

What contributes to a successful rehabilitation: A DAG analysis

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Purpose

- The aim of the study is to explore the factors that contribute to the rehabilitation of patients with acquired brain injury (ABI).
- Which factors are important to health recovery;
 - Demographic (gender and age)
 - Socio-economic (income, education and employment status)
 - Social support (family, siblings, social care)
 - Family environment (support, togetherness and quality of relationships)

Motivation

- Application of Bayesian Networks and Directed Acyclic Graphs (DAGs)
- Causal inference has a central role in public health
- The determination that an association is causal indicates the possibility for intervention and thus for policy making
- Causation can have profound public health consequences;
 - Giving the signal to reduce or avoid hazardous events and increasing exposure to the beneficial ones
 - Practitioners decide on interventions on the basis of consequences produced by presumed causal relationships
 - Causal inference is embedded in regulatory processes and medical practises

Previous Research

- Various studies explored the determinants of health outcomes.
 - ❑ Factors explored:
 - ❑ Body Mass Index (BMI) has negative effects
 - ❑ Income
 - ❑ Education
 - ❑ Age
 - ❑ Employment status
 - ❑ Lifestyle (e.g. smoking, alcohol consumption)
 - This study explores additional factors related to social support and family environment

Basics of Bayesian Networks (BNs)

- A Bayesian network is a graphical model for probabilistic relationships among a set of variables
- The graphical-models approach to causal inference was mainly applied in computer science and developed by:
 - Spirtes, Glymour, Scheines (2000), *Causation, Prediction, and Search*, 2nd edition.
 - Pearl (2000), *Causality: Models, Reasoning, and Inference*.

Basics of Bayesian Networks (BNs)

- Overall
 - ❑ BNs are graphical models, capable of displaying relationships clearly and intuitively, which would otherwise be impossible or very difficult to do with the single equation econometric modelling.
 - ❑ They are directional, thus being capable of representing cause-effect relationships.
 - ❑ They can handle uncertainty, based on probability relationships.
 - ❑ They can be used to represent indirect causation in addition to direct.

Basics of Bayesian Networks (BNs)

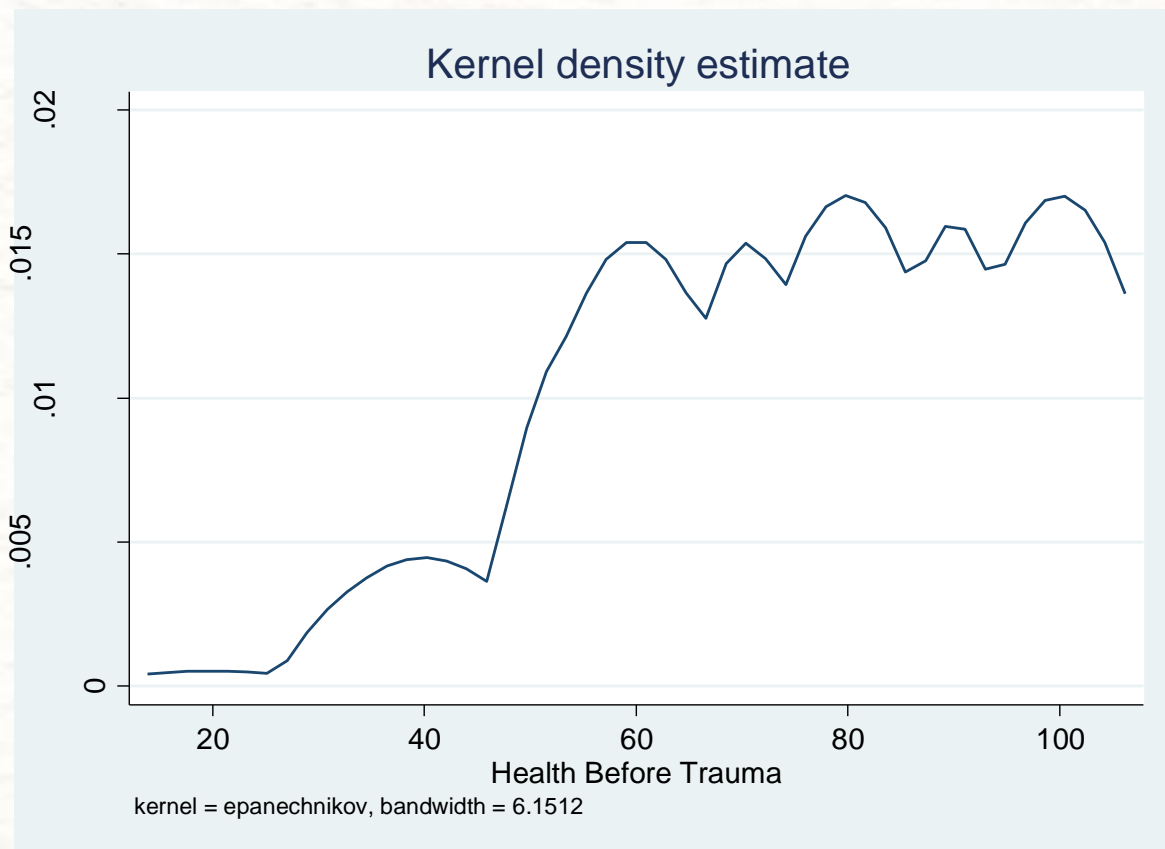
- DAGs are visual representations of causal assumptions
- Their two main uses are the determination of the identifiability of causal effects from observed data and the derivation of testable implications of a causal model.

Data

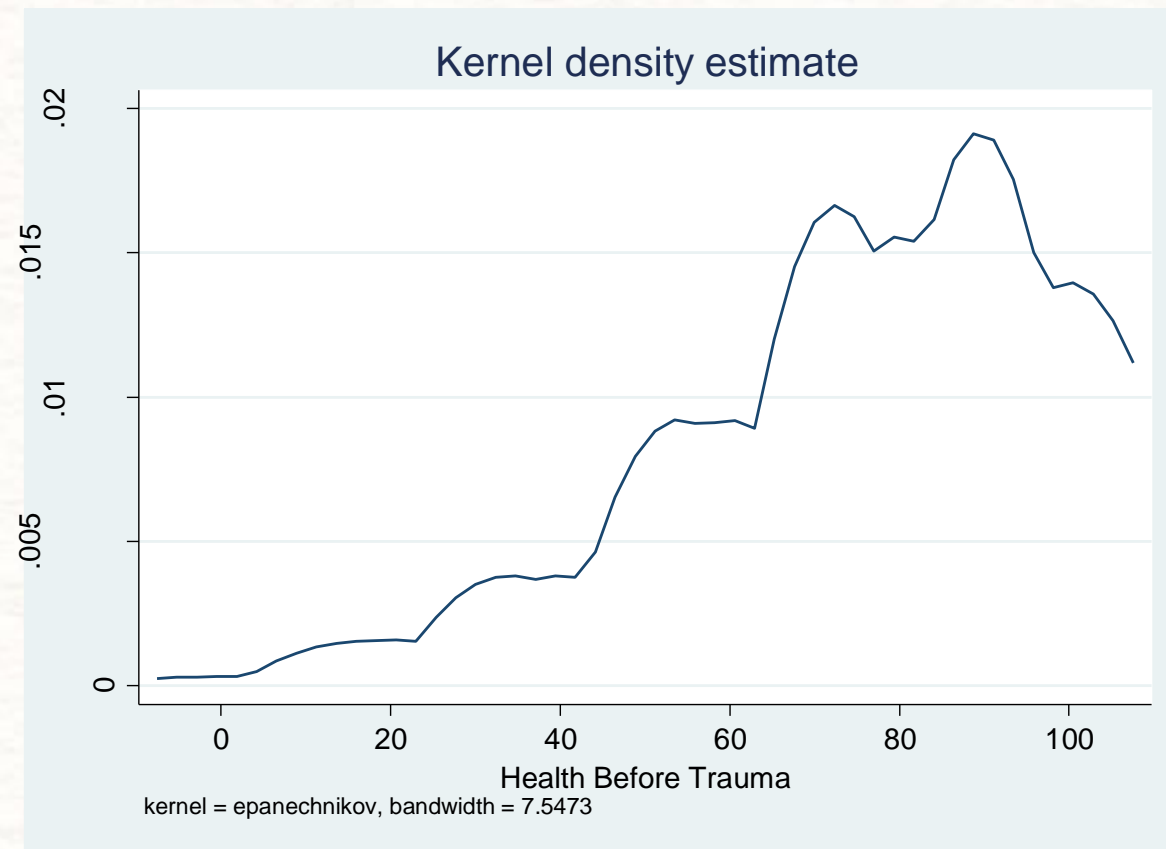
- The data have been collected from surveys taken place in the main hospitals in the provinces of Verona and Florence in Italy.
- The individual questionnaire was administered to the person with ABI when it was possible and only individuals who were above 18 years old were included in the sample.
- Two main health outcomes are examined; the EQ-VAS and the EQ-5D

