Microeconomic principles of production/consumption of health. Lecture 2

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Outline

Recap on health

- Health is an asset $\Rightarrow$ Production good
- Inputs: a) medical services (curative care); and b) our own effort (preventative care)
- More health increases utility $\Rightarrow$ Consumption good
- This model was developed by Grossman (1972)
- Simplified version contains 2 time periods only

Preferences and Utility

- Utility describes level of satisfaction that consumers obtain from goods:

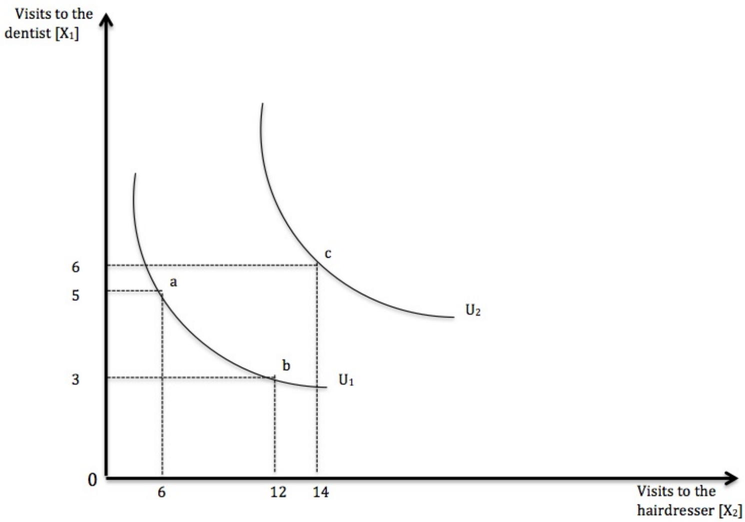
$$U = U(X_1, X_2, \ldots, X_n)$$

- Marginal Utility: additional utility from one more unit of good X:

$$MU_{X_i} = \frac{\Delta U}{\Delta X_i} \text{ OR } \frac{\partial U}{\partial X_i}$$

- Rational consumers
- Utility Maximisation as wellbeing maximisation

Indifference curves (IC)



Source: Morris et al (2012)

Properties

- Complete
- Transitive: if $a \succeq b$ and $b \succeq c$, then $a \succeq c$
- Non-satiable

IC: comparison between utilities

- Comparing different bundles:

$$\Delta U = MU_{X_i} \Delta X_i$$

- But ΔU must be the same for all bundles:

$$MU_{X_1} \Delta X_1 = MU_{X_2} \Delta X_2$$

- It follows that MRS is:

$$\frac{\Delta X_1}{\Delta X_2} = \frac{MU_{X_1}}{MU_{X_2}}$$

- From graph, from a to b individual gave up 2 visits to doctors to gain 6 visits to the hairdresser
- MU(visits to dentist)=3*MU(visit to hairdresser) as $MRS = \frac{2}{6}$
- Diminishing Marginal Utility of consumption from convexity of IC

Application: Patients' choice of hospital in NHS

- Department of Health (DH) experiment in 2002 giving patients choice of National Health Service (NHS) hospital for surgical procedure
- Selected sample: patients who had been waiting 6+ months for elective treatment
- Discrete Choice Experiment (DCE): with bundle of choices with different characteristics (RUM)
- Every additional hour of travel time=2 months reduction in waiting time
- Choices depended on patients' socioeconomic and demographic characteristics

Budget constraint and maximisation

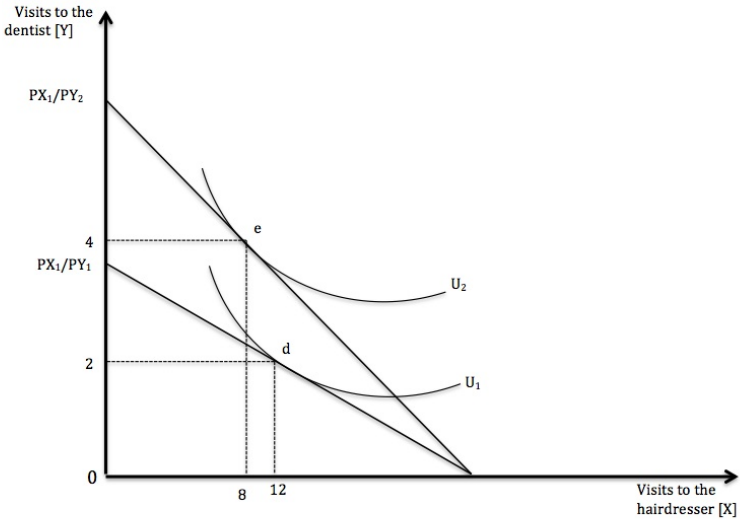
- Non-satiable IC but budget constraint (BC)
- Consumers maximise utility subject to income and prices:

