

Example 2 (Health insurance)

Source: van de Ven, W. P. M. M., Health as an unobservable, in: Journal of Health Economics 1, 1982, 157-83

The model

Unobservable predisposing factor

$$(1) \text{ PH}^* = a_{1,1} + a_{1,2} \text{ PINC}^* + a_{1,3} \text{ FS} + a_{1,4} \text{ UNEMPL} + a_{1,5} \text{ AGE} + a_{1,6} \text{ EDUC} + u_1$$

Permanent family income

$$(2) \text{ PINC}^* = a_{2,1} + a_{2,2} \text{ PH}^* + a_{2,3} \text{ FS} + a_{2,4} \text{ AGE} + a_{2,5} \text{ EDUC} + a_{2,6} \text{ EMPL} + a_{2,7} \text{ INCRS} \\ + a_{2,8} \text{ EARN} + u_2$$

Family-income after taxes

$$(3) \text{ FINC} = a_{3,1} \text{ PINC}^* + u_3$$

$$(4) \text{ INS2} = a_{4,1} + a_{4,2} \text{ FINC} + a_{4,3} \text{ AGE} + a_{4,4} \text{ EDUC} + u_4$$

Number of days being ill

$$(5) \text{ ILL} = a_{5,1} + a_{5,2} \text{ PH}^* + u_5$$

Money value of non-prescribed self-medication during six months

$$(6) \text{ SELF} = a_{6,1} + a_{6,2} \text{ FINC} + a_{6,3} \text{ ILL} + a_{6,4} \text{ FS} + a_{6,5} \text{ UNEMPL} + a_{6,6} \text{ AGE} + a_{6,7} \text{ EDUC} \\ + a_{6,8} \text{ TIME} + u_6$$

Number of general practitioner consultations during six months

$$(7) \text{ GPCON} = a_{7,1} + a_{7,2} \text{ PH}^* + a_{7,3} \text{ FINC} + a_{7,4} \text{ ILL} + a_{7,5} \text{ INSI} + a_{7,6} \text{ TIME} + a_{7,7} \text{ DIST} \\ + a_{7,8} \text{ FULLT} + u_7$$

Money value of medicine prescribed by the GP during six months

$$(8) \text{ GPMED} = a_{8,1} + a_{8,2} \text{ PH}^* + a_{8,3} \text{ FINC} + a_{8,4} \text{ ILL} + a_{8,5} \text{ GPCON} + a_{8,6} \text{ INSI} \\ + a_{8,7} \text{ TIME} + u_8$$

Number of specialist consultations during six months

$$(9) \text{ SPCON} = a_{9,1} + a_{9,2} \text{ PH}^* + a_{9,3} \text{ ILL} + a_{9,4} \text{ GPCON} + a_{9,5} \text{ DIST} + a_{9,6} \text{ SPEC} + u_9$$

Money value of medicine prescribed by a specialist during six months

$$(10) \text{ SPMED} = a_{10,1} + a_{10,2} \text{ PH}^* + a_{10,3} \text{ FINC} + a_{10,4} \text{ ILL} + a_{10,5} \text{ SPCON} + a_{10,6} \text{ INSI} + u_{10}$$

Number of days spent in general or university hospital during one year

$$(11) \text{ HOSP} = a_{11,1} + a_{11,2} \text{ PH}^* + a_{11,3} \text{ INS2} + a_{11,4} \text{ ILL} + a_{11,5} \text{ SPCON} + a_{11,6} \text{ DIST} \\ + a_{11,7} \text{ BED} + u_{11}$$

A re-writing of the model

- (1) $h_1 = a_1 h_2 + b_{1,1} x_1 + b_{1,2} x_2 + b_{1,3} x_3 + b_{1,4} x_4 + c_1 + u_1$
- (2) $h_2 = a_2 h_1 + b_{2,1} x_1 + b_{2,2} x_2 + b_{2,3} x_3 + b_{2,4} x_{11} + b_{2,5} x_{12} + b_{2,6} x_{13} + c_2 + u_2$
- (3) $h_3 = a_3 h_2 + u_3$
- (4) $h_4 = a_4 h_3 + b_{4,1} x_3 + b_{4,2} x_4 + c_4 + u_4$
- (5) $h_5 = a_5 h_1 + u_5$
- (6) $h_6 = a_6 h_3 + a_{6,2} h_5 + b_{6,1} x_1 + b_{6,2} x_2 + b_{6,3} x_3 + b_{6,4} x_4 + b_{6,5} x_6 + c_6 + u_6$
- (7) $h_7 = a_7 h_1 + a_{7,1} h_3 + a_{7,2} h_5 + b_{7,1} x_5 + b_{7,2} x_6 + b_{7,3} x_7 + b_{7,4} x_8 + c_7 + u_7$
- (8) $h_8 = a_{8,1} h_1 + a_{8,2} h_3 + a_{8,3} h_5 + a_{8,4} h_7 + b_{8,1} x_5 + b_{8,2} x_6 + c_8 + u_8$
- (9) $h_9 = a_{9,1} h_1 + a_{9,2} h_5 + a_{9,3} h_7 + b_{9,1} x_7 + b_{9,2} x_9 + c_9 + u_9$
- (10) $h_{10} = a_{10,1} h_1 + a_{10,2} h_3 + a_{10,3} h_5 + a_{10,4} h_9 + b_{10,1} x_5 + c_{10} + u_{10}$
- (11) $h_{11} = a_{11,1} h_1 + a_{11,2} h_4 + a_{11,3} h_5 + a_{11,4} h_9 + b_{11,1} x_7 + b_{11,2} x_{10} + c_{11} + u_{11}$

