

Climate and Canadian Real Estate: The North Effect

Online Appendix

1 Impact of Climate Factors on Immigration

We collect census data for U.S. counties and Canadian census divisions for 2011, 2016, and 2021 from the U.S. Census Bureau and Statistics Canada. Our variable of interest is the change in the share of immigrants (foreign-born) as a percentage of the local population in either a U.S. county or a Canadian census division relative to 2011. As demographic controls, we also calculate the natural logarithm of population and median income for each U.S. county or Canadian census division.

We merge census data with climate factors collected from various sources. Daily temperature data, including averages, minimums, and maximums, are obtained from NASA satellite maps, covering both U.S. counties and Canadian census divisions from 1980 onward. Additionally, wildfire data are sourced from the U.S. National Interagency Fire Center's database and the Canadian Wildland Fire Information System (CWFIS).

Our analysis focuses on four primary climate factors: mean temperature, abnormal temperature, abnormal hot degree days, and wildfire activity. To compute monthly abnormal temperature, we first calculate the difference between each month's temperature and the average for that specific month during the 1980–2000 period. These monthly differences are then averaged to derive an annual abnormal temperature. For hot degree days, we count the number of days in a year that exceed 30°C, compute the average number of such days between 1980 and 2000, and subtract this baseline from each subsequent year's count. This provides a measure of the additional hot days experienced in recent years. Wildfire impact is measured as the percentage of the total area affected by wildfires in each U.S. county or Canadian census division.

We estimate the following linear regression model:

$$y_{i,t} = \beta_0 + \beta_1 \mathbf{ClimateFactor}_{i,t-1} + \beta_2 x_{i,t-1} + \gamma_t + \delta_z + u_{i,t} \quad (1)$$

where the dependent variable $y_{i,t}$ represents the change in the share of immigrants (foreign-born) as a percentage of the local population relative to 2011 for U.S. county or Canadian census division i in year t (2016 or 2021). γ_t denotes country \times year fixed effects, and δ_z represents state/province fixed effects. $x_{i,t}$ includes economic and demographic characteristics at the county or census division level, namely the natural logarithm of population and median income. All independent variables are lagged to reflect their values at the beginning of each year. Heteroskedasticity-robust standard errors are reported.

More specifically, we regress the change in the share of immigrants (foreign-born) as a percentage of the local population in either a U.S. county or a Canadian census division on climate factors, the natural logarithm of population and median income, time-varying country-level unobservables (such as interest rates and inflation), and time-invariant state-level factors. The combined results are presented in Table 1. Table 2 presents results where each climate factor is interacted with a country dummy variable to isolate its impact in each country.

Table 1. Joint Impacts of Climate Factors on Canada and the U.S.

VARIABLES	(1)	(2)	(3)	(4)
Mean Temperature by Year	-0.092*** (0.025)			
Abnormal Temperature		-0.057*** (0.005)		
Abnormal Hot Degree Days			-0.052*** (0.004)	
Wildfire Area (%)				-0.021*** (0.004)
ln(Median Income)	-0.041*** (0.004)	-0.051*** (0.004)	-0.047*** (0.003)	-0.041*** (0.004)
ln(Population)	-0.464*** (0.038)	-0.509*** (0.033)	-0.537*** (0.033)	-0.491*** (0.038)
Mean Temperature (1980-2000)		-0.028*** (0.004)		-0.008* (0.005)
Mean Hot Degree Days (1980-2000)			-0.107*** (0.010)	
Constant	6.267*** (0.430)	6.985*** (0.324)	7.538*** (0.364)	5.513*** (0.359)
State/Province FE	Yes	–	Yes	–
Country × Year FE	Yes	Yes	Yes	Yes
Observations	6,837	6,837	6,847	6,837
Adj. R-squared	0.416	0.353	0.374	0.417

The table presents the regression results for the change in the share of immigrants (foreign-born) as a percentage of the local population relative to 2011 for US counties or Canadian census divisions. Heteroskedasticity-robust standard errors are shown in parentheses. Statistical significance is denoted by: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 2. Separate Impacts of Climate Factors on Canada and the U.S.

