Master Thesis: Climate change economic effect on health through temperature

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1 Introduction

1.1 Introduction to the subject

Climate change is projected to strongly impact temperature distribution in the upcoming century. Therefore, it is important to try to identify the different effects of temperature on the economy. One of the particular effect channels is health. How will temperature change affect the health status of the population, and therefore the economic production?

1.2 Related literature

In order to study this question,

The relationship between temperature, health, and economics is deeply intricated in several literature fields.

First, since the 2000s, the relationship on how climate and economics are intertwined has been studied in a more climate-related literature.

Second, health economics has identified important findings in the last years.

- Health economics: - Health and productivity. - Health and life expectancy. - Climate and economics: - Hotter temperature and conflicts.

1.3 Research question and strategy

The goal of this Master Thesis is to propose a simple approach to model the effect of temperature on the health of individuals, and subsequently on the economy.

In order to achieve this, two main parts are identified.

First, an empirical part studying the link between temperature and health will be done.

Second, a macroeconomic model is presented to explain the economic mechanisms that will be affected by the identified empirical relationships.

2 Setting

This section is dedicated to the presentation of the general setting in which individuals live in this model. First, the relationships between the different elements in a general framework will be presented. Then, the data used will be presented and discussed. The methods used to estimate the functional forms of the relationships will then be presented, and will be refered as the specific case of this work. Finally, results of the estimation process of these relationships will be presented and discussed.

2.1 Goal

2.2 Formal Description

At each period, an exogenous weather realization occurs, and individuals draw a health and living status.

2.2.1 History vectors

In a general framework, we can think of the health of an individual at time t as a vector $\mathcal{H}_t \in \mathbb{R}^t$ containing all the health status of the individual throughout their life. Similarily, we can think of the weather experienced by an individual at time t as a vector $\mathcal{W}_t \in \mathbb{R}^t$ containing all the weather conditions experienced by the same individual throughout their life.

2.2.2 Health Status

Let $H_t \in \Omega(H)$ be a random variable denoting the health status of an individual at time t. The functional form of its distribution f_h will depend on its sample space $\Omega(H)$. The past health history and the temperature also affect the probability distribution of health status. Generically, we can therefore write:

$$H_t \sim f_h(\mathcal{H}_{t-1}, \mathcal{W}_t) \tag{1}$$

2.2.3 Living Status

Let $L_t \in \{0, 1\}$ be a random binary variable denoting the living status of an individual at time t. It is determined by a Bernoulli distribution with parameter p_t such that:

$$L_t \sim \mathcal{B}(p_t) \tag{2}$$

The probability parameter p_t depends on their health, age, and temperature. In a general approach, we can rewrite the first equation such as:

$$L_t \sim \mathcal{B}(p_t(\mathcal{H}_t, \mathcal{W}_t)) \tag{3}$$

As such, the probability of an individual to be alive at period t is:

$$Pr(L_t = 1|\mathcal{H}_t, \mathcal{W}_t) = \prod_{j=1}^{t} p_j(\mathcal{H}_j, \mathcal{W}_j) \tag{4}$$

2.3 Data

Three main datasets were used to estimate the mentioned relationships: the Health and Retirement Study (HRS) dataset for health status and survival, the Berkeley Earth dataset, and finally the Federal Reserve Bank of Saint Louis (FRED) dataset for other economic variables.

2.3.1 HRS Data

The HRS data

variable	mean	min	median	max
Year	2010.28	2002.00	2010.00	2018.00
Age	68.11	11.00	67.00	112.00
Health	2.95	1.00	3.00	5.00
Status	0.96	0.00	1.00	1.00
GDP	15759.15	10929.11	15048.97	20656.52
Temperature	0.55	0.40	0.52	0.73

