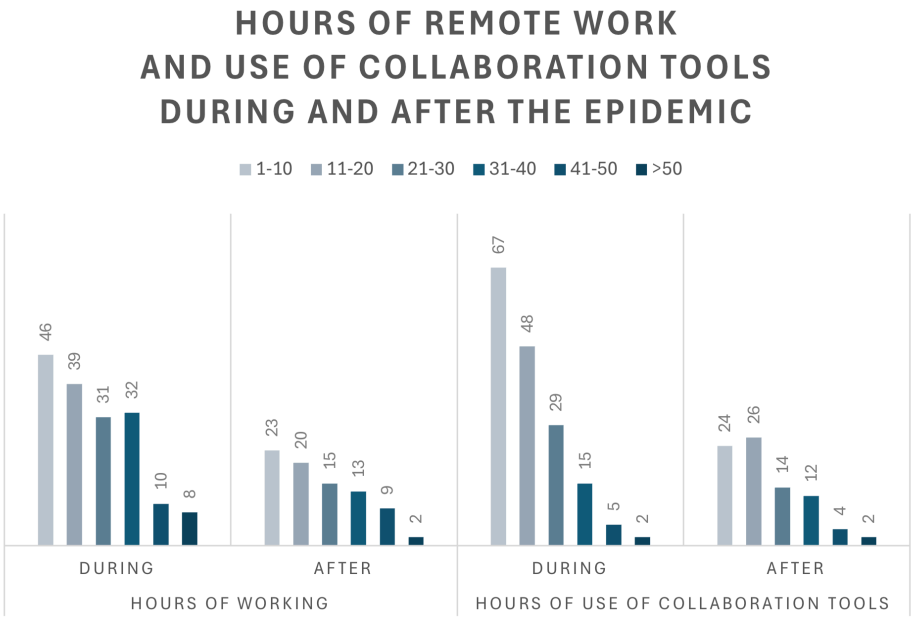


Figure 8. Hours of remote work and use of collaboration tools during and after the epidemic

Figure 8 shows the distribution of telework hours and the use of collaboration tools during and after the outbreak. The data is organized into six hourly ranges. During the epidemic, most respondents teleworked 1-10 hours per week (46 selected), followed by 11-20 hours (39 selected). A similar pattern was observed in the use of collaboration tools, with 67 people using these tools for 1-10 hours and 48 people using them for 11-20 hours. Remote working hours decreased significantly after the outbreak, with 23 respondents working 1-10 hours and 20 respondents working 11-20 hours. The length of time spent with collaboration tools followed a similar trend, but a proportional increase was observed in the 11-20 hour range. Overall, the number of respondents followed a decreasing trend as the number of hours worked went longer. In contrast, as the number of remote workers decreased after the epidemic, the trend in the distribution of proportions did not change significantly.

Overall, the likelihood of spending more time with family is generally higher than the likelihood of spending more time travelling. Family members had a relatively lower preference for travelling, while the preferences for travelling of individuals were higher. The majority of respondents cited ease of use and team requirements as reasons for choosing collaboration tools, reflecting the fact that collaboration tools are not yet solidly integrated into the workflow of remote workers in terms of functionality. In the aftermath of the epidemic, the number of respondents working remotely decreased, indicating a return to traditional work patterns. After the intervention and catalyst of the epidemic, even in the more developed areas of China, remote work still belongs to the future rather than the present.

Results

Mobility

In the mobility part, in order to ensure the robustness of the results, control variables such as respondent age, education level and income level were also introduced based on the original model (equation (1)). Not only ordinary least squares (OLS) regression was used, but robust regression (Robust Regression) was also introduced to deal with potential outliers in the data, and the robustness of the model was further verified through cross-validation.

First, the most basic OLS regression model is used according to equation (1). The results of the initial OLS model are shown in Figure 9.

