

Should I eat or should I smoke? A model of rational eating and addiction

Davide Dragone Francesco Manaresi Luca Savorelli
University of Bologna

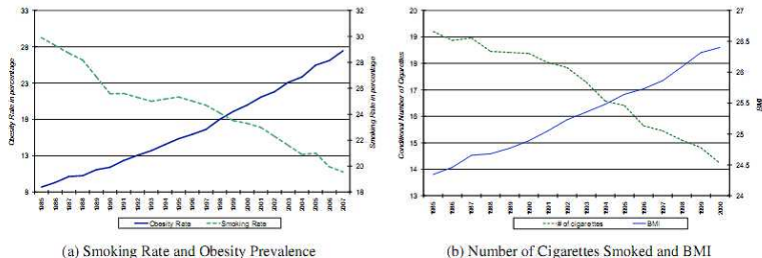
July, 2012

- A model with intertemporally-dependent preferences
 - different goods at the same date
 - the same good at different dates
- Show incentives behind health-related behaviors
 - useful for health policies
- As an illustration: focus on smoking and eating

- Policies to improve health: often "in isolation"
- Yet there is interdependence!
 - smoking reduces appetite
 - teenagers who start smoking to lose weight
 - quitters who gain weight

An intriguing negative correlation over time...

Figure 1: Correlation between Smoking and Weight - USA 1985-2007



Source: National Health Interview Survey and Behavioral Risk Factor Surveillance System, 1985 to 2007

Todeschini et al., 2010

- In US: smoking rate from 37.4 to 22.5% (1970-2002, CDC)
- In US: obesity rate from 14.6 to 30% (1970-2002, Flegal et al., 2002)

Research question

- Conditions for policies with different scope than expected?
 - based on increasing prices

Key features of the model

- 1 Choice between different goods
- 2 Current choices have persistent effects over time
- 3 Multiple addictive goods.

1. Optimal behavior

- Variety of behaviors, including apparently "pathological behavior"
 - Smoking, overweight despite being on diet
 - Smoking, underweight and on diet
- Demand for smoking
- Demand for food

2. Antismoking policies based on increasing the price of smoking

- May backfire and also affect eating and body weight
- May not reduce smoking

1.

The model

A model of eating and addiction

- The model bridges two literatures on health-related behavior
 - rational eating (Dockner, Feichtinger, AER, 1993, Levy, JHE, 2002)
 - rational addiction (Becker and Murphy, JPE, 1988)
- The "bridges": evidence from medical and behavioral lit.
- **2 channels**: metabolism and preferences

Interdependence between smoking and eating

1. Metabolism

Nicotine speeds up metabolism (Filozof et al., 2004)

2. Complements or substitutes

Interdependence between food consumption and current smoking

$$U_{cs} \neq 0$$

A reduced form for individual preferences, social habits, appetite reduction etc.:

e.g.

$U_{cs} < 0$: Nicotine is appetite suppressor (Mineur et al., Science, 2011)

$U_{cs} > 0$: Social Smoking (Schane et al., 2009; Moran et al., 2004)

Situational cues (Dunbar et al. 2010):

The intertemporal problem

- Choose food consumption $c(t)$, smoking $s(t)$, a composite good $q(t)$ s.t.

$$\max \int_0^{\infty} e^{-\rho t} U(c(t), s(t), q(t), w(t), a(t)) dt$$

- where $a(t)$ is addiction and $w(t)$ body weight

$$\dot{a} = s(t) - \delta_a a(t)$$

$$\dot{w} = c(t) - \varepsilon s(t) - \delta_w w(t)$$

- $U(\cdot)$ jointly concave in controls and states
- $a(0), w(0)$ given and $\lim_{t \rightarrow \infty} e^{-\rho t} (\lambda(t) w(t) + \mu(t) a(t)) = 0$

- **Crucial assumptions**

Reinforcement: $U_{sa} > 0$

Interdependence: either $U_{cs} \neq 0$
or $\varepsilon > 0$

- **Some notation**

Underweight: $U_w > 0$

On diet: $U_c > 0$

2.

Results

Demand for smoking

- 1 Steady state
- 2 Reaction to price shocks

Steady state

$(s^{ss}, c^{ss}, a^{ss}, w^{ss})$ s.t.

$$\begin{cases} \dot{s} = 0 \\ \dot{c} = 0 \\ \dot{a} = 0 \\ \dot{w} = 0 \end{cases} \rightarrow \begin{cases} U_a = (\delta_a + \rho) [(p_s - U_s) + \varepsilon (p_c - U_c)] \\ U_w = (\delta_w + \rho) (p_c - U_c) \\ s = \delta_a a \\ c - \varepsilon s = \delta_w w \end{cases} \quad \begin{matrix} (1) \\ (2) \end{matrix}$$

Interpretation:

- Take (2).
- For an overweight person ($U_w < 0$), it is optimal to stay on diet ($U_c > p_c > 0$)
- Take (1) and $\varepsilon = 0$.
- Since addiction is harmful ($U_a < 0$), optimal to smoke less than desired ($U_s > p_s > 0$).

Theorem

In the long run equilibrium $(s^{ss}, c^{ss}, a^{ss}, w^{ss})$, the agent will be

- 1. smoking less than she would like, underweight and yet possibly on diet*
- 2. smoking less than she would like, overweight and on diet*
- 3. smoking more than she would like, overweight and on diet*

A variety of behavior that is consistent with the evidence

Theorem

When the price of smoking increases:

- *In the short run: smoking decreases*
- *In the long run:
smoking decreases if it is mildly addictive,
smoking increases if it is highly addictive,*

What about eating?

Suppose p_s increases

- If no metabolic effect of smoking ($\varepsilon = 0$)
 - 1 eating decreases if food and smoking complements: $U_{cs} > 0$
 - 2 eating increases if food and smoking substitutes: $U_{cs} < 0$

- If $\varepsilon > 0$, there exists a threshold of substitutability $\zeta < 0$, s.t.
 - 1 eating decreases if $U_{cs} > \chi$
Note: complements and "light" substitutes!
 - 2 eating decreases if $U_{cs} < \chi$

1. Optimal behavior

- Variety of behaviors, including apparently "pathological behavior"
 - Smoking, overweight despite being on diet
 - Smoking, underweight and on diet
- Interdependence between behavior requires careful consideration

2. Antismoking policies aimed at increasing the price of smoking

- May backfire and affect eating and body weight
- May not reduce smoking