Thinness and obesity: a model of food consumption, health concerns, and social pressure

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PET10
June, 26th 2010
1 Facts and existing policies
Structure of the presentation

1. Facts and existing policies
2. A model of individual intertemporal choice of food consumption
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3. Policy implications
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Increasing concerns about eating behavior

- Obesity

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- promote a healthy body image and reject the unhealthy ideal of extreme thinness particularly among girls and women
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- set a minimum size for fashion models (BMI $\geq$ 18.5)
- refuse to accept and distribute any photos of extremely thin potential role models
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- 30,000 Euros fine and 2 years of prison for promoting extreme forms of slenderness

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- avoid promoting slender ideals
Incipit of the foreword to the National Charter of the German Textile and Fashion Industry

"Many young people suffer because they feel they do not correspond with the prevailing ideal of beauty as propagated by the fashion industry, the media and advertising. Hence, more than half of the young people in Germany say that they would prefer to be thinner. Some are even willing to put their health at risk: eating disorders like anorexia and bulimia are becoming increasingly common."
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Ulla Schmidt
The Federal Minister of Health
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2. they can affect what body weight is considered to be desirable
3. the *desirable body weight* affects eating behavior
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Rationale for regulation

- Negative externalities:

  Both the government and the fashion industry recognize that the choice of models of beauty have external effects on people’s behavior, supported as well by the psychological and sociological literature. Trend-setters do not internalize the external effects of a thin ideals (chosen mainly on the basis of esthetic criteria). Increasing the ideal weight is required to encourage the promotion of an ideal of beauty to improve the well-being of the youth.
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- Trend-setters **do not internalize** the external effects of a thin ideals (chosen mainly on the basis of esthetic criteria)

- **Increasing the ideal weight** is required to encourage the promotion of an ideal of Beauty to improve the well-being of the youth.
The research question

- The Ministry suggests industry to increase the desirable weight

The target is to affect the eating behavior of the youth female population to improve its well-being and health condition.

Being overweight is the average condition in US and Europe.

a) Is the Ministry right in suggesting an increase in the ideal weight from a welfare point of view from a health point of view.

b) Should the healthy weight be the ideal body weight.
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We contribute to the (sparse) literature on policies for eating behavior:

- fat taxes or thin subsidies (Yaniv et al., 2009)
- the implementation of educational programs (Acs and Lyles, 2007; Philipson and Posner, 2008)
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A unique framework for undereating/overeating behaviors, two generally distinct research fields:

1. Unhealthy eating (eating disorders)
2. Obesity epidemics (Acs, Lyles, 2007, Bhattacharya, Bundorf, 2009)

Key ingredient: social pressure
A model of individual intertemporal choice of food consumption
A country is made up of $M$ groups indexed by $G = \{1, \ldots, M\}$. 

- Group $G$ is made up of $N$ individuals indexed by $i = f_1, \ldots, f_N$.

- Individual parameters:
  - $c_i$: level of satiation of individual $i$.
  - $w_{Hi}$: healthy weight of individual $i$.
  - $U_{iG}$: utility function of individual $i$ in group $G$ with ideal weight $w_G$. 

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The setting

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  - $c_i^F$ level of satiation of individual $i$
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- $U_{i,G}$ utility function of individual $i$ in group $G$ with ideal weight $w^G$
Individual utility function at time $t$

$$U_{i,G}(c_i, w_i) = \left[ c_i \left( c_i^F - \frac{c_i}{2} \right) - \frac{(w_i - w_i^H)^2}{2} \right] - \left[ \beta \frac{(w_i - w_i^G)^2}{2} \right]$$ (1)

Utility from food consumption: $c_i \left( c_i^F - \frac{c_i}{2} \right)$, $c_i \geq 0$

Definitions

- **overeating** if $c_i > c_i^F$ and **undereating** if $c_i < c_i^F$.
- **overweight** if $w_i > w_i^H$ and **underweight** if $w_i < w_i^H$. 