Health Before Injury

Traumatic

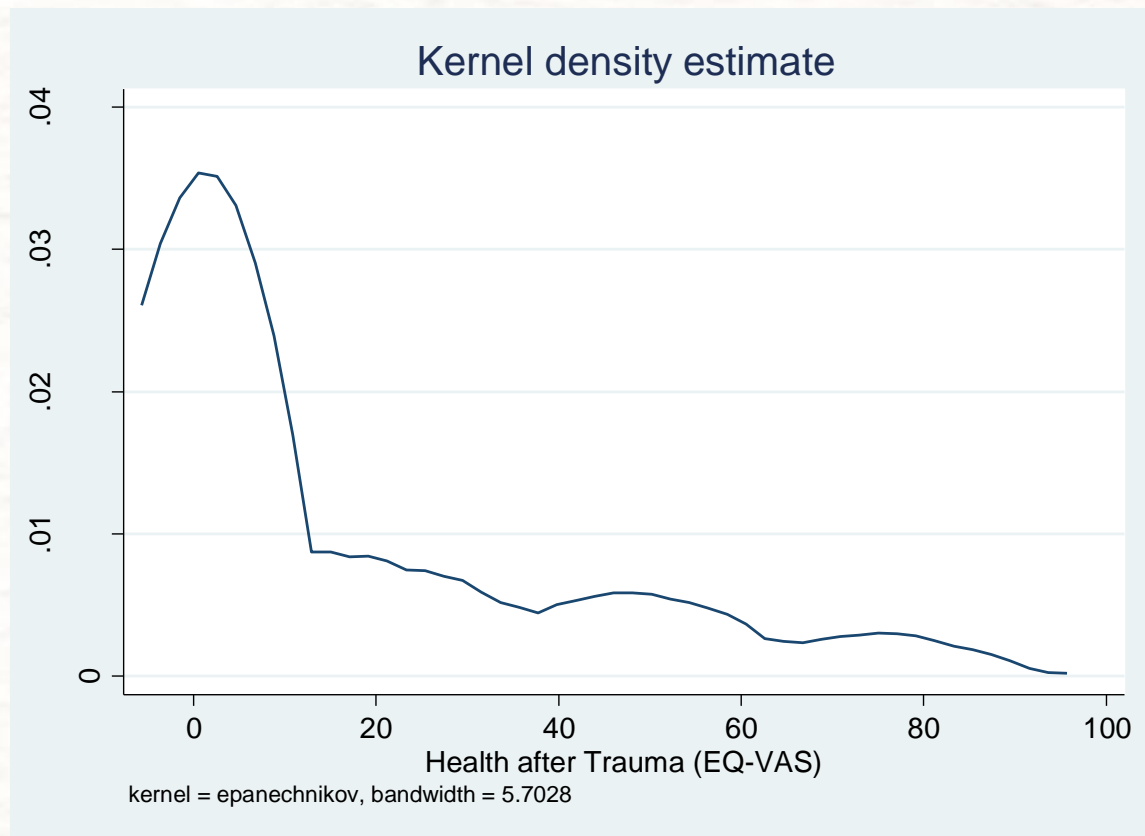


Vascular

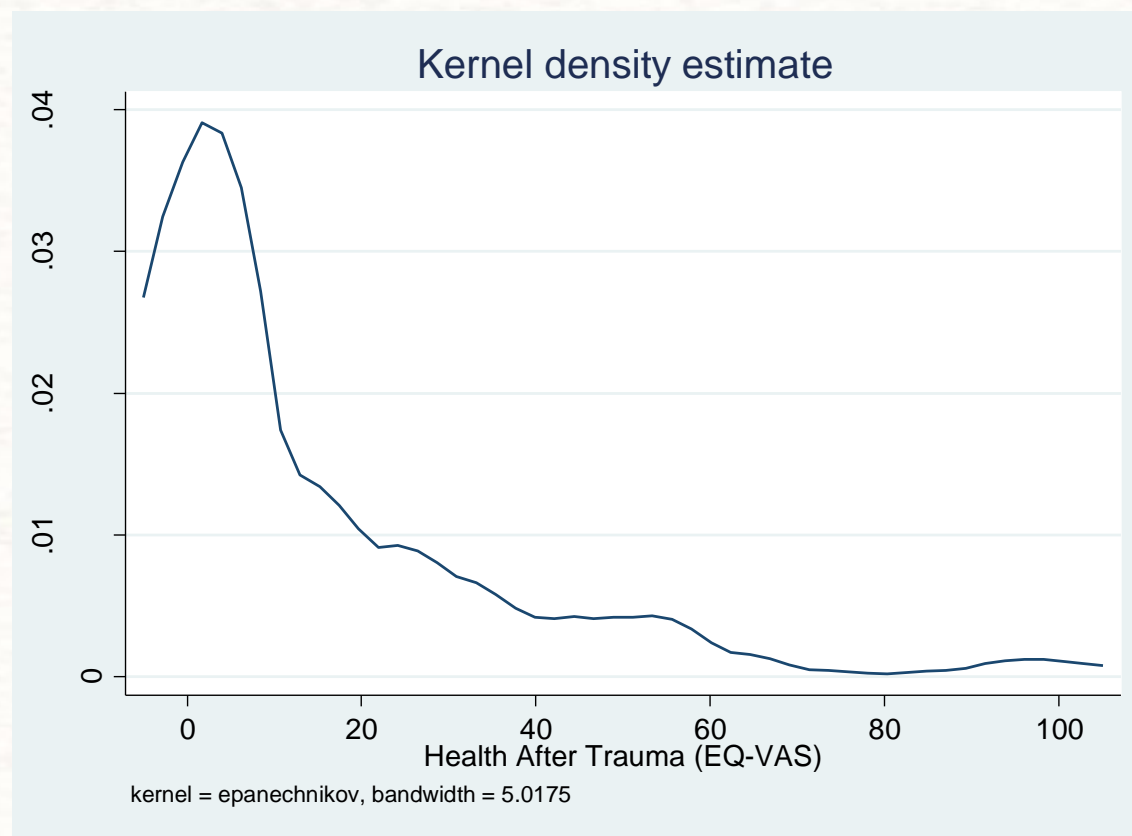


Health After Injury