First OLS Regression Results

	Dependent variable:
	Mobility
IRM	0.258**
	(0.101)
F	−0.019
	(0.041)
P	0.128
	(0.077)
Constant	2.282***
	(0.146)
Observations	136
R^2	0.078
Adjusted R^2	0.057
Residual Std. Error	1.310 (df = 132)
F Statistic	3.732** (df = 3; 132)
Note:	*p<0.1; **p<0.05; ***p<0.01

Second OLS Regression Results

	Dependent variable:
	Mobility
IRM	0.224**
	(0.101)
P	0.123
	(0.075)
Income	0.133**
	(0.061)
Constant	1.735***
	(0.292)
Observations	136
R^2	0.109
Adjusted R^2	0.089
Residual Std. Error	1.287 (df = 132)
F Statistic	5.405*** (df = 3; 132)
Note:	*p<0.1; **p<0.05; ***p<0.01

Figure 9. (left) First OLS regression results
Figure 10. (right) Second OLS regression results

The coefficient of the intercept is 2.28226 ($p < 0.001$), indicating the baseline value of mobility when all independent variables are 0. The coefficient of the IRM is 0.258 ($p = 0.0119$), which is significant at the 0.05 level of significance, indicating that telework has a significant positive impact on mobility. the coefficient of F is -0.01874 ($p = 0.6508$), in the preliminary regression, family factors failed to significantly influence mobility. the coefficient of p is 0.12755 ($p = 0.1014$), which is significant at close to 0.1 level of significance, but still not significant. The value of R-squared is 0.07818 indicating that the model explains only about 7.82% of the variance in mobility. The p-value of the F-statistic is 0.01294, indicating that the overall model is significant at the 0.05 level. Preliminary results indicate that teleworking has a significant effect on mobility, while family factors and personal preferences have a weaker effect on mobility. The limited explanatory power of the model suggests that there may be key factors that were not included.

In order to improve the explanatory power of the model, more control variables were introduced into the model, including age (Age), educational background (Education) and income level (Income). The new regression model is

$$M_i = \alpha_3 + \beta_3 IRM_i + \gamma_3 Fi + \delta_3 P_i + \lambda_3 Age + \mu_3 Education + \nu_3 Income + \epsilon_{3i} \quad (3)$$

Then a stepwise regression analysis was performed to finalize an optimal model with IRM, P and Income.

The OLS regression results of the extended model are shown in Figure 10. The IRM coefficient of the optimized model is 0.22375, which is still significant at the 0.05 level of significance (p = 0.028), indicating that telework has a significant positive effect on mobility. The coefficient of P is 0.12345, which is close to the 0.1 level of significance (p = 0.1035). The coefficient of Income is 0.13331, which is significant at the 0.05 level of significance (p = 0.0295), indicating that income level also has a significant effect on mobility. The value of R-squared becomes 0.1094, meaning an increase in the explanatory power of the model. The p-value of the F-statistic is 0.001539, which means the overall model is significant.

The extended model improves the explanatory power of mobility, with income level as a new control variable that has a significant positive effect on mobility. Family factors and educational background are excluded from the stepwise regression, suggesting that they have a lesser impact on mobility.

Furthermore, taking into account possible outliers in the data, a robust regression method was used to improve the robustness of the model. The results of robust regression are shown in Figure 11.

Robust Regression Results

	Dependent variable:
	Mobility
IRM	0.247**
	(0.105)
P	0.134*
	(0.077)
Income	0.107*
	(0.056)
Constant	1.766***
	(0.289)
Observations	136
R^2	0.114
Adjusted R^2	0.094
Residual Std. Error	1.285 (df = 132)
Note:	*p<0.1; **p<0.05; ***p<0.01

Figure 11. Robust regression results

The coefficient of IRM in the robust regression is 0.24669 (p = 0.0202), which is slightly more significant than the OLS model, further supporting the positive impact of remote work on mobility. The coefficient of P is 0.13411, which is significant at the 0.1 level (p = 0.0826), indicating an enhanced effect. The coefficient of Income is 0.10744 (p = 0.0585), which is close to significance at the 0.1 level. Robust regression provides

more reliable estimates when dealing with outliers. The influence of IRM and income in the robust regression is still significant, while the influence of P is slightly enhanced.

To verify the stability of the robust regression model, we performed cross-validation. The results in Figure 12 show that the coefficient estimates of the robust regression model are relatively stable. Although there is a certain deviation, the overall standard error is small, indicating that the model's performance in different samples is consistent.

