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The Climate Temperature and Migrants' Settlement Intention in Cities: A Study on China

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Abstract

This paper examines the impact of climate temperature on the settlement intentions of rural and urban migrants in Chinese cities, using data from the China Meteorological Data Service Center and the China Migrants Dynamic Survey (2012–2018). By employing a logit regression model, we analyze migrants in 293 cities across 31 provinces. Our findings reveal an inverted U-shaped relationship between temperature and migrants' settlement intentions, with extreme temperatures (above 32°C, 27°C-32°C, -12°C--7°C, and below -12°C) negatively affecting their willingness to settle. These results are robust across various sensitivity tests. Additionally, the heterogeneity analysis indicates that the adverse effects of extreme temperatures on settlement intentions vary according to migrants' demographic and industry characteristics. Our findings highlight the disruptive potential of climate temperature on a significant portion of migrant workers in Chinese cities, underscoring the need for policymakers to address these challenges.

Keywords

Climate Temperature; Migrants; Settlement Intention; China.

1. Introduction

Climate-induced migration is a critical issue, particularly in developing countries where catastrophic events such as extreme droughts and flooding have long been recognized as significant drivers of human displacement. However, it is increasingly evident that more subtle and pervasive forms of climate variability, such as rising temperatures, also play a crucial role in influencing migration patterns. Research indicates that slow-onset climate changes, like temperature fluctuations, are more likely to spur migration than rapid-onset events[8]. These temperature variations, particularly in rural areas where livelihoods are closely tied to agriculture and are thus highly vulnerable to climate shocks, can trigger both internal and cross-border migration[2][14].

Climate-induced migration is a critical issue, particularly in developing countries where catastrophic events such as extreme droughts and flooding have long been recognized as significant drivers of human displacement. Moreover, climate-driven migration typically manifests as long-distance internal migration within countries as an adaptive mechanism [4]. In many developing countries, migrants constitute a significant portion of the urban workforce, and rising temperatures are considered a strong driver of migration[1]. Migration decisions are influenced by a complex interplay of factors including environmental change, economic opportunities, and family needs. In regions with limited climate adaptation capacity and predominantly agricultural economies, extreme weather events can severely disrupt livelihoods. Temperature impacts are particularly pronounced during hot spells, potentially leading to income losses and reduced well-being, which in turn influence migration.

China presents a significant case study due to its massive migrant population, with nearly one-quarter of its citizens being migrant workers. As global warming persists, China's temperatures are rising faster than the global average. The frequency of extreme heat events has also increased markedly. The China Meteorological Administration released the 'Blue Book on Climate Change in China (2023)', which points out that the incidence of such events in 2022 reached the highest record since 1961. Extreme cold events, including cold waves and blizzards, also occur frequently, further complicating the environmental landscape. Existing literature has examined the influence of factors such as institutions, income, and housing on residential preferences, but the socioeconomic consequences of climate change remain understudied[7]. To address this gap, this study utilizes Chinese meteorological data and migrant population survey data to investigate the impact of climate temperature on residential preferences and its underlying mechanisms, conducting heterogeneity analyses at both the individual characteristic and industry levels.

2. The Theoretical and Empirical Background

2.1. The Impact of Climate Temperature on Migration

The spatial equilibrium theory posits that individuals weigh income, living costs, and urban comfort when choosing a city to reside in, aiming to maximize utility[11][12]. Climate, as a key element of urban comfort, has increasingly become a significant factor influencing labor force location decisions. Extensive empirical research has confirmed the strong link between climate change and migration. While early studies focused on variables like precipitation, current evidence indicates that temperature anomalies exert a persistent and critical influence on migration patterns[1]. For instance, analyses of interprovincial migration in China reveal that rising temperatures are a major driver of migration, with higher temperatures correlating with stronger migration intentions. Some studies have begun examining the distinct effects of extreme temperatures. Empirical results indicate that extreme cold significantly reduces the willingness to reside among specific groups (e.g., the elderly), while extreme heat may exhibit different impact patterns[13]. This suggests a potentially more complex nonlinear relationship between temperature and settlement intention.

2.2. Other Factors Influencing Migration

The decision to migrate to a specific city is complex, influenced by both economic and non-economic factors such as environmental changes, employment, income, education, family needs, and expectations for future generations. Some scholars argue that migration often stems from shifts in economic opportunities and climate comfort driven by climate change[9]. Temperature can influence mobility through multiple mechanisms, including damage to housing and infrastructure, physiological changes affecting household finances (e.g., increased costs to avoid heat stress), and broader sectoral or economic effects[5]. Yang (2018) demonstrated that extreme temperatures negatively impact agricultural production in China, increasing the likelihood of rural residents migrating in search of employment[14].

