Modeling self-control problems II: Dual-self models

Lectures in Behavioral economics
Fall 2014, Part 4
(Based on notes by Kjell Arne Brekke)

Dual self models of impulse control

- Thaler and Sherfin (1981)
  - Consider each individual as an organization
  - Consist of a planner and doers
  - The planner is concerned with lifetime utility
  - The doers exists only one period and is completely selfish

- Current interpretation
  - Planner is prefrontal cortex
  - Doers are the rest of the brain (reptilian brain)

- Fudenberg and Levine (2006)
  - Equivalent formulation: Planner control doers at a cost.
Using new insight from neurology—Neuroeconomics

The importance for economics discussed
- “Economics needs brains”
  - Camerer, Loewenstein and Prelec (2004, 2005)
- “The case for a mindless economics”
  - Gul and Pesendorfer (2008)

New knowledge about the brain has made the dual self model much more plausible
- Some argue as if such evidence is almost conclusive
- Others insist that econ. th. should be tested on econ. data
  - Consumer theory makes no claims about the brain
  - Nor about underlying psychology

Neurology can inspire new theory building
- To be tested on economic data

The prefrontal cortex

- Phineas Gage survived a pole through frontal lobe
- After the damage, the doctor described him: “. . . devising many plans for future operation which are no sooner arranged than they are abandoned. . . . Ladies were advised not to stay in his presence. The hallmark of Gage’s new condition was his complete inability to direct or control himself”
Choices under cognitive load

- Shiv and Fedorikhin (1999)
- Subjects were instructed to memorize 2 (7) digits inducing low (high) cognitive load
- Then walk from one room to another, in-between choosing between a cake and a fruit salad

<table>
<thead>
<tr>
<th>Memorize</th>
<th>Choice</th>
<th>Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>37 (5274657)</td>
<td>![cake]</td>
<td>![fruit salad]</td>
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</tbody>
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Choices under cognitive load (cont.)

- **Results**
  - High load: 59 percent chose cake
  - Low load: 37 percent chose cake
- **Interpretation**
  - Prefrontal cortex cares about the long run (health)
    - Prefer the fruit salad
  - Sugar (the cake) is tempting to reptilian brain (the crocodile within)
  - High cognitive load reduces the prefrontal cortex’s ability to control the impulses from the reptilian brain
- Cognitive load; short term memory has 7 slots
The dual self model

- Thaler and Shefrin (1981) do not talk about prefrontal cortex and reptilian brain, but this how the model is often interpreted today. (And this is this interpretation that we will use here).
- Their motivation: “The idea of self-control is paradoxical unless it is assumed that the psyche contains more than one energy system, and that these energy systems have some degree of independence from each other” (McIntosh, 1969).

The dual self model (cont.)

- A planner (the prefrontal cortex; frontal lobe)
- A sequence of doers (the reptilian brain)
- Setting
  - Income stream: \( y = (y_1, y_2, \ldots, y_T) \)
  - Consumption plan: \( c = (c_1, c_2, \ldots, c_T) \)
- The utility of the doer at time \( t \): \( Z_t(c_t) \)
- The utility of the planner: \( V(Z_1, Z_2, \ldots, Z_T) \)
Alter incentives

The planner can alter the doer's incentives through $\theta_t$. Doer's utility: $Z_t(c_t; \theta_t)$. Such altering of the doer's preferences induces costs. If $\theta_t$ is chosen such that $\arg\max Z_t(c_t; \theta_t) = \hat{c}$, then $Z_t(\hat{c}; \theta_t) < Z_t(\hat{c}; 0)$.

Equivalent formulation: Fudenberg and Levine (2006)

Doer's utility $u(c_t)$ is strictly increasing. Maximum feasible consumption $c^*_t$.

Cost of self control: $C(c, c^*) = \gamma(u(c^*) - u(c))$. The more the doer sacrifices the more effort required.