Cross–Validation Summary

	Original	Bias	Std.Error
Intercept	1.469	0.764	0.707
IRM	0.613	−0.463	0.178
P	0.192	−0.113	0.093
Income	0.106	−0.042	0.072

Figure 12. Cross-Validation summary

Overall, by extending and optimizing the original OLS model, we confirm the significant positive impact of remote work on mobility. After introducing more control variables, the explanatory power of the model is improved, and the impact of income level on mobility is equally significant. Robust regression further validates this result, providing more reliable estimates especially when dealing with outliers. Cross-validation showed good performance of the robust regression model, further supporting the rationality of using robust regression as the primary analysis method. However, this regression still has areas that can be optimized. The R-squared value of this study is still low, indicating that the model explains less variability in mobility. Subsequent research can introduce more control variables to improve the explanatory power or conduct a larger and more rigorous investigation to improve sample quantity and quality.

According to the results of the regressions, remote work significantly affects individual mobility, while personal preferences and income levels are also factors that affect mobility, exhibiting significant or marginally significant effects on mobility in the robust regression model. Counter-intuitively, household factors do not affect mobility as significantly as expected. However, due to sample size limitations, this preliminary result still needs to be confirmed by further research.

Tools

In the tools part, Equation (2) was used as the entry point for the most basic OLS regression analysis. Following this, the data during the epidemic were analyzed using a multiple linear regression model with the quadratic term and a generalized additive model (GAM) to gradually explore the nonlinear relationships through model optimization. The results of the first OLS regression analysis are shown in Figure 13.

Initial OLS Regression Results

	Dependent variable:
	IT
UL	−0.008
	(0.008)
S	0.146***
	(0.027)
Constant	0.859***
	(0.230)
Observations	159
R^2	0.164
Adjusted R^2	0.153
Residual Std. Error	1.372 (df = 156)
F Statistic	15.276*** (df = 2; 156)
Note:	*p<0.1; **p<0.05; ***p<0.01

OLS Regression with Quadratic

	Dependent variable:
	IT
UL	0.052**
	(0.026)
I(UL2)	−0.001**
	(0.0005)
S	0.144***
	(0.027)
Constant	0.367
	(0.304)
Observations	159
R^2	0.194
Adjusted R^2	0.179
Residual Std. Error	1.352 (df = 155)
F Statistic	12.448*** (df = 3; 155)
Note:	*p<0.1; **p<0.05; ***p<0.01

Figure 13. (left) Initial OLS regression results

Figure 14. (right) OLS regression with quadratic

It can be seen that while S has a significant positive effect on IT ($p < 0.001$), the other independent variable, UL, does not have a significant effect on IT ($p = 0.267$), which suggests that UL fails to significantly affect work efficiency in the initial model. The result for UL suggests that we may need to consider the nonlinear relationship between UL and IT. Therefore, we further optimized the model.

To capture the possible nonlinear relationship, we introduced the squared term of UL and constructed the following model:

$$IT_i = \alpha_4 + \beta_4 UL_i + \gamma_4 S_i + \rho UL_i^2 + \epsilon_{4i} \quad (4)$$

This model allows us to explore whether there is an "inverted U-shaped" relationship between UL and IT, i.e., whether there is an optimal point at which UL affects IT.

The results of the regression analysis with the introduction of the quadratic term are shown in Figure 14.

This result much more significant than the initial regression, with the linear term of UL having a significant effect on IT ($p = 0.0479$), suggesting that IT initially increases as UL increases. The squared term of UL is significant and negative ($p = 0.0168$), suggesting an "inverted U-shaped" relationship: once UL reaches a critical point, further increases in UL lead to a decrease in IT. Beyond changes in UL, S still had a significant positive effect on IT ($p < 0.001$).