The parameter matrices B and C of $Bh = Cx + u$, $B \in \mathbb{R}^{11,11}$, $C \in \mathbb{R}^{11,14}$, $h \in \mathbb{R}^{11}$, $x \in \mathbb{R}^{14}$, $u \in \mathbb{R}^{11}$

$$B = \begin{bmatrix} 1 & -a_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -a_2 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -a_4 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -a_5 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -a_{6,1} & 0 & -a_{6,2} & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & -a_{7,1} & 0 & -a_{7,2} & 0 & 1 & 0 & 0 & 0 & 0 \\ -a_{8,1} & 0 & -a_{8,2} & 0 & -a_{8,3} & 0 & -a_{8,4} & 1 & 0 & 0 & 0 \\ -a_{9,1} & 0 & 0 & 0 & -a_{9,2} & 0 & -a_{9,3} & 0 & 1 & 0 & 0 \\ -a_{10,1} & 0 & -a_{10,2} & 0 & -a_{10,3} & 0 & 0 & 0 & -a_{10,4} & 1 & 0 \\ -a_{11,1} & 0 & 0 & -a_{11,2} & -a_{11,3} & 0 & 0 & 0 & -a_{11,4} & 0 & 1 \end{bmatrix}$$

$$C = \begin{bmatrix} b_{1,1} & b_{1,2} & b_{1,3} & b_{1,4} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & c_1 \\ b_{2,1} & 0 & b_{2,2} & b_{2,3} & 0 & 0 & 0 & 0 & 0 & 0 & b_{2,4} & b_{2,5} & b_{2,6} & c_2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{4,1} & b_{4,2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & c_4 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{6,1} & b_{6,2} & b_{6,3} & b_{6,4} & 0 & b_{6,5} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & c_6 \\ 0 & 0 & 0 & 0 & b_{7,1} & b_{7,2} & b_{7,3} & b_{7,4} & 0 & 0 & 0 & 0 & 0 & c_7 \\ 0 & 0 & 0 & 0 & b_{8,1} & b_{8,2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & c_8 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{9,1} & 0 & b_{9,2} & 0 & 0 & 0 & 0 & c_9 \\ 0 & 0 & 0 & 0 & b_{10,1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & c_{10} \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{11,1} & 0 & 0 & b_{11,2} & 0 & 0 & 0 & c_{11} \end{bmatrix}$$

List of variables

Predisposing variables

AGE	Age of the family head (in years)
EDUC	Number of years of education of family head
FS	Family size (log)
PH	Permanent health, unobservable predisposing factor
PINC	Permanent family income (log)
SEX	Dummy variable (1 if female, 0 if male)
UNEMPL	Percentage of unemployment in the region (here, per Province in the Netherlands)

Enabling variables

DIST	Distance to the nearest general or university hospital (in km)
FINC	Family-income after taxes (log)
FULLT	Dummy variable (1 if working in full-time paid job, 0 otherwise)
INSI	Dummy variable indicating yes/no (1/0) insurance (with a coinsurance rate of 0.2) for GP-visits and prescribed medicine
TIME	Total time needed for a visit to the GP

Income-determining variables

AGE	Age of the family head (in years)
EARN	Dummy variable, 1 if earned income (labor) constitutes the main source of family income, 0 otherwise
EDUC	Number of years in education of family head
EMPL	Number of employed family members
INCRS	Number of different family income sources (e.g., labor, wealth, pension, Social security benefits, grant, alimention)
PH	Permanent health, s.a.

Health-services utilization

GPCON	Number of general practitioner consultations during six months
GPMED	Money value of medicine prescribed by the GP during six months
HOSP	Number of days spent in general or university hospital during one year
SELF	Money value of non-prescribed self-medication during six months
SPCON	Number of specialist consultations during six months
SPMED	Money value of medicine prescribed by a specialist during six months

Supply variables

BED	Number of beds in general or university hospitals per 1000 population in the region (123 regions around hospitals)
SPEC	Number of specialists per 1000 population in the region (15 regions)

Other variables

CONST	Constant (=1)
INS2	Dummy variable indicating complete hospital insurance for three categories of "luxury" treatment in the hospital, 2 if highest class, 1 if medium class, 0 if lowest class

Need variable

ILL	Number of days being ill (during a half year) as reported by the respondent
-----	---