Existing literature extensively explores the relationship between climate temperature and migrantion, but research primarily focuses on the linear effects of temperature, overlooking the nonlinear relationship between temperature and migration. This study delves into how different temperature ranges influence the settlement intention of migrant. This methodology preserves daily temperature variations, which is crucial for understanding the nonlinear relationship between temperature and migrants' settlement intention. While examining the direct effects of temperature, we incorporate multiple types of groups into our heterogeneity analysis.

ISSN: 2688-9323

3. Data and Empirical Strategy

3.1. Data Sources

Weather data is sourced from the China Meteorological Data Service Center (CMDC), which records daily maximum, minimum, and average temperatures, precipitation, sunshine duration, and wind speeds from approximately 800 meteorological stations across China since 1952. We aggregated the data from the station level to the city level. Migrant data is sourced from the China Migrants Dynamic Survey (CMDS). This survey's sample covers all 31 provinces in China, ensuring national representativeness. As this study examines temperature's impact on migrants at the employment level, we selected migrants aged 16 to 60 - a demographic within China's working-age population - and utilized data from 293 cities spanning 2012 to 2018.

3.2. Empirical Model and Variable Definition

Our city-level variables are observed annually. To estimate the effects of daily temperatures on annual outcomes, we employ a widely used method that allows flexible estimation of nonlinear temperature effects across various daily temperature values[3][16]. The above method divides the annual distribution of daily temperature in each city, measured in degrees Fahrenheit, into $m = 1 \dots 10$ bins. Each interior bin is 10°F wide. T_{jt}^{m} is the number of days in year t experienced by city j with daily temperature that falls in bin m. We use degrees Centigrade to measure temperature change. T_{jt}^{1} is the number of days in city j during year t with daily temperature below -12 °C (10°F). At the upper trend, T_{jt}^{10} is the number of days with temperature above 32 °C (90 °F).

In our empirical exploration migrants' settlement intention is a binary variable (1=Yes and 0=No). A logistic regression model is used to investigate the impact of temperature on the migrants' settlement intention:

$$settlement_{ijt} = \alpha_0 + \sum_{m} \alpha_m T_{jt}^{m} + \sigma' W_{jt} + \theta' Z_{ijt} + \gamma_j + \gamma_t + \varepsilon_{ijt} \tag{1}$$

Subscript i represents the individual worker, j is the residence city, and t is the year. The explained variable $settlement_{ijt}$ indicates whether the migrant i in year t chooses to settle in the city j . The core explanatory variable is T_{jt}^{m} denotes the number of days in city j and year t where the daily mean temperature is in the mth of the ten bins. Other climatic factors may also affect the migrants' settlement intention, we control a set of weather variables W_{jt}, including annual average precipitation, average annual sunshine time, and average annual wind speed[1][16]. Z_{ijt} is a set of personal variables, including gender, *hukou* status, marriage, education and age. γ_j is city fixed effect, and γ_t is year fixed effect. ε_{ijt} is the residuals.

The explained variable $settlement_{ijt}$ refers to the dummy variable of whether migrant i chooses to settle in city j in year t. If migrant i chooses to settle in city j , the value of $settlement_{ijt}$ is 1, otherwise the value of $settlement_{ijt}$ is 0. The probability of the migrants choosing to settle in the city j is:

$$Prob(settlement_{ijt} = 1) = \frac{exp(\alpha_0 + \sum_m \alpha_m T_{jt}^{m} + \sigma' W_{jt} + \theta' Z_{ijt} + \gamma_j + \gamma_t + \varepsilon_{ijt})}{1 + exp(\alpha_0 + \sum_m \alpha_m T_{jt}^{m} + \sigma' W_{jt} + \theta' Z_{ijt} + \gamma_j + \gamma_t + \varepsilon_{ijt})} \tag{2}$$

Specifically, the definitions and statistical descriptions of the urban and individual characteristic variables are shown in Table 1. Among the groups examined, about 89% of the migrants choose to stay in their original cities, with a balanced proportion of men and women,

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slightly more men than women. Most of them with rural household registration, and with an average age of 35 years old. The above characteristics are in line with the basic characteristics of the current Chinese migrants.