Traumatic

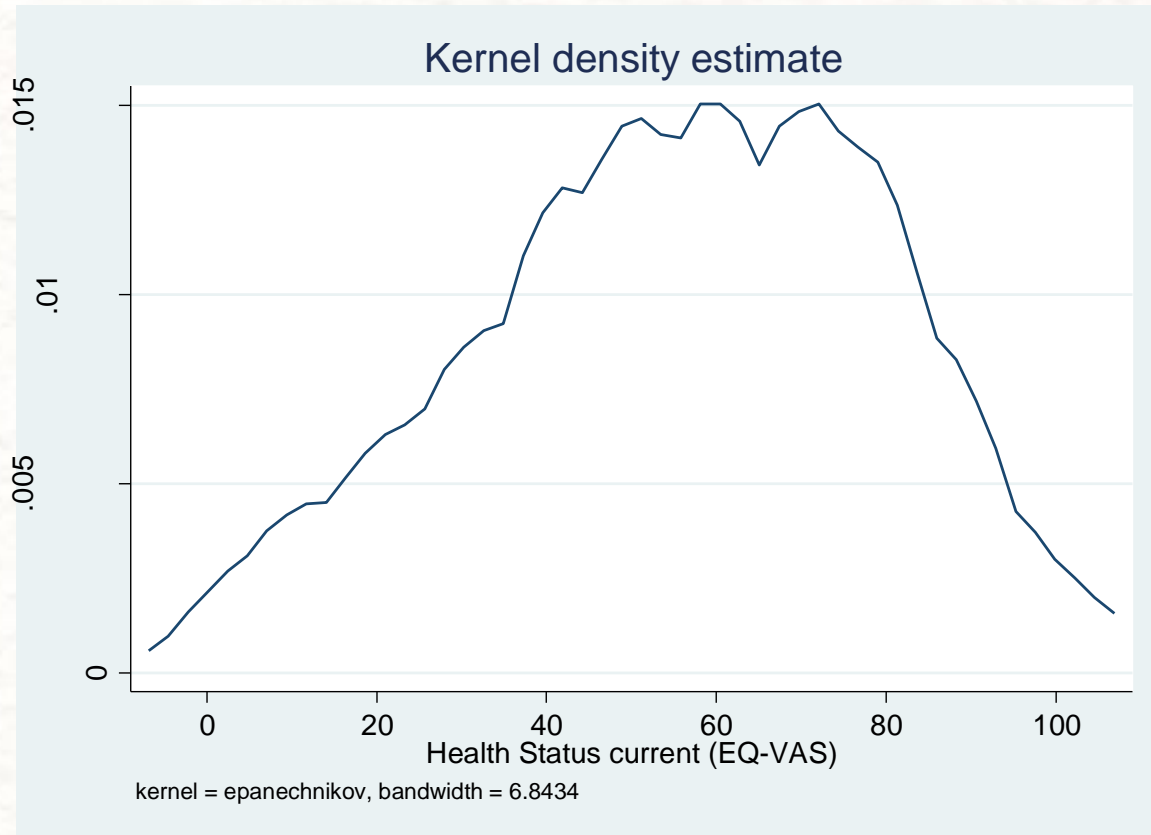


Vascular

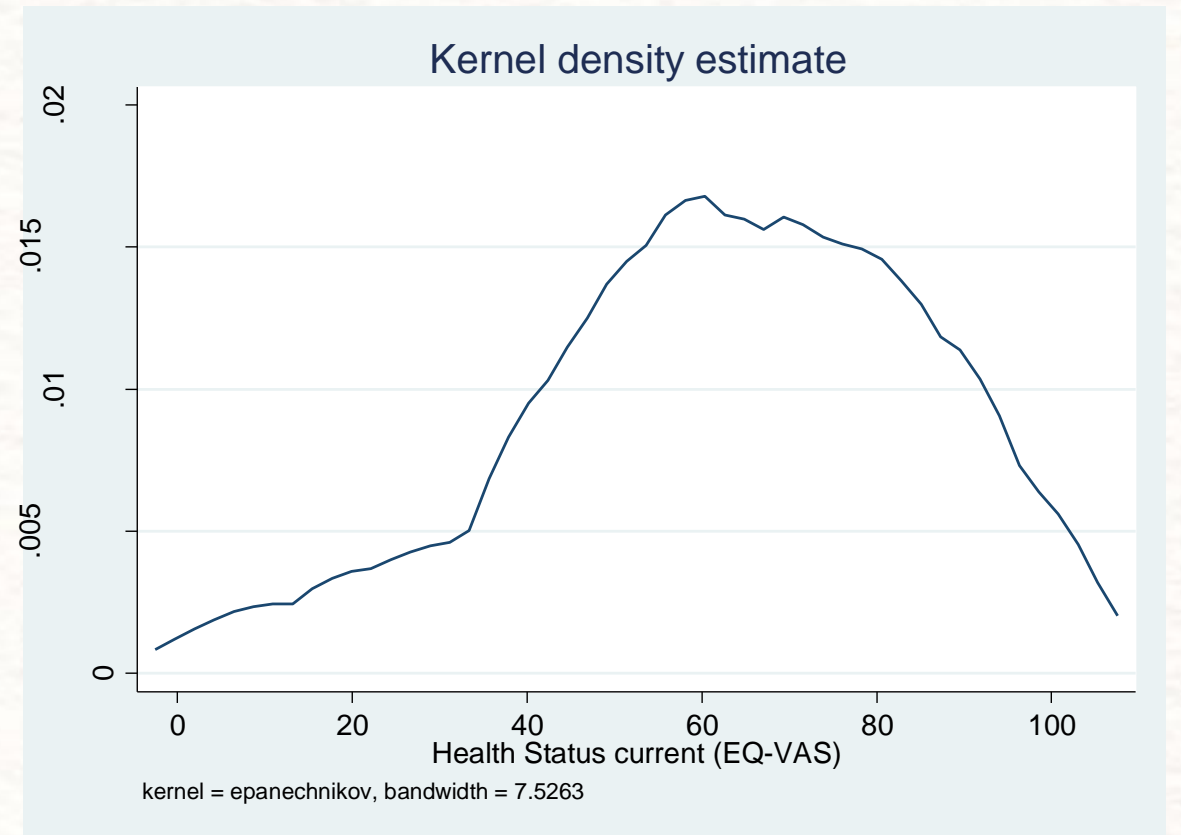


Health at the Time of Interview