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1. Utility from food consumption: $c_i \left( c_i^F - \frac{c_i}{2} \right)$, $c_i \geq 0$

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1. **Utility from food consumption**: $c_i \left( c_i^F - \frac{c_i}{2} \right)$, $c_i \geq 0$

2. **Cost of not being healthy**: $-\frac{(w_i - w_i^H)^2}{2}$

3. **Cost of not having an ideal weight**: $-\beta \frac{(w_i - w^G)^2}{2}$, $\beta \geq 0$

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- **overweight** if $w_i > w_i^H$ and **underweight** if $w_i < w_i^H$.
The intertemporal maximization problem

Given $\rho > 0$ and $w(0) = w_0$, choose at each $t$ the level of consumption.

$$\max_{\{c(t)\}} \int_0^{\infty} e^{-\rho t} U(c(t), w(t)) \, dt$$  \hspace{1cm} (2)

subject to

$$\dot{w}(t) = c(t) - \delta w(t)$$  \hspace{1cm} (3)

Note: if $c(t) = c_i^F$ at all $t$ (static choice of food consumption), body weight converges to the steady state weight $w_i^F = c_i^F / \delta$. However this is not optimal.

$w_i^F > w_i^H \rightarrow$ tendency to be overweight
Proposition

1. *the steady state*

\[ w^* = \frac{w_i^H + \delta (\delta + \rho) w_i^F + \beta w_i^G}{A}, \quad c^* = \delta w^* \]

is unique and has saddle point stability;

2. *in steady state, the agent is underweight if* \( w^G > w_i^W \) *and overeating results if* \( w^G > w_i^C \);

3. *along the optimal path food consumption is given by the decreasing function of body weight*

\[ c_i = \frac{B}{2\delta} c_i^* + \left( \delta - \frac{B}{2} \right) w_i. \quad (4) \]
An implication of Proposition 1

4 possible steady states

The steady state can belong to one of the following four categories:

1. **Overweight and undereating**
2. **Overweight and overeating**
3. **Underweight and overeating**
4. **Underweight and undereating**

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Note

If $\beta = 0$, no improper eating behavior, because only steady states (1) and (3) are possible.

Same result if $\beta > 0$ and $w_G = w_H$. 
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Same result if \( \beta > 0 \) and \( w^G = w^H_i \).
Is increasing the ideal body weight desirable?
**Assumptions**

**Target group** $G$ made up of $N$ individuals $i$

- heterogeneous in $w^H$ and $c^F$ distributed according to
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There is no possibility for inter-population mobility.
**Target group** $G$ made up of $N$ individuals $i$

- heterogeneous in $w^H$ and $c^F$ distributed according to $f_G(w^H, c^F)$ with $E(w^H) = \overline{w}^H$, $E(c^F) = \overline{c}^F$.
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There is no possibility for inter-population mobility.
**Objective function**: maximization of aggregate utility of the target group $G$ in steady state.

\[
\max_{w^G} \int \int U(w^*, c^*) f(w^H, c^F) \, dw^H \, dc^F
\]

**Proposition**

The ideal body weight that maximizes the average steady state utility of group $G$ is

\[
w^{G'} = [1 + \beta + \delta (\delta + 2 \rho)] C \, \bar{w}^H + \delta^2 \left[1 + \beta + (\delta + \rho)^2\right] C \, \bar{w}^F; \quad (5)
\]

where $C > 0$.

*Notice*: $w^{G'}$ lies between $w^F$ and $w^H$
**Objective function:** maximization of the health of the target group $G$ in steady state.

$$\min_{w^G} \int \int L \left( w^* - w^H \right) f(w^H, c^F) dw^H dc^F,$$  \hspace{1cm} (6)

**Proposition**

*The ideal body weight that maximizes the average steady state health of group $G$ is*

$$\bar{w}^W = \bar{w}^H - \frac{\delta (\delta + \rho)}{\beta} \left( \bar{w}^F - \bar{w}^H \right).$$  \hspace{1cm} (7)
Increasing the current ideal body weight to the average healthy weight?

1. \( w^G \) is lower than \( \overline{w}^H \) (ideal weights are thin \( \rightarrow \) fashion models and celebrities are thinner than 98% American women)

2. \( \overline{w}^H \) is lower than \( \overline{w}^F \) (overweight and obesity are widespread)

Then, the policy maker suggests to set \( w^G = \overline{w}^H \)
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When the target group tends towards being overweight —> welfare improving.