Table 1. Descriptive statistics

Variable name	Definition	Number of observations	Mean value	Standard deviation	Minimum value	Maximum value
settlement	Whether the worker chooses to settle in the city. Yes =1, no =0	599650	0.887	0.317	0	1
Temp	Temperature (°C).	599650	15.03	4.858	-1.276	25.28
$Days > 32℃$	No. of days: Temp $_{>32℃}$	599650	1.809	4.409	0	27
$Days\ 27℃ - 32℃$	No. of days: Temp $_{27℃\text{-}32℃}$	599650	41.00	36.25	0	160
$Days\ -12℃ - -7℃$	No. of days: Temp $_{-12℃\text{-}-7℃}$	599650	7.261	13.50	0	62
$Days < -12℃$	No. of days: Temp $_{<-12℃}$	599650	4.514	15.39	0	128
ln(prec)	Logarithm of precipitation(mm).	599650	9.182	0.502	7.608	10.22
ln(sun)	Logarithm of sunshine time(h).	599650	7.557	0.275	6.609	8.117
ln(wind)	Logarithm of mean wind speed(m/s).	599650	1.631	0.220	0.798	2.143
employment	Employment status. Employed = 1, unemployed = 0	437292	0.852	0.355	0	1
ln(income)	Logarithm of Labour income	374927	8.093	0.605	-0.059	13.533
well-being	Sense of well-being to place of residence. Completely disagree = 0, disagree = 1, basically agreed = 2, agree = 3.	152113	2.423	0.577	0	3
gender	Male=1, female=0	599650	0.519	0.500	0	1
Household Registration (Hukou)	Urban =1, rural =0	599650	0.208	0.406	0	1
marriage	Marital status. Unmarried = 0, first marriage = 1, remarriage = 2, divorces = 3, bereaved of one's spouse = 4.	599650	0.901	0.522	0	4
educ	Education. Below primary school =0, junior high school, high school /technical secondary school =1, college degree or above =2	599650	1.042	0.554	0	2
age	Age	599650	35.10	9.353	16	60

Notes: The sample contains 599650 individuals in 293 cities across 7 years. All nominal variables are deflated by CPI of provincial level. Temperature, sunlight time, and wind speed are calculated as annual mean value from daily observations. Precipitation is calculated as the annual sum from daily observations.

4. Baseline Estimation Results

We first present baseline regression results estimated using Eq. (1). Estimates are relative to daily temperature between 10°C-16°C, the omitted reference group. According to the results presented in Table 2, the estimation coefficients of each temperature bin are significant whether we use the control variables, year fixed effects, city fixed effects or not and show an inverted U-shaped relationship between temperature and migrants' settlement intention. The climate temperature changes have a non-linear impact on the migrants' settlement intention. Hypothesis 1 is proven.

Table 2. Estimation results of migrants' settlement intention

	(1)	(2)	(3)
$Days\ > 32℃$	-0.0051***	-0.0029***	-0.0027***
	(0.0001)	(0.0003)	(0.0003)
$Days$ 27℃ − 32℃	0.0009***	-0.0012***	-0.0010***
	(0.0000)	(0.0001)	(0.0001)
$Days$ 21℃ − 27℃	0.0000	-0.0007***	-0.0005***
	(0.0000)	(0.0001)	(0.0001)
$Days$ 16℃ − 21℃	0.0003***	0.0002**	0.0003***
	(0.0000)	(0.0001)	(0.0001)
$Days$ 4℃ − 10℃	0.0012***	-0.0005***	-0.0005***
	(0.0000)	(0.0001)	(0.0001)
$Days$ − 1℃ − 4℃	-0.0011***	-0.0004***	-0.0003***
	(0.0000)	(0.0001)	(0.0001)
$Days$ − 7℃ − −1℃	-0.0004***	-0.0004***	-0.0004**
	(0.0000)	(0.0001)	(0.0001)
$Days$ − 12℃ − −7℃	0.0000	-0.0005***	-0.0004**
	(0.0001)	(0.0002)	(0.0002)
$Days\ < -12℃$	0.0006***	-0.0008***	-0.0007***
	(0.0000)	(0.0002)	(0.0002)
lnprec	-0.0689***	-0.0298***	-0.0300***
	(0.0022)	(0.0051)	(0.0051)
lnsun	0.0846***	0.0306***	0.0266***
	(0.0033)	(0.0094)	(0.0093)
lnwind	0.0420***	0.0483***	0.0580***
	(0.0024)	(0.0101)	(0.0101)
gender			-0.0062***
(default is female)			(0.0008)
Hukou			0.0193***
(default is rural)			(0.0011)
marriage =1			0.0831***
(default is unmarried)			(0.0015)
marriage =2			0.0905***
(default is unmarried)			(0.0033)
marriage =3			0.0495***
(default is unmarried)			(0.0036)
marriage =4			0.0667***
(default is unmarried)			(0.0062)
educ =1			0.0198***
(default is educ=0)			(0.0014)
educ =2			0.0627***
(default is educ=0)			(0.0016)
age			-0.0003***
			(0.0001)
City fixed effect	NO	YES	YES
Year fixed effect	NO	YES	YES
Observations	599650	599650	599650
Pseudo R^2	0.0193	0.1357	0.1523