$$\sum_{i=1}^{n} X_i P_i \leq I$$

- Budget line indicates bundles of goods X and Y that consumers can purchase, given constraints on income and prices P_X and P_Y
- Slope: $\frac{P_X}{P_Y}$
- Utility Maximisation s.t. BC:

$$MRS_{XY} = -\frac{dY}{dX} = \frac{MU_X}{MU_Y} = \frac{P_X}{P_Y}$$

Max. U s.t. BC



Source: Morris et al (2012)

Common criticisms

- Self-interest, rationality and utility maximisation usually criticised as over simplistic especially by other researchers in the health care sector
- But "caring" and addiction can be included in U
- Health and health care specific characteristics: a) uncertainty and b) asymmetric information

Application: Rational addiction and price elasticity of demand

- Becker and Murphy (1988): addicted people maximise utility consistently over time
- U depends on addictive and non-addictive goods:

$$U(t) = U[Y(t), X(t), S(t)]$$

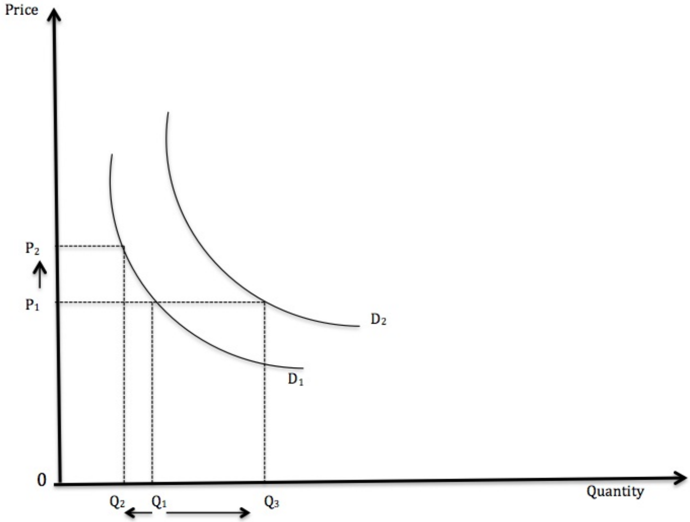
- Addiction: increase in X at t, increases X at (t+1)
- Price elasticity of demand lower in SR than in the LR.

Determinants of demand (i)

Demand curve describes relation between prices and quantity

- Price: if P decreases Q rises $\Rightarrow$ Law of demand
- Are prices of medical treatments different?
- "Money" prices vs. "Time" prices (Acton, 1973)

Demand functions

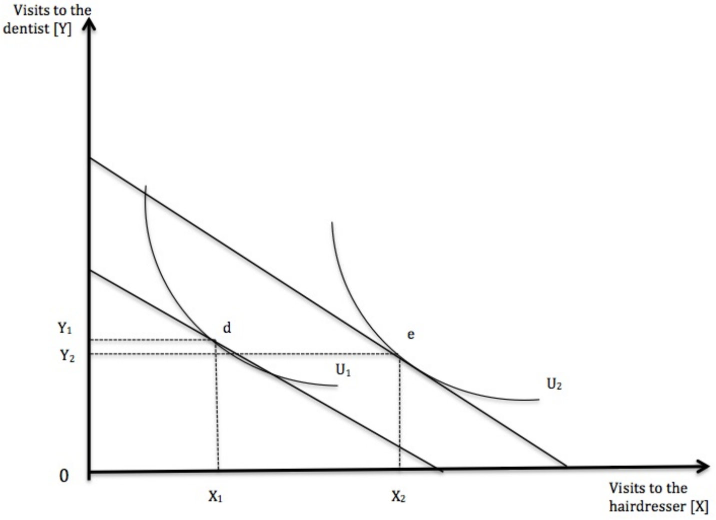


Source: Morris et al (2012)