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Increasing the current ideal body weight to the average healthy weight?

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*When the target group tends towards being overweight —→ welfare improving.*

Health

Proposition

*When the target group tends towards being overweight —→ health improving if the current ideal body weight is very low.*
Intuition

**Target group underweight and undereating**

- very low ideal weight: both welfare and health improve
- if the ideal weight is not very low, increasing it up to the average healthy weight should lead them to be overweight, and even further away from the healthy weight than in the previous underweight condition

**Target group overweight and undereating**

- the representative agent getting a higher $w^G$ reduces her cost sourced from social pressure
- *but* not necessarily the individual will keep closer to his healthy body weight!
- on the contrary, she could trade off the lower discomfort with a higher level of food consumption, getting even more overweight
- *thus*: higher utility, but less health.
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- *thus*: higher utility, but less health.
Increasing the ideal weight might be beneficial to underweight and on a diet young people, both for welfare and health

BUT

In the US and in Europe people are on average overweight: policies may foster the obesity epidemic.
Increasing the ideal weight might be beneficial to underweight and on a diet young people, both for welfare and health

BUT

If the population exposed to the same ideal body weight is on average overweight, increasing the ideal body weight may increase welfare by reducing social pressure. By contrast, health is on average reduced: people depart even further from their healthy weight.
Increasing the ideal weight might be beneficial to underweight and on a diet young people, both for welfare and health

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If the population exposed to the same ideal body weight is on average overweight increasing the ideal body weight may increase welfare by reducing social pressure.
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Final message

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Conclusions

- Both overweight and underweight can correspond to an optimal eating behavior
- With social pressure to conform to an ideal body weight: improper eating can emerge
- We derive the optimal policy action either targeting welfare or health
- We show when the action is effective and its qualitative properties
Note:

- a perfectly informed agent
- no self-control problem
Future Research

- introducing the role of peers in the definition of the ideal body weight
- allowing agents to choose their ideal body weight among multiple available ideal weights
- novelty of the policies considered (first agreement was signed in 2006): empirical assessment does not exist \(\rightarrow\) collecting data and running a program to monitor the effects of these policies
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Evidence

*The diet industry has never been in such a good shape*

- In US: on any given day 45% of women and 25% of men are on a **diet** (Smolak, 1996).
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- US spending on dieting and **diet-related products**: over $56 billion each year
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- In US: on any given day 45% of women and 25% of men are on a diet (Smolak, 1996).
- US spending on dieting and diet-related products: over $56 billion each year
- Over 50% of teenage girls, about 30% of teenage boys use unhealthy weight control behaviors: skipping meals, fasting, smoking cigarettes, vomiting, taking laxatives (Neumark-Sztainer, 2005).
Evidence

- 42% of 1st-3rd grade girls want to be thinner (Collins, 1991).

- 81% of 10 year olds are afraid of being fat (Mellin et al., 1991).

- 46% of 9-11 year-olds are "sometimes" or "very often" on diets.

- 82% of their families are "sometimes" or "very often" on diets (Gustafson-Larson & Terry, 1992).

- 91% of women recently surveyed on a college campus had attempted to control their weight through dieting 22% dieted "often" or "always" (Kurth et al., 1995).
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Girls who diet frequently are 12 times as likely to binge as girls who don’t diet (Neumark-Sztainer, 2005).
Why should dieting be an issue?

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- Of those, 20-25% progress to partial or full-syndrome **eating disorders** (Shisslak & Crago, 1995).
- Girls who diet frequently are 12 times as likely to binge as girls who don’t diet (Neumark-Sztainer, 2005).
Health Maximization

**Goal:** to maximize the steady state health condition of target population

**Objective function:** $L (w - w^H)$, increasing and convex.

**Problem:**

$$\min_{w^S} \int \int L (w^* - w^H) f(w^H, c^\sigma) dw^H dc^\sigma,$$  \hspace{1cm} (8)

For concreteness consider a quadratic loss function, $L = (w - w^H)^2 / 2$.