VARIABLES	(1)	(2)	(3)	(4)
Canada×Mean Temperature by Year	0.098** (0.039)			
US×Mean Temperature by Year	-0.122*** (0.010)			
Canada×Abnormal Temperature		0.008 (0.013)		
US×Abnormal Temperature		-0.070*** (0.006)		
Canada×Abnormal Hot Degree Days			0.026 (0.021)	
US×Abnormal Hot Degree Days			-0.055*** (0.004)	
Canada×Wildfire Area (%)				-0.045 (0.060)
US×Wildfire Area (%)				-0.043*** (0.004)
ln(Median Income)	-0.064*** (0.004)	-0.051*** (0.004)	-0.046*** (0.003)	-0.053*** (0.004)
ln(Population)	-0.445*** (0.034)	-0.510*** (0.033)	-0.541*** (0.033)	-0.509*** (0.033)
Mean Temperature (1980-2000)		-0.029*** (0.004)		-0.023*** (0.004)
Mean Hot Degree Days (1980-2000)			-0.104*** (0.010)	
Constant	7.549*** (0.334)	7.054*** (0.323)	7.520*** (0.364)	6.501*** (0.322)
Country×Year FE	Yes	Yes	Yes	Yes
Observations	6,837	6,837	6,847	6,837
Adj. R-squared	0.353	0.356	0.375	0.351

The table presents the regression results for the change in the share of immigrants (foreign-born) as a percentage of the local population relative to 2011 for US counties or Canadian census divisions. Heteroskedasticity-robust standard errors are shown in parentheses. Statistical significance is denoted by: * p<0.1; ** p<0.05; *** p<0.01.

2 How Home Country Climate Affects Migration Patterns

We collect data from Statistics Canada on immigration to Canada by country of origin and year. Specifically, we obtain data on work permit holders under the Temporary Foreign Worker Program (TFWP), study permit holders, and permanent residents, categorized by country of origin and year. For each year, we calculate the share of TFWP holders, study permit holders, and permanent residents as a percentage of the total number of immigrants to Canada.¹

The Notre Dame Global Adaptation Initiative evaluates a country’s vulnerability based on six essential categories: food, water, health, ecosystem services, human habitat, and infrastructure. From this dataset, we obtain the Climate Exposure indicator, which measures the degree to which these six categories are exposed to climate-related or climate-exacerbated hazards. This serves as our primary climate variable of interest. Additionally, we collect GDP, population, governance, and social indices for each country from the Notre Dame Global Adaptation Initiative.

We merge these datasets by country of origin and estimate the following regression model:

$$y_{i,t} = \beta_0 + \beta_1 \mathbf{ClimateExposure}_{i,t-1} + \beta_2 x_{i,t-1} + \gamma_t + u_{i,t} \quad (2)$$

where the dependent variable $y_{i,t}$ represents the share of immigrants from country of origin i as a percentage of total immigration to Canada in year t . γ_t captures year fixed effects. $x_{i,t}$ includes the natural logarithm of population and GDP per capita, as well as governance and social indices for country i in year t . We exclude countries in the lowest quartile of the Human Development Index (HDI). All independent variables are lagged to reflect their values at the beginning of each year. Country-clustered robust standard errors are reported. The results are presented in Table 3.

¹We winsorize these variables at the 1% level.

Table 3. Impact of Climate and Economic Immigrants on Immigration to Canada

VARIABLES	(1) Temporary Worker	(2) Study Permit	(3) Permanent Resident	(4) All Combined
Climate Exposure	0.570** (0.252)	0.346*** (0.130)	0.283** (0.139)	0.518** (0.216)
ln(GDP per Capita)	-0.289 (0.415)	-0.382* (0.205)	-0.508** (0.245)	-0.830* (0.455)
Social Index	-2.402 (1.540)	1.636 (1.016)	1.141 (0.912)	1.511 (1.473)
Governance Index	1.356 (1.421)	0.659 (0.879)	0.872 (0.949)	1.335 (1.508)
ln(Population)	0.358*** (0.129)	0.328*** (0.105)	0.354*** (0.112)	0.497*** (0.173)
Constant	-4.179 (4.176)	-3.308*** (1.089)	-2.080* (1.254)	-2.400 (2.094)
Year FE	Yes	Yes	Yes	Yes
Observations	1,004	1,139	1,096	971
Adj. R-squared	0.136	0.330	0.310	0.315

The table presents the regression results for the share of immigrants from a country of origin as a percentage of total immigrants to Canada. Country-clustered robust standard errors are shown in parentheses. Statistical significance is denoted by: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.