Traumatic

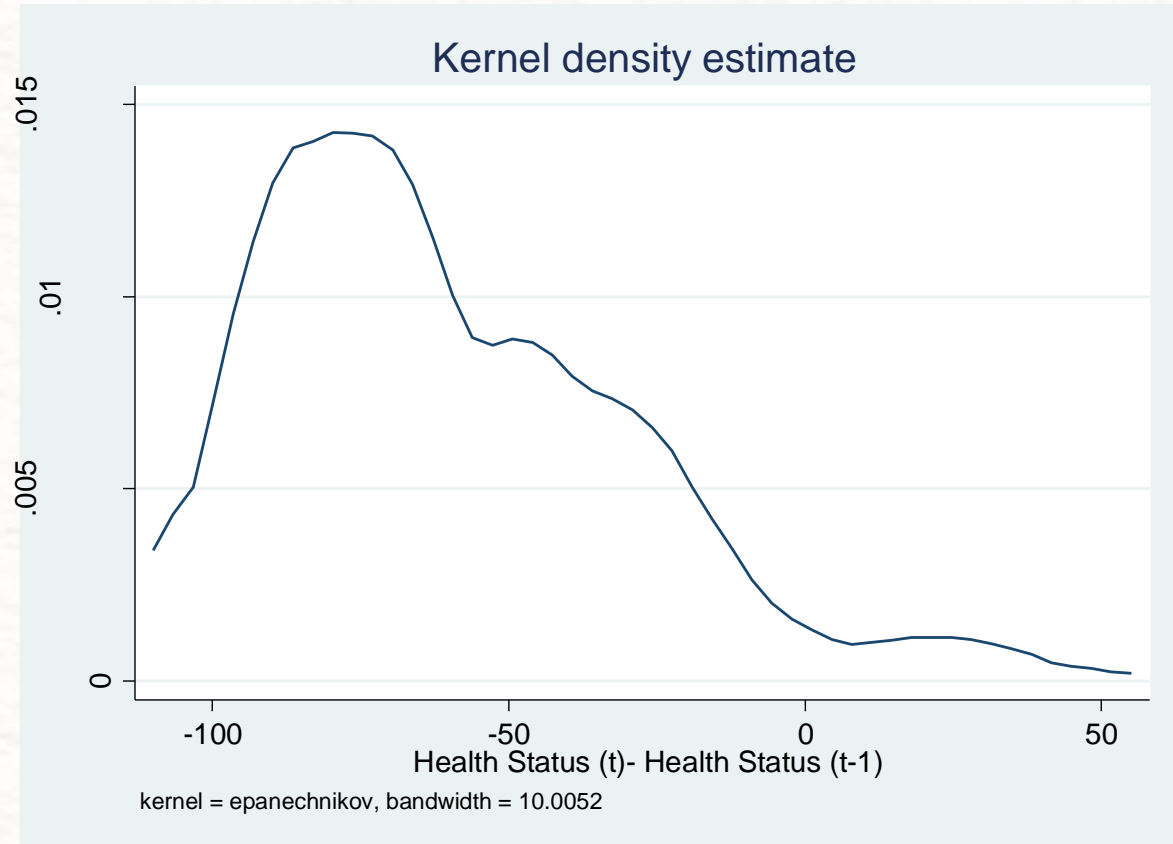


Vascular

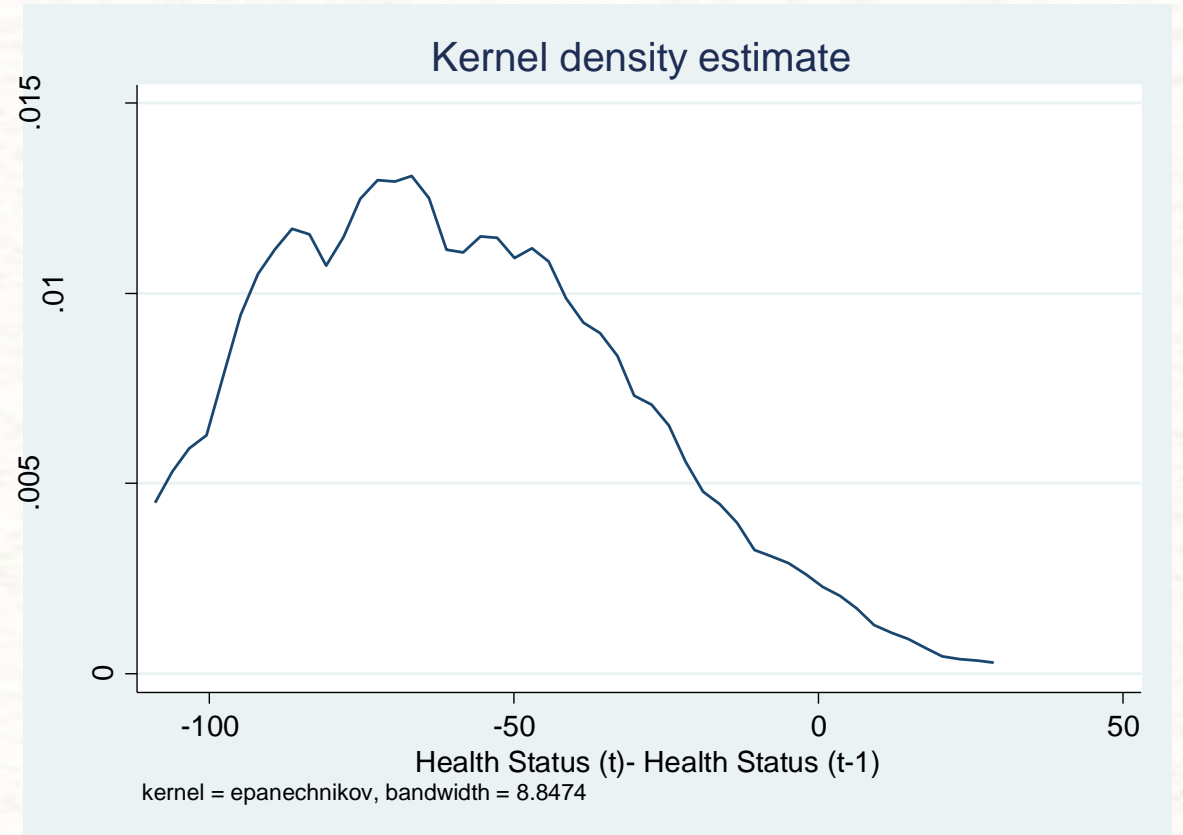


Transition from health before