1. If in steady state the $w^S$ was such that the representative agent ($w^H_i = \bar{w}$ and $c^\sigma_i = \bar{c}$) is **overweight and undereating**, the policy maker would **decrease** the social reference.  
   *Opposite direction of the policy maker maximizing overall utility.*

2. On the contrary if the representative agent is **underweight and undereating**, the social reference should be **increased**.

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*No pareto improvement of the health condition of the individuals.*
Eating behavior affects

- health
  - individual body weight
  - health-related quality of life (Fontaine and Barofsky, 2001; Hassan et al., 2003)
  - probability of incurring in non-transmittable diseases
  - individual life expectancy (Fontaine et al., 2003)
Eating behavior and wellbeing

- social & working life
  - wages and job opportunities
  - marriage opportunities
  - the quality of social life (Hamermesh, Biddle, 1994; Register, Williams, 1990).
Note: The desirable body weight is relevant as long as other people will judge others according to it (Strahan et al., 2006), even if it is recognized as unrealistic and unattainable\(^1\), and even if a person does not judge herself w.r.t it.

\(^1\)Fashion models and celebrities are thinner than 98% of American women (Smolak, 1996).
It is optimal to adapt the amount of food consumption to the current body weight:

- restrain food consumption (i.e. dieting) when body weight is high and to consume much (eventually beyond satiation) when body weight is too low.
- in steady state, the choice of food consumption is such that the marginal utility of food is equal to the marginal disutility of weight.
Intuition for the steady state

If $w^H < w^i$, then $w_W < w_C$.

Note: if $\beta$ increases, $w_W$ and $w_C$ get closer.
Intuition for the steady state

If $w^H < w^i$, then $w_W < w_C$.

Depending on $w^S$:

- underweight
- overweight

$w_W \quad w^\phi \quad w^i \quad w_C$
Intuition for the steady state

If $w^\phi < w^i$, then $w_W < w_C$.

Depending on $w^S$:

- Underweight
- Overweight

- Undereating
- Overeating
Intuition for the steady state

If $w^\phi < w^i$, then $w_W < w_C$.

Depending on $w^S$:

- $w^S < w_W$: underweight
- $w_W < w^\phi$: undereating
- $w^\phi < w^i$: overweight
- $w^i < w_C$: overeating

OUTCOME:

- Underweight: undereating
- Overweight: undereating
- Overweight: overeating
A theoretical assessment of the welfare and health effects of increasing the ideal body weight.

A theory of *intertemporal eating behavior*

- useful to assess the welfare and health effects of the mentioned policies
- rationalizes the observed heterogeneity in eating behavior and conditions of overweightness/underweightness

We do so by *adding social conformism* to endogenous weight determination

- Food consumption determines body weight
- Body weight affects health and social desirability
Implications 1

Proposition

*When targeting health, the optimal social reference weight is* \( \bar{w}_W \).

That is ...

1. If in steady state the \( w^S \) was such that the representative agent \((w^H_i = \bar{w} \text{ and } c^g_i = \bar{c})\) is **underweight and underconsumes**, then the policy maker would set \( \hat{w}^{SH} > w^S \).

2. Also the only health maximization is in support of the studied policies.
The two policy interventions when the agent is underweight and underconsumes are qualitatively similar.

**Proposition**

If in steady state the representative agent engages in improper eating, targeting either health or utility recommends changing the desirable weight in the same direction.

**Intuition:** If \( w^S < \min\{\hat{w}^S, \bar{w}_W\} \), increasing \( w^S \) improves both the aggregate utility and the aggregate health condition of the target population. If \( w^S > \max\{\hat{w}^S, \bar{w}_W\} \) decreasing it is welcome to both.
The two policy interventions are **not** always qualitatively similar.

**Intuition:** since the welfare maximization policy maker takes into account the discomfort not to conform, he can set $w^S$ so as to reduce this discomfort, but not necessarily the individual will keep closer to the healthy body weight, on the contrary she could trade off the lower discomfort with an higher level of food consumption. In this case, the decision maker targeting health would suggest to lower the $w^S$. 

![Graph showing the relationship between weight and health]

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