Determinants of demand (ii)

- Income: shifts BC up
- Normal vs. Inferior goods
- Normal goods: a) necessity and b) luxury

Demand functions



Source: Morris et al (2012)

Determinants of demand (iii)

- Prices of other goods
- Complements vs. substitutes
- Tastes and Lifestyles
- Population size and composition
- Price elasticity in demand: Percentage change in quantity divided by the percentage change in price
- Income elasticity of demand: Percentage change in quantity divided by the percentage change in income

Summary

- Preferences and Utility (IC and its properties)
- Budget constraint (max. U)
- Demand functions (its determinants)
- All ingredients of Grossman model

Set-up

Two time periods with discounting factor $\beta \leq 1$. Maximisation is given by:

$$\max_{H_1, t^l, M, X_0, X_1} U = U(t^s(H_0), X_0) + \beta U(t^s(H_1), X_1)$$

$$s.t.$$

$$H_1 = H_0(1-\delta) + I(M_0, t^l)$$

$$A_0 + w_0(1 - t^s(H_0) - t^l) + \frac{w_1(1 - t_1^s(H_1))}{R} = pM + cX_0 + \frac{cX_1}{R}$$

Set-up the Lagrangean with multipliers $\mu, \lambda > 0$, H_0 is predetermined

Solution

The derivatives are given by:

$$\frac{\partial L}{\partial H_1} = \beta \frac{\partial U}{\partial t^s} \frac{\partial t^s}{\partial H_1} - \frac{\lambda}{R} w_1 \frac{\partial t^s}{\partial H_1} - \mu = 0 \tag{1}$$

$$\frac{\partial L}{\partial t^l} = \mu \frac{\partial I}{\partial t^l} - \lambda w_0 = 0 \tag{2}$$

$$\frac{\partial L}{\partial M} = \mu \frac{\partial I}{\partial M} - \lambda p = 0 \tag{3}$$

$$\frac{\partial L}{\partial X_0} = \frac{\partial U}{\partial X_0} - \lambda c = 0 \tag{4}$$

$$\frac{\partial L}{\partial X_1} = \beta \frac{\partial U}{\partial X_1} - \frac{\lambda}{R} c = 0 \tag{5}$$

Solution (cntd.)

Dividing (2) by (3):

$$\frac{\frac{\partial I}{\partial t^I}}{\frac{\partial I}{\partial M}} = \frac{w_0}{p} \tag{6}$$

Dividing (4) by (5):

$$\frac{\frac{\partial U}{\partial X_0}}{\frac{\partial U}{\partial X_1}} = \beta R \tag{7}$$

Solve (5) for λ/R and substitute in (1):

$$-\beta \frac{\partial t^s}{\partial H_1}\left[\frac{w_1}{c}\frac{\partial U}{\partial X_1} - \frac{\partial U}{\partial t^s}\right] = \mu \tag{8}$$

Using (3) and (4):

$$\mu = \frac{\frac{\partial U}{\partial X_0}}{\frac{\partial I}{\partial M}}\frac{p}{c} \tag{9}$$

Solution (cntd.)

The solution is given by substituting (9) into (8):

$$-\beta \frac{\partial t^s}{\partial H_1}\left[\frac{w_1}{c}\frac{\partial U}{\partial X_1} - \frac{\partial U}{\partial t^s}\right] = \frac{\frac{\partial U}{\partial X_0}}{\frac{\partial I}{\partial M}}\frac{p}{c} \qquad (10)$$

That is, MU = MC of health investments

Marginal Utility of Health Investments

- $MU > 0$ if $\frac{\partial t^s}{\partial H_1} < 0$ and $\left[\frac{w_1}{c}\frac{\partial U}{\partial X_1} - \frac{\partial U}{\partial t^s}\right] > 0$. Effectiveness of health investments;
- *Pure Consumption Model*: $t^s < 0 \Rightarrow \frac{\partial U}{\partial t^s} < 0$
- *Pure Investment Model*: $t^s < 0 \Rightarrow -\beta\frac{\partial t^s}{\partial H_1} > 0$ *and* $\frac{w_1}{c} > 0$