trauma to health after trauma

Traumatic



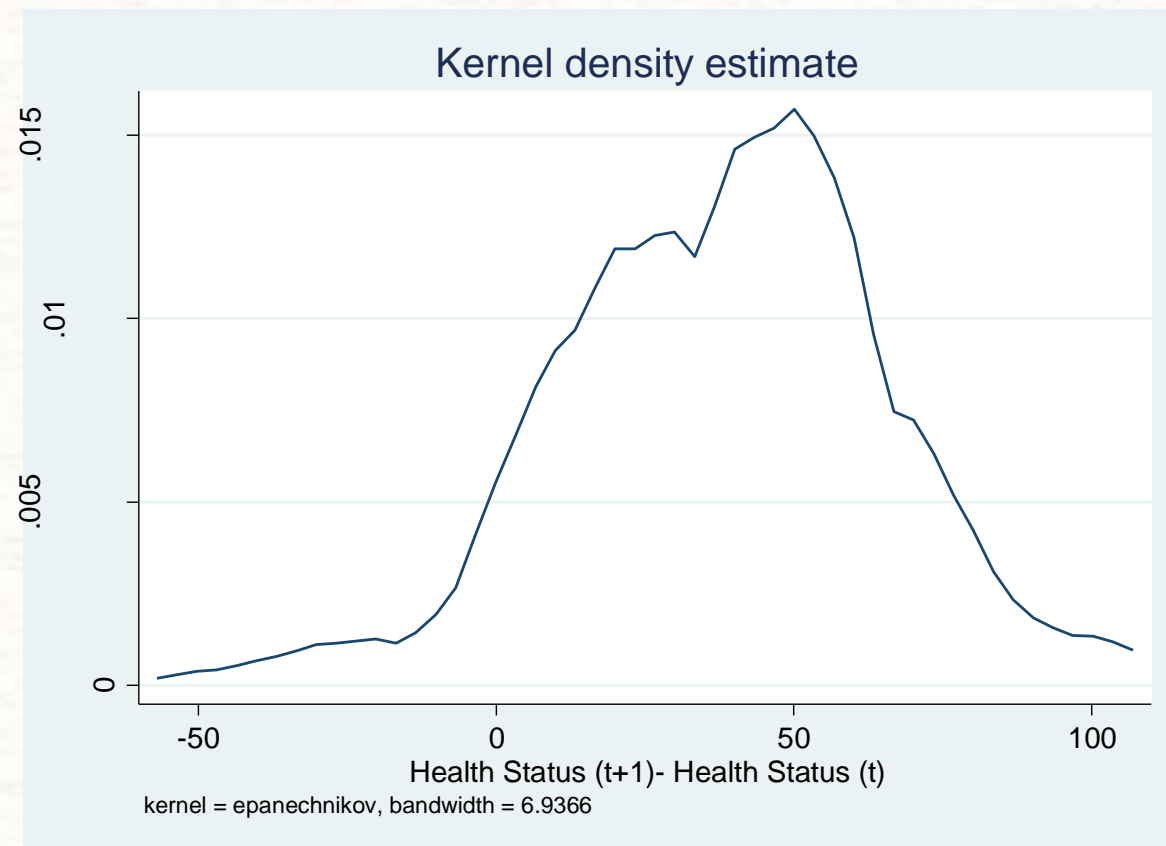
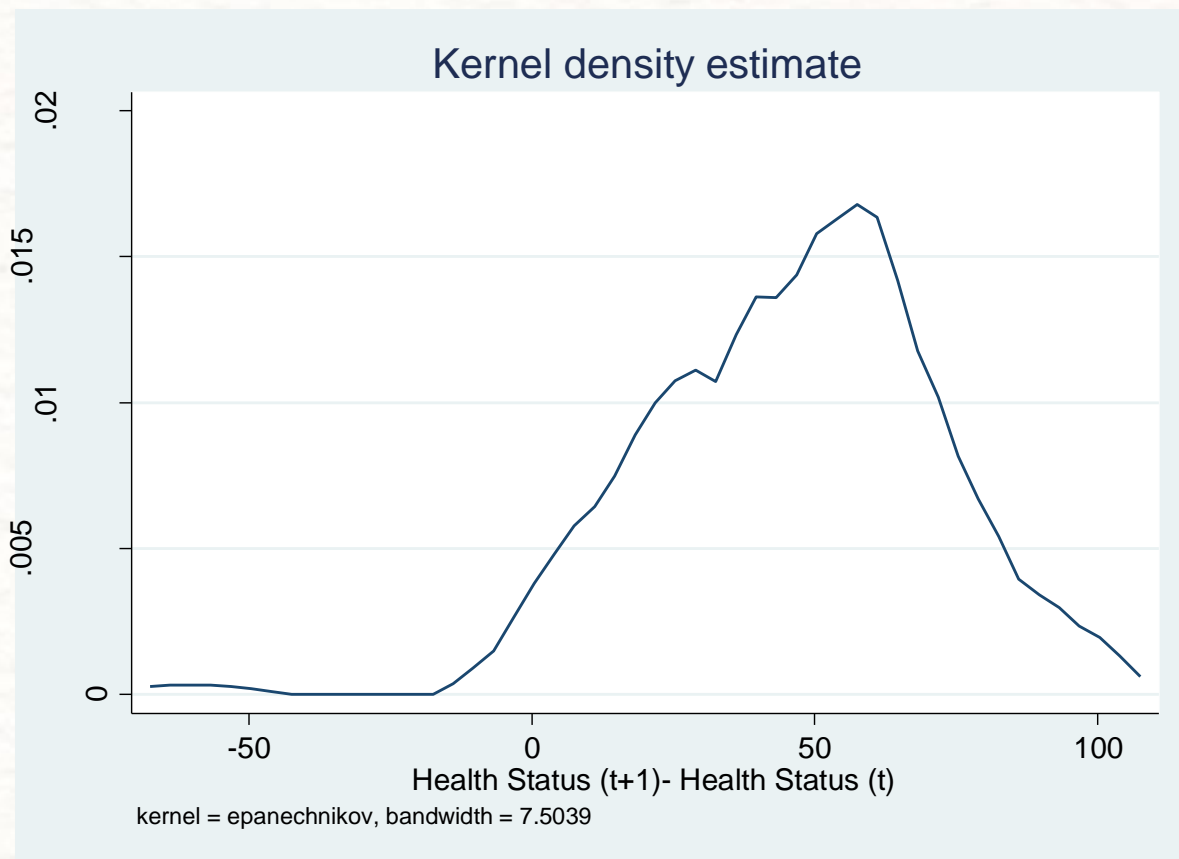
Vascular



