Modelling disaster risk behaviour on the household level

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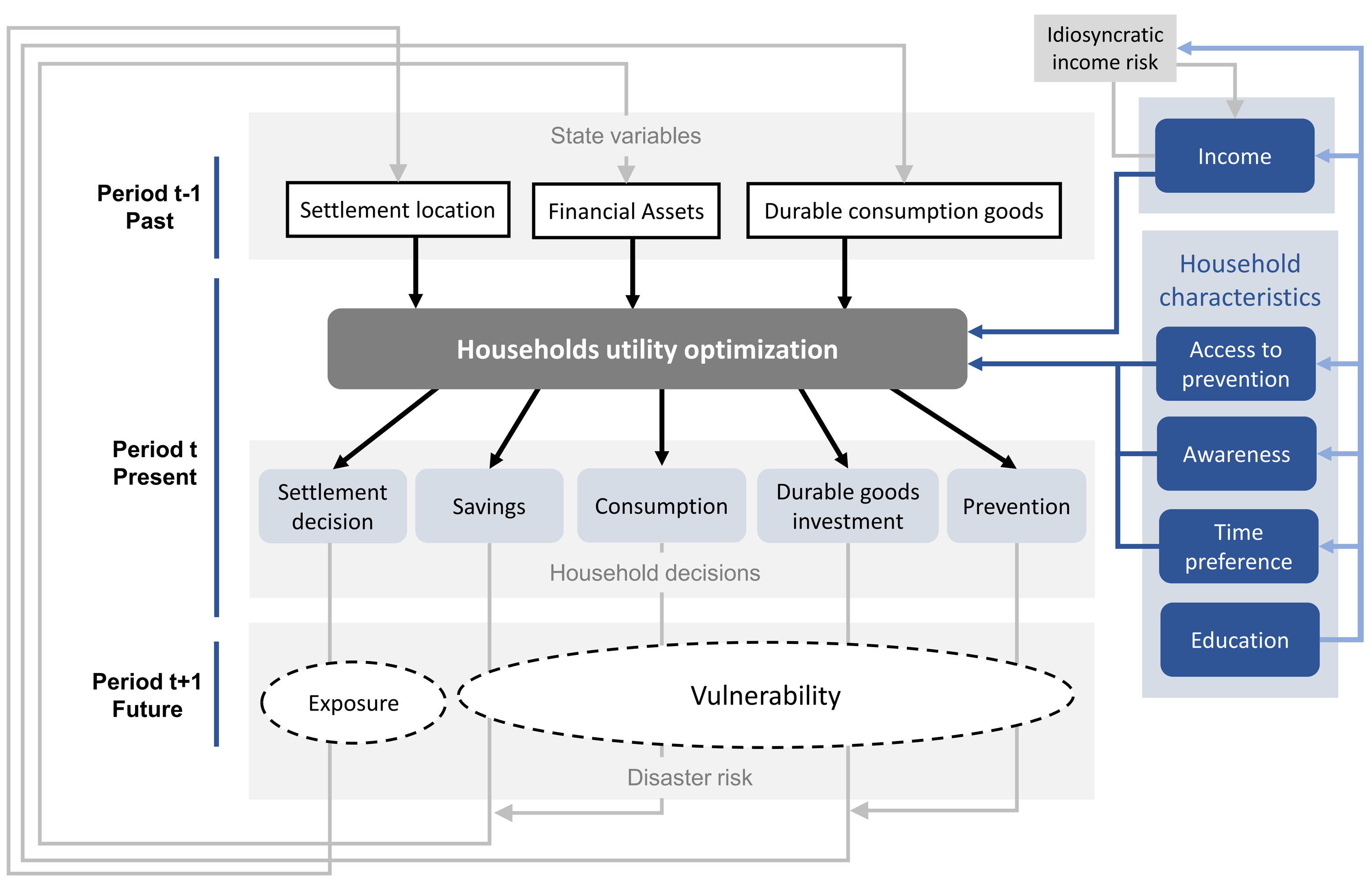
1 | Motivation

Disaster risk is a combination of **natural hazard**, **exposure**, and **vulnerability**. While the natural hazard can be seen as exogenously given on the household level, exposure and vulnerability are **highly heterogeneous**. A collection of empirical studies (see references) has investigated the impact of household characteristics (such as **education**, **awareness**, **access to prevention measures**, and **time preference**) on exposure and vulnerability to natural disasters. However, a theoretical model being able to replicate these findings is still missing in the literature. We propose such a **dynamic household model**, which consequently allows for better predictions and estimations regarding the impacts and the effectiveness of various community wide policy measures aiming to decrease disaster risk.