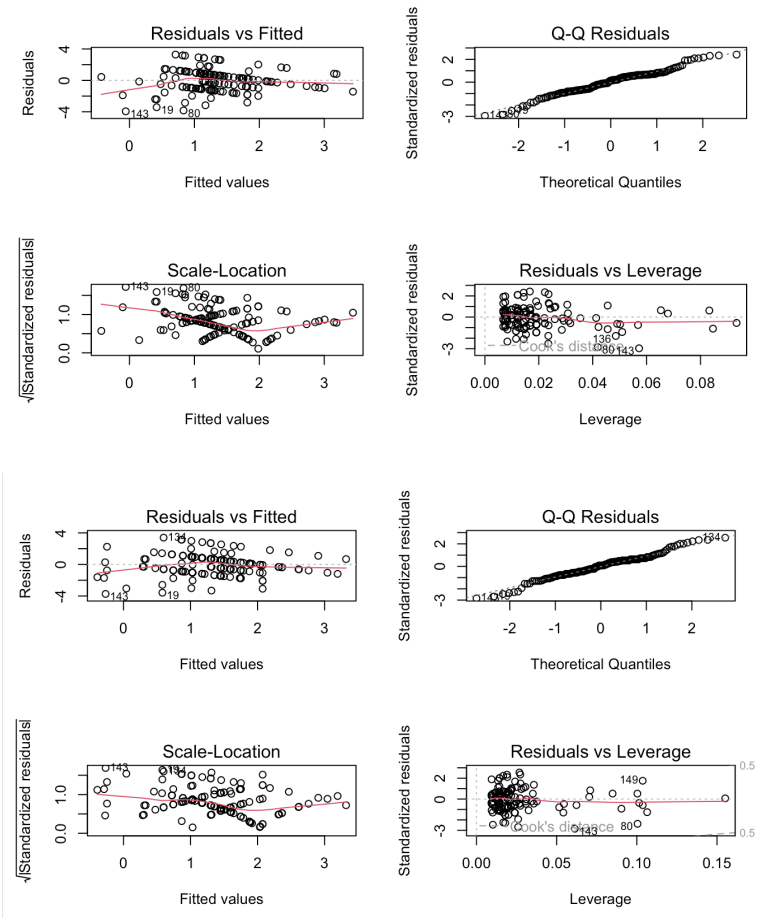


Figure 15. (upper) Residual plots of initial OLS regression

Figure 16. (bottom) Residual plots of OLS regression with quadratic

Also, looking at the residual plots of the two models (Figures 15&16), it can also be seen that the multiple regression model with quadratic term improves the initial OLS regression to some extent. Before the introduction of the squared term, a slight curvature can be seen in the plots of the residuals against the fitted values, which suggests that there may be uncaptured nonlinear relationships in the model, especially in the low and high fitted value regions. Whereas, after the introduction of the squared term, the distribution of the residual pair fitted values becomes more random and flat, which indicates that the model has improved in capturing the nonlinear relationships. And the red smoothed line becomes closer to the horizontal line, indicating that the model fit better captures the nonlinear trends in the data. In the Q-Q Residuals plot, the residuals of the initial model have some deviations above and below the theoretical normal distribution line, especially in the right tail, while the distribution of points in the Q-Q Residuals plot after the introduction of the squared term is closer to the theoretical normal distribution line, especially the deviations at the two ends are reduced, which indicates that the residuals are closer to normal distribution after the introduction of the squared term, and the model is more in line with the normality assumption. The red line of the Scale-Location plot becomes flatter after the introduction of the squared term, which indicates that the variance of the residuals is more homogeneous, the heteroskedasticity problem is reduced, and the model is

more robust. Finally, the number of high-leverage points is slightly reduced and the overall distribution is more concentrated, meaning that the model has been adjusted so that the impact of these high-leverage points on the overall model has been reduced. Overall, the normality of the residuals, the homogeneity of the variance, and the linearity of the relationship to the fitted values are all improved with the introduction of the squared term.

After model optimization, the effect of UL becomes significant, implying that there is indeed a nonlinear relationship between UL and IT. However, the optimal range of UL usage needs to be captured more precisely. In order to more accurately describe the nonlinear relationship between UL and IT, we use the generalized additive model (GAM) and construct the following model:

$$IT_i = \sigma_0 + s(UL_i) + \sigma_1 S_i + \epsilon_{5i} \tag{5}$$

Among them $s(UL)$ is a smoothing term for UL to capture the complex nonlinear relationship between UL and IT.