Transition from health after trauma to current health

Traumatic

Vascular



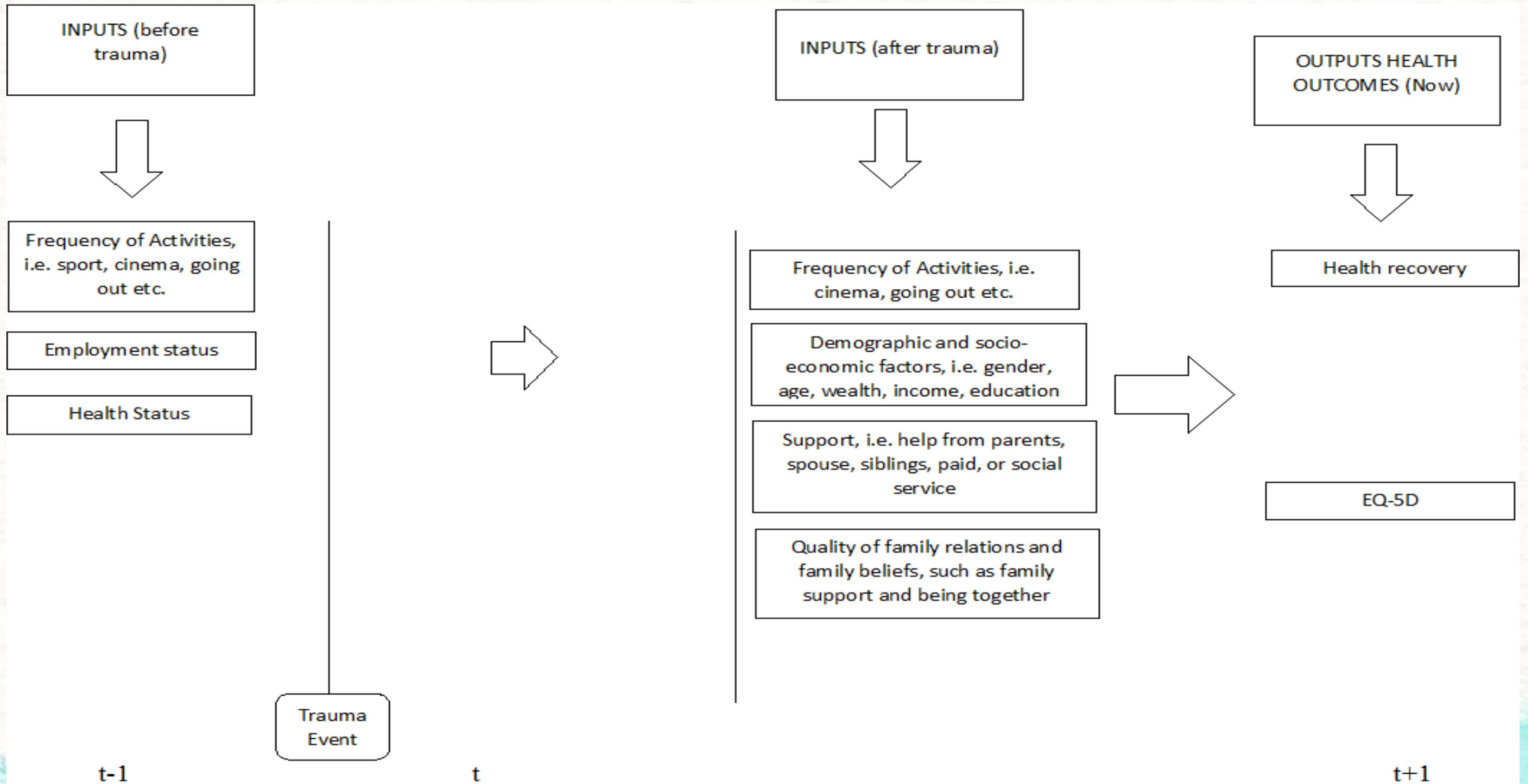
Utility

- Utility function
- $U=U(X,Q,L;Z)$
- U depends on the quality of health outcomes
- X the consumption of food expenditures
- Q quality of health outcomes
- L denotes the leisure
- Z includes observable individual and household characteristics (e.g. gender, age, employment status)
- The utility is conditioning on the health status after the trauma H_e and the health stock or the health status before the trauma/injury defined as H_0 .

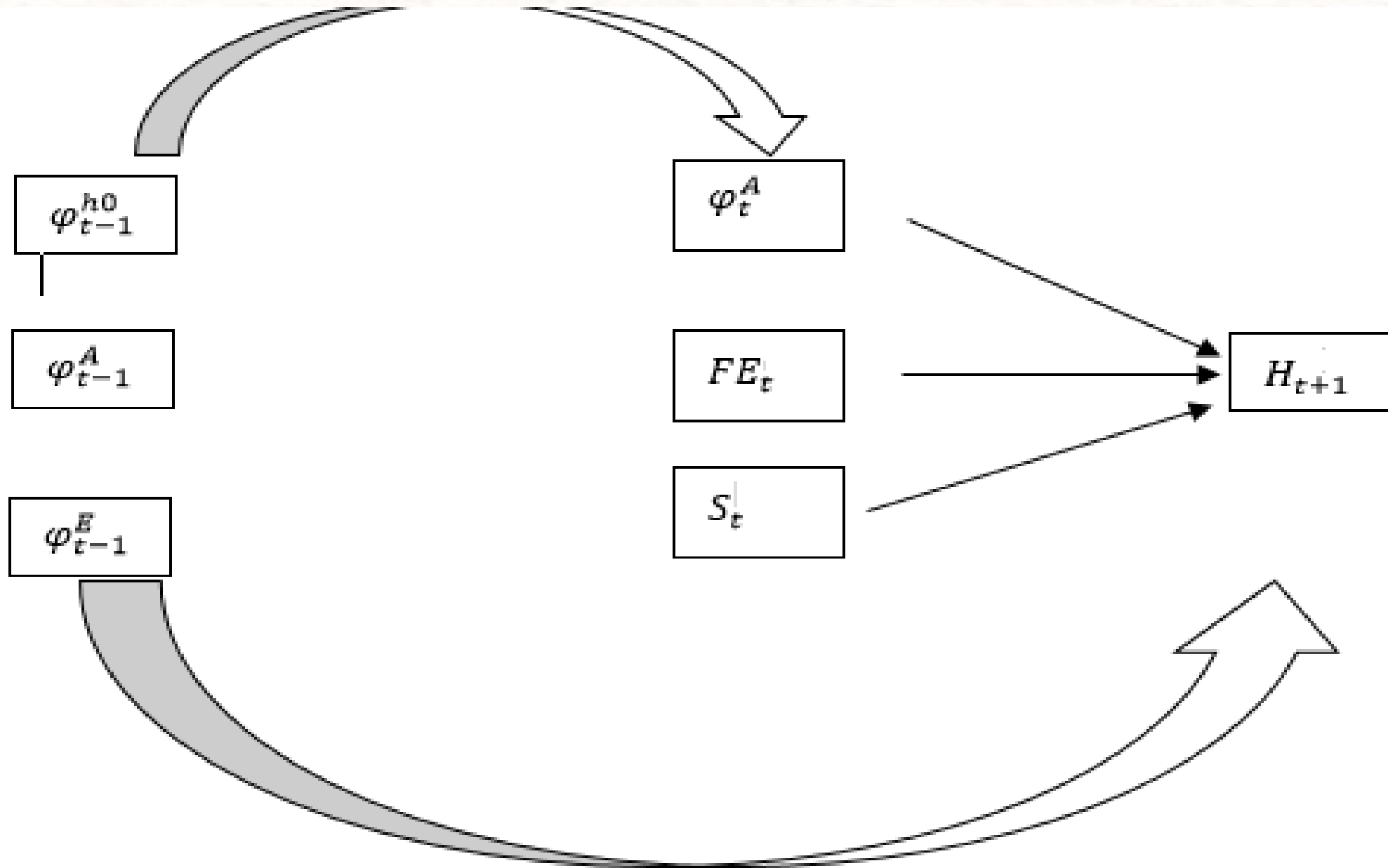
Health Production Function

- Then it is assumed the household's human capital production function for health status to be:
- $H=f(A, H_0, FE,S;Z,\delta)$
- A is the quality of leisure before and after the injury
- H_0 is the health status before the injury
- FE refers to the family environment (quality of family relations, the degree of family support, and the family togetherness)
- S denotes the support, such as receiving help from family, spouse, family members and social services
- δ denotes unobservable heterogeneity
- A, H_0, FE and S are positive "goods", where a marginal increase in any one of them indirectly increase the household utility through the improvement on health