2 | Conceptual framework

We propose a dynamic framework with **general economic decisions** and **risk-related behaviour** resulting from households **intrinsic motivation** to maximize their utility.



3 | Mathematical formulation

Households maximizes their **expected long-run utility** with respect to the stochastic income and disaster processes ($\mathcal{Y}$ resp. $\mathcal{H}$ and $\mathcal{D}$).

$$\max_{\substack{c_t, w_t, I_t, E_{t+1}, P_{t+1},\\ t\in\{1,2,\ldots\}}} \mathbb{E}_{\mathcal{N},\mathcal{D},\mathcal{Y}}\left[\sum_{t=1}^{\infty}\left(\frac{1}{1+\rho}\right)^t u(c_t, W_{t+1})\right]$$

$$S_{t+1} = y_t\cdot(1-\Delta^y D_t) + (1+r_t)S_t - c_t - p^w(w_t) - p^P(E_{t+1}, W_{t+1}, P_{t+1}) - p^E(E_{t+1})$$

$$W_{t+1} = (1-\delta)(1-\Delta^W I_t)(1-(1-P_t)D_t)W_t + w_t$$

$$0 = (E_{t+1} - E_t)(1-I_t)$$

$$\mathcal{N}\sim\begin{cases}\mathbb{P}[N_t=1]=H_t\\ \mathbb{P}[N_t=0]=1-H_t\end{cases}, \quad \mathcal{D}\sim\begin{cases}\mathbb{P}[D_t=1]=a_{t-1}E_tH_t\\ \mathbb{P}[D_t=0]=1-a_{t-1}E_tH_t\end{cases}$$

- E_t ... Exposure of the settlement location (disaster probability)
- S_t ... Financial assets
- W_t ... Durable consumption goods (housing, appliances)
- y_t ... Working income (stochastic)
- D_t ... Disaster affectedness (stochastic)
- N_t ... Disaster occurrence (stochastic)
- c_t ... Household consumption
- P_t ... Prevention measures (i.e. protected share of W_t).
- I_t ... Relocation decision.