The results of the GAM analysis (Figure 17) further validate the non-linear effect of UL. The GAM model not only captures the nonlinear relationship of UL, but also provides a more intuitive explanation: the smoothed term of UL shows an "inverted U-shaped" curve that peaks between UL values of about 20 and 30, and then begins to decline. This suggests that it is in this range that the duration of use has the greatest impact on efficiency and that exceeding this range leads to a decrease in efficiency. And as far as the data are concerned (Figure 18), S continues to have a significant positive effect on IT ($p < 0.001$).

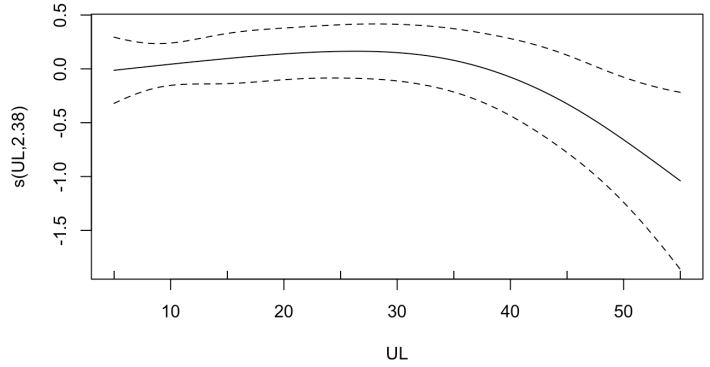


Figure 17. GAM analysis

Combining the results of the multiple linear regression and GAM models, the final model captures the nonlinear relationship between UL and IT through a smoothing term and optimizes the stability of the model

through residual analysis. The model results clearly indicate that the optimal range of UL use is between 20 and 30, while confirming the important impact of satisfaction on productivity.

GAM Regression Results

	Dependent variable:
	IT
S	0.145***
	(0.027)
s(UL).1	
s(UL).2	
s(UL).3	
s(UL).4	
Constant	0.686***
	(0.160)
Observations	159
Adjusted R^2	0.181
Log Likelihood	−276.412
UBRE	1.872
Note:	*p<0.1; **p<0.05; ***p<0.01

Figure 18. GAM regression results

Conclusion

Conclusions and Discussion

Through questionnaires, data collection and sorting, and digital visualization of respondents who have been or are still remote workers, we can draw some preliminary conclusions. First, as can be seen from the visual chart, the number of remote workers increased significantly during the epidemic (2020-2022), but in 2023 after the epidemic, the number returned to close to pre-epidemic levels. This shows that although remote work became the norm during the epidemic, its popularity has declined as society returns to normal, indicating that remote work has not yet become a long-term mainstream work model in China. Second, while a significant number of family members prefer to spend time together at home, remote workers are personally more inclined to travel. Personal travel preferences are stronger than family needs. When it comes to collaboration tools, a big reason for choosing to use a specific collaboration tool during and after the pandemic has been the requirements of the team or employer, rather than the functionality or ease of use of the tool. This suggests that most remote workers are not actively choosing tools but rather adapting to

them. However, despite this, user satisfaction is high for most collaboration tools, especially those used during the epidemic, indicating that these tools meet the needs of users in specific circumstances.

Further regression analyses on the original dataset allow us to draw additional in-depth conclusions in terms of mobility and collaboration tools. The mobility model yields the following three conclusions: 1. Remote working significantly increases individual mobility, indicating that individuals who work remotely travel more frequently over the course of a year, showing that remote working contributes to some degree to an increase in travel and other non-work related activities. 2. Individuals' travel preferences have a significant impact on mobility, as well as their income. 3. Although family factors (e.g., the needs and responsibilities of family members) are theoretically thought to have an impact on mobility, in this study, family factors had a relatively weak effect on the actual mobility of teleworkers, which is a departure from the expected results.

In the case of collaboration tools, we can also draw three conclusions: 1. Collaboration tools are most productive when they are used between 20 and 30 hours per week. 2. User satisfaction with collaboration tools is a key factor in productivity. Highly satisfied tool use can significantly improve employee productivity. 3. There is a non-linear relationship between tool usage hours and productivity, which manifests itself as an increase in productivity when usage hours increase initially, but a decrease in efficiency beyond a certain threshold, suggesting that spending too much time on tools may have a negative impact on the workplace. However, it is important to note that this data does not distinguish between active and passive. This means that remote workers could also be spending more time at the behest of their employer, which could lead to a decline in work performance.