The basic schematic of the health rehabilitation process



DAG Graph



$$\phi_{t-1}^{h0}, \phi_{t-1}^A, \phi_{t-1}^E$$

Denote respectively the health status, the quality of leisure and employment status in period $t-1$ before the trauma

$$\phi_t^A, FE_t, S_t$$

Are respectively the quality of leisure, the quality of family environment and the social support after trauma, employment status in period t after the trauma

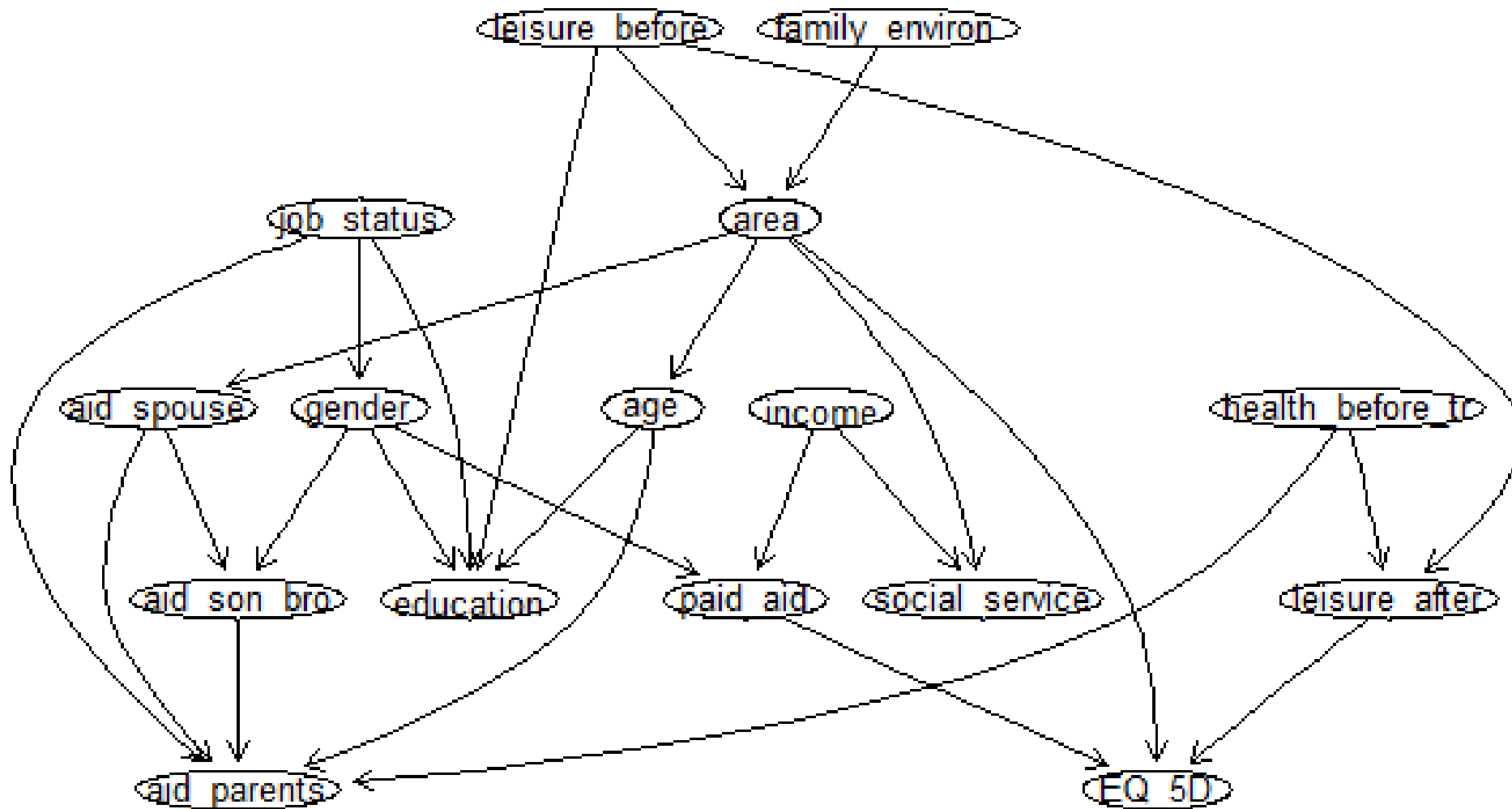
OLS Estimates

VARIABLES	(1) EQ-5D	(2) EQ-VAS	(3) Health Recovery
Health Before Trauma (Good)	0.00254** (0.00107)	0.106* (0.057)	0.0544* (0.0274)
Quality of Leisure Before Trauma (High)	0.00947** (0.00418)	0.482** (0.202)	0.168 (0.265)
Quality of Leisure After Trauma (High)	0.0249*** (0.00322)	1.028*** (0.166)	0.708*** (0.196)
Employment (Employed)			
Employment (Retired)	-0.1248** (0.0572)	-2.973 (1.786)	-4.956* (2.527)
Employment (Student)	0.0718 (0.0617)	7.8061* (4.218)	7.220 (6.212)
Employment (Housewife)	-0.0423 (0.1334)	6.4173 (10.901)	4.185 (15.730)
Log of Equivalent Household Income	-0.0403 (0.0382)	2.627 (1.853)	0.520 (2.516)
Gender(Male)	0.0682 (0.0453)	1.584 (2.276)	-0.326 (3.115)
Age	-0.00279* (0.00146)	-0.0789 (0.0797)	0.0392 (0.103)
Education (High)	0.0388 (0.0613)	4.057 (3.662)	9.253* (4.858)
Quality of Family Environment (High)	0.0325* (0.0185)	3.792*** (1.031)	3.074** (1.315)
Aid from parents	0.0772 (0.0715)	11.29** (4.442)	7.679* (3.959)
Aid from Spouse	0.0820 (0.0686)	6.591* (3.907)	7.115* (3.570)
Aid from Siblings-Children	0.0264 (0.0748)	5.783 (4.086)	-3.439 (5.294)
Paid Aid	-0.1766*** (0.0526)	-9.456*** (2.566)	-6.554* (3.362)
Aid from Social Service	-0.0553 (0.0747)	5.7886* (3.470)	1.5429 (4.765)
Area (Florence)	0.181*** (0.0517)	9.253*** (2.608)	-11.48*** (3.554)
R-squared	0.271	0.242	0.141