2.3.2 Climate Data

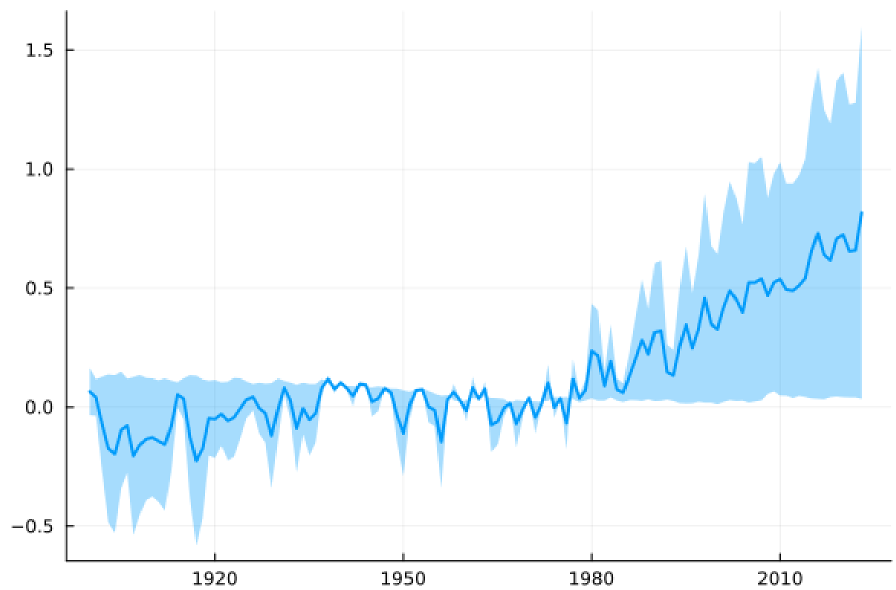

Figure 1: Average annual temperature from the Berkeley Dataset
The light blue area is delimited by the anomalies extrema of each year, and the dark blue line represents the average of the anomalies.

2.4 Methods

2.4.1 Health Transition

The HRS dataset provides rich information regarding the health status of individuals. To make use of the five different values of the self reported health, it was therefore decided not to recode the variables into a binary health status variable $H \in \{Bad, Good\}$.

2.4.2 Living Status

The living status variable, being binary, did not represent a challenge as great as the health transition estimation.

A simple logistic regression on age and health status yields findings similar with the rest of the literature.

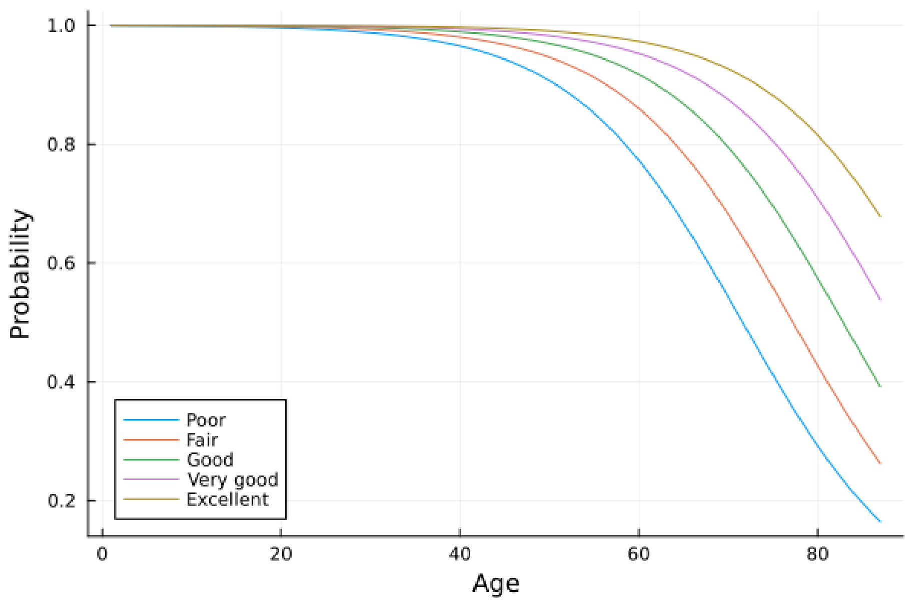

Figure 2: Annual probability of survival as a function of age and health status

2.5 Estimates

3 Model

3.1 Baseline specification

The agents maximizes:

$$\max_{c_t, l_t, s_{t+1}} \mathbb{E}\left[\sum_{t=1}^{100} \beta^t \cdot u(c_t, l_t)\right]$$

Their utility function is:

$$u(c_t, l_t) = \frac{c_t^{1-\rho}}{1-\rho} - \xi_t \cdot \frac{l_t^{1+\varphi}}{1+\varphi}$$

With :
- c the consumption
- l the quantity of labor supply provided by the agent
- h the health status
- w the weather variable, which is here temperature
- ξ the labor disutility coefficient

The agent is subject to:

$$c_t + s_{t+1} \leq l_t \cdot z_t + s_t \cdot (1 + r_t)$$

With:
- c_t the consumption at period t
- s_{t+1} the savings for period $t+1$
- l_t the labor supply provided by the agent at period t
- z_t the productivity at time t
- s_t the savings available at the beginning of period t
- r_t the interest rate at period t

Also, let us define the borrowing constraint as:

$$s_{t+1} \geq \underline{s}, \forall t$$

3.2 Numerical methods

4 Results

5 Conclusion

6 References

7 Appendix