Beyond the data, a small number of respondents also left their views on teleworking through open-ended questions in the questionnaire. Some became pessimistic about remote work and tools, believing that the misuse of remote work and collaboration tools can greatly reduce productivity and motivation. Due to the lack of productivity, they choose not to work remotely unless it is necessary. Others were quite optimistic about the future of telework, believing that telework that enhances cross-regional communication will become an inevitable trend. In their responses, respondents discussed the advantages and disadvantages of remote work: for the advantages, working remotely and from home saves transportation costs and reduces transportation risks; communication is more efficient as it breaks through the limitations of distance and time; and the working relationship is de-personalized and becomes purer. The shortcomings of remote work are also quite a lot, it is more demanding on people's time management ability, self-discipline and teamwork management ability; relying on application tools, there are risks of information security; not all industries are suitable for, for example, teaching, can't get timely and accurate feedback is not conducive to the adjustment of the work; the weakening of the emotional communication between people; the work and life will be invasive to each other, the boundary is fuzzy. One respondent provided meaningful personal experiences of the difficulties of traveling for remote work and the intrusion of collaboration tools into

"off-hours". He said, "Remote work involves being in front of a computer at all times, which can interfere with traveling, or having to take a computer with you on your trip, and using a computer to work remotely while traveling is a hassle with no place to sit and recharge. Requirements of the work content is very random time period and more urgent need to deal with, resulting in 24-hour standby personnel, it is very difficult. Collaboration tools are required to respond to messages 24 hours a day, and much of the specialized content is time-consuming to type and think about. Working through collaboration tools is exhausting, with the need to respond to wordy, specialized answers at all times." This is certainly not his predicament alone.

But perhaps more complex than these pros and cons is the fact that the situation in China today is worsening due to the saturation of the working population and the epidemic that has hit the job market. People value every opportunity to work, but a large number of people are still facing an unemployment crisis or are already unemployed. In this situation, the decision to work remotely or not is most of the time not a personal decision. Just as people had to stay home and use videoconferencing tools to communicate work progress during the epidemic, Chinese workers in the post-epidemic era often do not have the option of staying home and continuing to work remotely or returning to the office. As a result, Chinese tremote-workers can only be called remote-workers, but not yet "digital nomads". The tendency to travel, as reflected in the questionnaire, may also signify a desire for respite and work-life balance. However, as the respondent mentioned above, working remotely and using collaborative tools has eaten into his already scarce free time, and in a sense become a new form of shackle.

Future Improvements

The study still leaves much to be desired and is not without unfortunate shortcomings. Firstly, due to the limitations of the mode of dissemination, it was not possible to implement the study as initially conceived with regard to the distribution and direction of movement of remote-workers. Although this is to be expected, after all, in terms of China's vast territory and large population, the scope of the Internet today is too narrow to be disseminated on my own, and with the existence of information cocoons and big data filtering, it would be difficult to carry out this survey without considerable influence or power. All I can hope for is that in the future, the number of teleworkers in the community will continue to grow, and that telework technologies, platforms and norms will further develop so that teleworkers will also become a large group worthy of census-taking, and it will then be much easier to obtain data for research. However, as far as the current findings are concerned, teleworkers have also ebbed again after a brief and forced boom following the epidemic, with their numbers largely returning to pre-epidemic levels. This, in turn, relates to another regret of this study, which is that the sample size is still too small, especially the number of

teleworkers before and after the epidemic. In the regression analysis section, for the collaboration tools, the questionnaire design made a distinction between the mid-epidemic and the post-epidemic, wanting to see the changes in the comparison between the two time periods. However, since the number of teleworkers in the post epidemic period was only a quarter of the total number of respondents, the sample size was very insufficient, resulting in the inability to draw any significant conclusions in the regression model.

In addition to these shortcomings, which are limited by the context and beyond the capabilities of the study, there is room for other enhancements to this study. The variables of interest in this study are only a small portion of a complex system, and while it highlights the important relationship between the use of collaborative tools and productivity, future research could still explore other factors that affect productivity, such as the quality of teamwork and task complexity. This would contribute to a more comprehensive model to guide organizational practices.

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