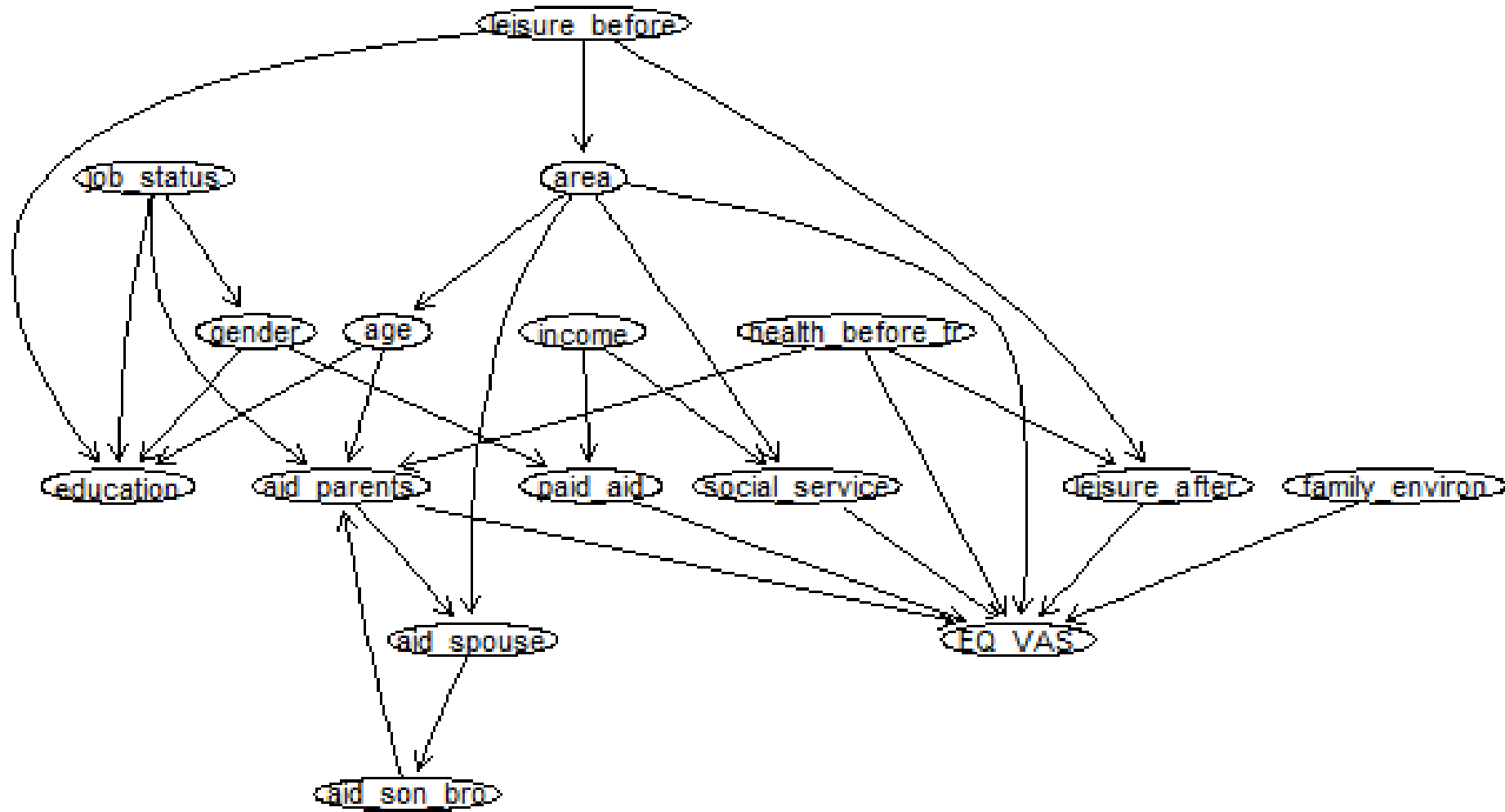
Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

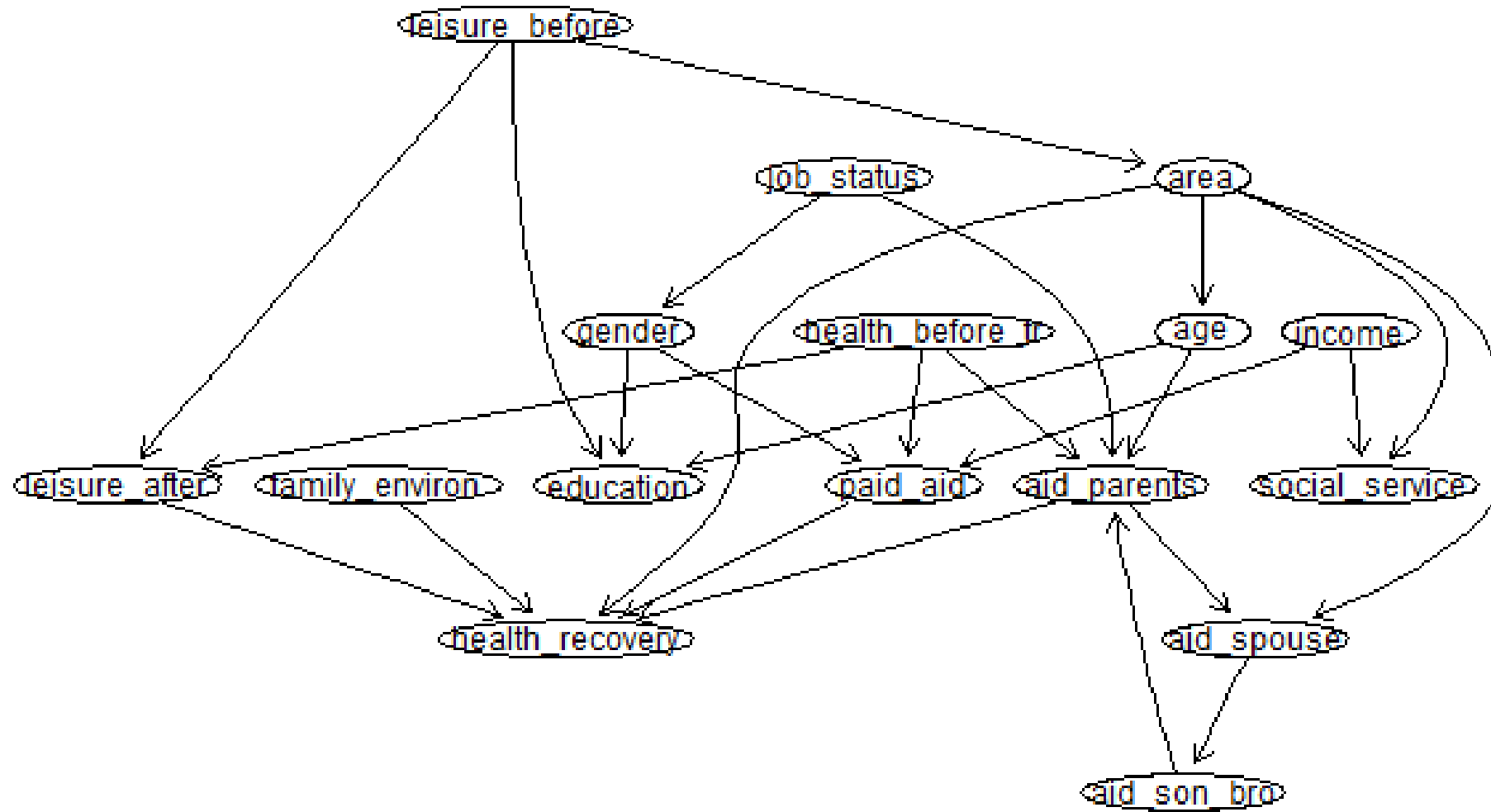
DAG for EQ-5D



DAG for EQ-VAS



DAG for Health Recovery



Conclusions

- Income, education and gender are insignificant
- Age is significant only in the case of EQ-5D
- On the contrary the results suggest that the most important factors are:
 - Health before the brain injury
 - Quality of leisure activities before and after the injury
 - The quality of family environment
 - The support from family members