4 | Behavioural rules

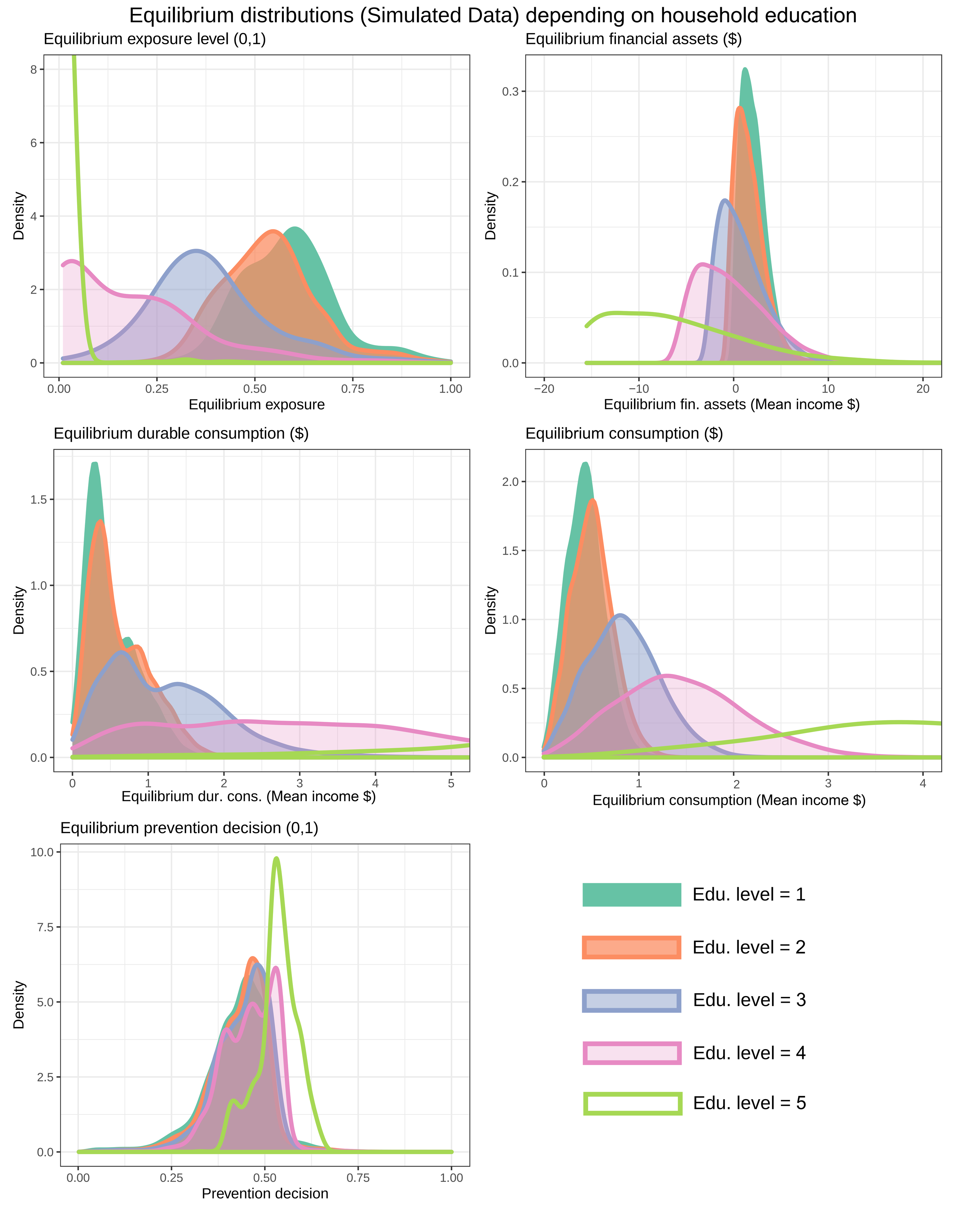
We solve the model numerically and calibrate it to data from the **Thailand-Vietnam-Socio-Economic-Panel**. The solution consists of set of rules describing the **optimal household behaviour for all potential scenarios** (i.e. combination of state variables) a household can potentially be in. An econometric analysis of these rules shows:

	Dependent variable:					
	Relocation Decision	Exposure Decision	Financial Savings	Dur. Cons. investment	Consumption	Prevention
Curr. Exp.	0.050	3.143	0.908	−0.319	0.112	0.155
Curr. Assets	−0.072	0.024	−0.122	0.087	0.113	−0.002
Curr. Dur. Cons.	−1.845	−0.508	0.161	−0.297	0.107	0.032
Curr. Income	0.252	−0.080	0.638	0.159	0.150	0.001
Dis. Exp.	1.068	−0.256	−0.484	0.263	−0.020	0.055
Edu. Class 2	0.095	0.022	−0.179	0.067	0.102	0.028
Edu. Class 3	0.595	0.127	−0.686	0.256	0.382	0.076
Edu. Class 4	1.299	0.168	−1.601	0.662	0.823	0.140
Edu. Class 5	1.835	0.595	−5.271	2.195	3.131	0.203
Mid Awareness	0.042	−0.058	0.044	−0.038	−0.026	0.253
High Awareness	0.075	−0.103	0.081	−0.074	−0.048	0.503
Mid Prev. Access	−0.496	0.063	−0.026	0.008	0.016	0.504
High Prev. Access	−0.676	0.117	−0.044	0.017	0.031	0.751
Mid Time Disc.	0.045	0.038	−0.133	0.045	0.089	0.013
High Time Disc.	0.082	0.053	−0.188	0.066	0.119	0.030
Constant	−2.279	−1.100	−0.687	0.054	−0.186	−1.504

5 | Equilibrium Distributions

Based on the decision rules we can use Monte-Carlo-Simulations to **simulate the long-run outcomes** of households and assess the **impact of different household characteristics in equilibrium**.

Equilibrium distributions (Simulated Data) depending on household education



References

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