Total utility: $Z_t = u(c_t) - C(c_t, c^*_t)$. Planner maximizes $V(Z_1, Z_2, ..., Z_T)$. 
Application: Immediate money

- First choice problem (in 1000 $):
  - A: 1 in year 1, or B: 1.5 in year 2
- Second choice problem (in 1000 $):
  - C: 1 in year 2, or D: 1.5 in year 3
- Basic income stream: 10 each year.
- Doer's utility: \( u(c_t) = \ln c_t \)
- May save, but no borrowing.
- Cost of self control: \( 0.5 (\ln c_t^* - \ln c_t) \)
- Planner's utility: \( V(Z_1, Z_2, Z_3) = Z_1 + Z_2 + Z_3 \)

No saving due to control costs—B as an example

- Income stream: 10, 11.5, 10
- In year 2, \( c_2^* = 11.5 \)
- Saving some of the additional income would induce cost of self control:
  - For \( c_2 \leq c_2^* = 11.5 \), utility equals
  \[
  \ln 10 + \ln c_2 + \ln(10 + 11.5 - c_2) - 0.5(\ln 11.5 - \ln c_2) = 1.5 \ln c_2 + \ln(10 + 11.5 - c_2) + \ln 10 - 0.5 \ln 11.5
  \]
- Optimal consumption stream: 10, 11.5, 10
Choosing A or B

- Additional income in A or B will be cons. immediately.
- Without problems of self control, B is best:
  - A: $\ln 11 + \ln 10 + \ln 10$
  - B: $\ln 10 + \ln 11.5 + \ln 10$
- But with A as an option, $c_1^* = 11$, while choosing B implies $c_1 = 10$.
- The cost of self control exceed additional utility.
- The planner will choose A.

Choosing C or D

- Additional income in C or D will be cons. immediately.
- With no cost of self-control, D is best:
  - C: $\ln 10 + \ln 11 + \ln 10$
  - D: $\ln 10 + \ln 10 + \ln 11.5$
- With cost of self control
  - Only 10 available to the doer in year 1 in both C and D.
  - Choice made before doer in year 2 or 3 may influence it.
  - No cost of self control.
  - The planner will choose D.

- With only A available, utility is \( \ln 11 + \ln 10 + \ln 10 \)
- With only B available, utility is \( \ln 10 + \ln 11.5 + \ln 10 \)
- With a choice between A and B, the planner will choose A due to the cost of self control. Thus:

\[ \{A\} \sim \{A, B\} \prec \{B\} \]


- B': 2 in year 2
- With only A available, utility is \( \ln 11 + \ln 10 + \ln 10 \)
- With only B' available, utility is \( \ln 10 + \ln 12 + \ln 10 \)
- With a choice between A and B', the planner will choose B' in spite of self control costs. Thus:

\[ \{A\} \prec \{A, B'\} \prec \{B'\} \]
Control methods

- Alter preferences
  - This corresponds to the approach studied
- Alter opportunities: Rules
  - Precommitment, (e.g. non-liquid assets)
  - Limiting choices (avoid Las Vegas)
  - Rules of thumb (ban on borrowing)

Why would rules of thumb work?
- Public announcement (“I’ve stopped smoking”)
- Other?

Applications in Thaler and Shefrin (1981)

- Rich in ideas; weak in formal proofs.
- The effect of mandatory pension saving
  - A person saves a share $s$ of income
  - Saving $p < s$ becomes mandatory
  - Does total saving change?
- Bonus-payments and saving
  - Two person with annual income 84 (thousand),
    - one get 7 per month
    - the other gets 6 per month + a bonus of 12 once a year.
  - Who saves most?
Bonus payment

- B gets the bonus, A does not
  - A earns 7 per month
  - B earns 6 except one month with 12
  - Both have doer utility $\ln c$
  - Both save 4.8, what are their cost of impulse control?

- A saves 0.4 per month.
  - Cost of impulse control: $\gamma 12(ln7 - ln6.6) = \gamma 0.71$

- B saves 4.8 in one month.
  - Cost of impulse control: $\gamma (ln18 - ln13.2) = \gamma 0.31$

- Least cost of self control for B, since marginal utility the one month is lower.

Conclusion

- Dual self model
  - “Planner” (prefrontal cortex) controlling
  - “Doer” (reptilian brain)
  - Equivalent to a cost of self control if deviating from short run optimum.

- Explains
  - Choosing 1 now over 1.5 in one year, while also choosing 1.5 in two years over 1 in one year.
  - Demand for commitment.
  - Consumption correlating with income.
Additional references