Notes: (1) * p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors are given in parentheses and are clustered by city. (2) Because $\sum_m T_{jt}^m = 365$ for every city and year, dropping one of the m temperature bins is required to avoid multicollinearity. We omit the 10℃ − 16℃ bin because it is in the middle of our temperature range. Our results do not depend on this choice. (3) Marital status: unmarried = 0, first marriage = 1, remarriage = 2, divorces = 3, bereaved of one's spouse = 4. Education levels: below primary school = 0, junior high school, high school /technical secondary school = 1, college degree or above = 2. (4) Without any controls in Column (1). City and year fixed effects are in Column (2). Weather and personal factors are controlled and fixed effects are in place in Column (3).

For extreme hot weather, an extra day with a temperature larger than 32°C and between 27°C-32°C decreases migrants' settlement intention by 0.27%, 0.1%, respectively. For extreme cold weather, an extra day with a temperature lower than -12°C and between -12°C--7°C decreases migrants' settlement intention by 0.04%, 0.07%, respectively. (when various other factors are controlled and fixed effects are in place, and by -0.51%, 0.09%, 0.00%, 0.06% without the controls).

5. Heterogeneity Analysis

Much of the literature describes the impact of temperature changes on different types of migrants. Research indicates that women[2], older adults[13], individuals with lower educational attainment[15], and those employed in outdoor or climate-sensitive industries (such as agriculture and construction) are particularly vulnerable to temperature-related health risks, older individuals[13], those with lower educational attainment[15], and workers in outdoor or climate-sensitive industries (e.g., agriculture, construction)[6] are more vulnerable to temperature fluctuations, with their migration decisions being more profoundly influenced by climatic factors. Therefore, understanding the relationship between climate and migration must incorporate these heterogeneous characteristics. We analyze the diverse effects of temperature on the settlement intention among migrants across different age, gender, household registration, education level, and occupational groups. Due to space limitations, we only report the coefficients on the two highest and lowest temperature bins: 27°C-32°C and above 32°C, -12°C--7°C and below -12°C.

As shown in Part A of Table 3, extreme heat (above 32°C and between 27°C and 32°C) and extreme cold (below -12°C) exert a significant negative impact on the settlement intention of migrants across all age groups, with this probability increasing sequentially with age. Consequently, the adaptability of migrants to temperature fluctuations diminishes with age, accompanied by a decline in their settlement intention.

Part B shows that the estimated coefficient of $temp * gender$ is significantly positive in both extreme heat and cold weather, indicating that men experience less negative impact from temperature than women. Among migrants, women tend to be poorer, less educated, and in poorer health on average, with limited direct access to or ownership of natural resources. Gender barriers constrain their capacity to adapt to climate change and increase their incentive to move[2].

The estimation coefficient of $temp * hhr$ in Part C is significantly positive during extreme heat events, indicating that extreme heat has a greater negative impact on rural migrants than on urban migrants. Uncertainty in temperature fluctuations may lead to reduced income or even livelihood crises for farmers, prompting some to leave rural areas and migrate to cities in search of better livelihood opportunities.

Part D presents estimated results by education levels. Compared to migrants with primary school education or below, those with junior high school, high school/technical secondary school degrees, and college education or above experience a smaller negative impact from extreme temperatures. This indicates that in China, the heightened migration propensity driven by extreme temperatures is more pronounced among individuals with lower educational level [15].

Section E presents estimation results across different industries. The estimated coefficient for the industry interaction term is significantly negative during extreme heat and cold events, suggesting that extreme temperatures may disproportionately affect productivity and working hours among migrants in manufacturing compared to those in service industries. This could lead to unemployment among some migrants, and the loss of employment opportunities may further impact their willingness to settle[10].