Marginal Cost of Health Investments

- $\frac{\partial U}{\partial X_0} \Rightarrow$ Subjective loss from sacrificing consumption in favour of health;
- $\frac{\partial I}{\partial M} \Rightarrow$ Effectiveness of medical services;
- $\frac{p}{c} \Rightarrow$ Price deflation factor

Conclusion

- Health affects wealth and vice versa;
- Health is both a production and a consumption good;
- As production, individual decides how much time and medical services to use for health production;
- As consumption, individual enjoys health and has to trade it against consumption of other goods;
- This trade-off is formalised by the MU=MC
- Closed form solutions to the model require specification of the production (i.e. $I(M_0, t^I)$) and the utility (i.e. $U(t^s(H_1), X_1)$) functions

The Demand for Medical Services

Cobb-Douglas production function:

$$I = M^{\alpha_M}(t^I)^{1-\alpha_M}e^{\alpha_E E} \quad \text{where} \quad 0 < \alpha_M < 1, \alpha_E > 0$$

Cost-minimisation gives the structural demand function for medical services:

$$lnM = const. + lnH_1 - (1-\alpha_M)lnp + (1-\alpha_M)lnw_0 - \alpha_E E$$

Higher health capital increases demand for medical services as derived demand for a factor of production

Solution (cntd.)

Predictions of the model:

- The higher the price p of medical services, the smaller the quantity;
- The higher the initial wage w_0, the higher the demand for medical services;
- The higher the education level, the lower the demand for medical services;

The Demand for Health - Investment Model

Functional form:

$$t^s(H_1) = \theta_1 H_1^{-\theta_2} \quad \text{where} \quad \theta_1 > 0, \theta_2 > 0$$

So the demand for health is:

$$lnH_1 = const - \epsilon\alpha_M lnp + \epsilon\alpha_M lnw + \epsilon\alpha_E E$$

Substituting this demand in the demand for medical services, we get the reduced demand function of medical services:

$$lnM = const - (1 + \alpha_M(\epsilon - 1))lnp + (1 + \alpha_M(\epsilon - 1))lnw - (1 - \epsilon)\alpha_E E$$

Solution (cntd.)

Predictions of the model:

- The higher the price p of medical services, the smaller the quantity of H_1;
- The higher the wage w, the higher the demand for health;
- The higher the education level, the higher the demand for health;

The Demand for Health- Consumption Model

Additive utility function:

$$U = \alpha_1 (t^s)^{\alpha_2} + g(X)$$

The demand function for health:

$$lnH_1 = const. - k\alpha_M lnp - k(1-\alpha_M)lnw + k\alpha_E E - kln\lambda$$

where $k \equiv \dfrac{1}{(1+\alpha_2\theta_2)} < 1$ is the elasticity of MU of less sick time with respect to H_1.

Solution (cntd.)

Predictions of the model:

- The higher the price p of medical services, the lower the demand for health;
- The higher the wage w_0, the lower the demand for health;
- The higher the education level, the higher the demand for health;

The Demand for Medical Services

The reduced demand function for medical services can be derived by substituting the demand for health in the demand for medical services:

$$lnM = const. - [1 + \alpha_M(k-1)]\, lnp + (1-k)(1-\alpha_M) lnw - (1-k)\alpha_E E - k ln\lambda$$

Implications of the Grossman Model

Predictions of the model:

- Health: health status and demand for medical services are positively correlated. But empirical evidence says otherwise (Wagstaff (1986) and Leu and Gerfin (1992));
- Education: education and demand for medical services are negatively correlated. Again, empirical evidence says otherwise (Wagstaff 1986);
- Age: is negatively correlated with demand for health, but positively correlated with demand for medical services. The latter is not confirmed by empirical evidence;

Main drawbacks

Neglects uncertainty:

- Depreciation of health capital: not affected by stochastic shocks;
- Rate of depreciation: also depends on unexpected shocks;

Conclusions

- Grossman Model: health is a capital stock that can depreciate. It is both a production and a consumption good;
- Some predictions particularly with regard to education are not confirmed by empirical evidence;
- It might confirm the view that health cannot be fully determined by individuals. We can only change the transition probabilities to and from health/ill states.

- Morris et al. (2012) Economic Analysis in Health Care (Chapter 2) pp.21-43
- Zweifel et al. (2009) chapter 3 pp.75-89
- Acton (1973) Demand for health care when time prices vary more than money prices, RAND.