ISSN: 2688-9323

Table 3. Heterogeneity of individual and industry characteristics

		(1)	(2)	(3)	(4)
		Days **> 32℃**	***Days*** **27℃ − 32℃**	***Days*** **− 12℃ − −7℃**	***Days*** **< −12℃**
	age	-0.0025***	-0.0011***	-0.0003	-0.0007***
		(0.0003)	(0.0002)	(0.0002)	(0.0002)
Part A	temp ∗ age(31 − 45)	-0.0002***	0.0003***	-0.0002***	-0.0001***
Age	(default is 16-30 years old)	(0.0003)	(0.0001)	(0.0002)	(0.0002)
	temp ∗ age(46 − 60)	-0.0009***	0.0000***	-0.0003***	-0.0002***
	(default is16-30 years old)	(0.0004)	(0.0002)	(0.0002)	(0.0002)
	Observations	599650			
	Pseudo R^2	0.1544			
	gender	-0.0028***	-0.0011***	-0.0004**	-0.0007***
Part B		(0.0003)	(0.0001)	(0.0002)	(0.0002)
Gender	temp ∗ gender	0.0002***	0.0001***	0.0001*	0.0000***
	(default is female)	(0.0003)	(0.0001)	(0.0002)	(0.0002)
	Observations	599650			
	Pseudo R^2	0.1523			
	hhr	-0.0029***	-0.0011***	-0.0005***	-0.0006***
Part C		(0.0003)	(0.0001)	(0.0002)	(0.0002)
Household	temp ∗ hhr	0.0012***	0.0003***	0.0004	-0.0004***
registration	(default is rural)	(0.0003)	(0.0001)	(0.0002)	(0.0002)
	Observations	599650			
	Pseudo R^2	0.1524			
	educ	-0.0039***	-0.0014***	-0.0005**	-0.0006**
		(0.0004)	(0.0002)	(0.0002)	(0.0003)
	temp ∗∗ educ 1	0.0010***	0.0004***	0.0001**	-0.0001***
Part D	(default is educ=0)	(0.0003)	(0.0002)	(0.0002)	(0.0002)
Education	temp ∗∗ educ 2	0.0033**	0.0007***	0.0003	0.0000***
levels	(default is educ=0)	(0.0003)	(0.0001)	(0.0001)	(0.0002)
	Observations	599650			
	Pseudo R^2	0.1525			
	Industry	-0.0017***	-0.0008***	-0.0004**	-0.0007***
Part E		(0.0003)	(0.0002)	(0.0002)	(0.0002)
Industry	temp ∗ Industry	-0.0020***	-0.0004***	-0.0003	-0.0002**
	(default is service sector)	(0.0004)	(0.0002)	(0.0003)	(0.0004)
	Observations	456033			
	Pseudo R^2	0.1633			
Weather control variables		Yes			
Personal control variables		Yes			
City fixed effects		Yes			
Year fixed effects		Yes			

Notes: (1) * p < 0.1, ** p < 0.05, *** p < 0.01. Standard errors are given in parentheses and are clustered by city. (2) Because $\sum_m T_{jt}^m = 365$ for every city and year, dropping one of the m temperature bins is required to avoid multicollinearity. We omit the 10℃ − 16℃ bin because it is in the middle of our temperature range. Our results do not depend on this choice. (3) Education levels: below primary school = 0, junior high school, high school /technical secondary school = 1, college degree or above = 2. Industry: service sector = 0, manufacturing sector = 1.

6. Conclusion

This study examines the impact of climate temperature on the mgrants' settlement intention, revealing a complex relationship characterized by an inverted U-shaped curve. Extreme temperatures significantly reduce migrants' willingness to settle. Heterogeneity analysis indicates that migrants aged 45–60 are most likely to migrate due to temperature changes. Women and rural household registrants experience greater negative impacts from extreme temperatures than men and urban household registrants. Migrants with lower educational backgrounds exhibit reduced settlement intention when confronted with temperature fluctuations. Furthermore, migrants employed in manufacturing are less likely to settle during extreme temperatures compared to those in the service sector.

Based on these findings, we offer several policy recommendations. First, the government should leverage China's experience in ecological and poverty alleviation resettlement to develop climate migration policies, regulations, and strategic plans aimed at enhancing employment rates, labor income, and well-being, thereby making cities more attractive to migrants. Second, in light of temperature changes, government agencies, particularly the Ministry of Labour and Social Security, should focus on addressing the employment and health challenges faced by vulnerable migrant groups identified in this study.

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