Incorporating reference dependence into CGE models
4th Behavioral Macroeconomics Workshop presentation

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Research Aim

Research Question

How should we model aggregate household consumption behaviour in Computable General Equilibrium models?

- Does the reference dependence model of Kahneman and Tversky 1979 help us explain aggregate consumption in macroeconomic models?
- Are habit formation models more appropriate in proxying for aggregate consumption behaviour?
- Are homo-economicus agents a good approximation for aggregate consumption behaviour?

Myopic representative households:

$$C_t = f(Y_{d,t}).$$

- $t :=$ time subscript.
- $C_t :=$ consumption in period t.
- $Y_{d,t} :=$ household disposable income in period t.
- $f(*) :=$ function mapping disposable income to consumption.
- The function is often linear e.g. Keynesian demand function.
- Inter-temporal optimisation is neglected in favour of a constant saving rate assumption.

Ramsey 1928 style household:

$$U = \sum_{t=0}^{\infty} \beta^t u(C_t).$$

- $t :=$ time subscript.
- $U :=$ total lifetime utility.
- $\beta \in (0,1) :=$ discount factor (Samuelson 1937).
- $u(*) :=$ utility function (Ramsey 1928). Where:
  - $u(0) = 0$.
  - $u'(x) \geq 0 \,\forall\, x \in \mathbb{R}_+^*$.
  - $u''(x) \leq 0 \,\forall\, x \in \mathbb{R}_+^*$.
- $C_t :=$ aggregate consumption in period t.

Ramsey 1928 style household:

- Rational preference utilitarians (Mill and Hausman 2007).
- Follow the axioms of consumer preferences (Varian 2006).

These assumptions are extremely strict and unlikely to hold. Why do we use them?

- They are better than assuming a constant marginal propensity to consume (Friedman 1957; Modigliani 1966).
- Friedman and Savage 1948 analogy.
- What is the alternative?

What does the habit formation literature propose?

- Duesenberry 1949 and Modigliani 1949 amongst many others suggest that households form consumption habits.
- This contradicts the assumption of time-separability.
- We can extend the status quo framework to capture habit formation (Pollak 1970):

$$U = \sum_{t=0}^{\infty} \beta^t u(C_t - \gamma X_t).$$

- $\gamma \in [0, \infty) :=$ habit formation parameter.
- $X_t :=$ habit level (for representative agent models, $X_t \equiv C_{t-1}$).

Literature - Alternative 1: Habit formation

Macroeconomic applications of the habit formation model.

- Fuhrer 2000 adopts this approach to explain hump-shaped consumption responses in DSGE models.
- This has become a standard in modern DSGE models.

How has this improved consumption models?

- By adding a habit formation term to the rational agent utility function, Fuhrer 2000 found that empirically observed hump-shaped consumption responses to various shocks could be captured.
- This improved DSGE model predictions.

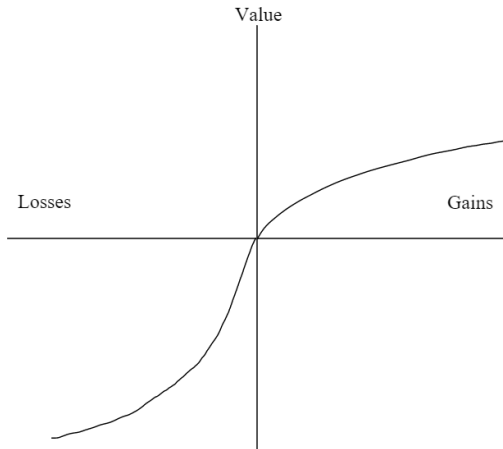What about reference dependence?

Figure: Kahneman and Tversky 1979 hypothetical value function.

Literature - Alternative 2: Reference dependence

- There is a multitude of evidence suggesting that anchoring/ reference points and loss aversion play a crucial role in many decisions:
  - Kahneman and Tversky 1979; Tvesky and Kahneman 1992 provide experimental evidence.
  - O'Donoghue and Sprenger 2018 summarise plenty of supporting evidence from the literature.
  - Shea 1995a; Shea 1995b finds empirical evidence of loss-aversion for aggregate consumption.
- Some authors have developed reference dependence models for aggregate consumption:
  - Kőszegi and Rabin 2007 develop a model in which the reference point is an expectation of future outcomes.
  - Bowman, Minehart, and Rabin 1999 create a two-period model.
  - Foellmi, Rosenblatt-Wisch, and Schenk-Hoppé 2011 construct a reference dependence model within an RCK model.

Literature - Alternative 2: Reference dependence

What are the weaknesses of the reference dependence models proposed in the literature?

- To my knowledge, no author has adapted a reference dependence model to a CGE context.
- Bowman, Minehart, and Rabin 1999 and Foellmi, Rosenblatt-Wisch, and Schenk-Hoppé 2011 use great simplifications to obtain tractable solutions.
- Little effort has been made to compare expectations and backward-looking reference dependence models.

Contribution

- I develop a tractable reference dependence model within a CGE context.
    - Captures reference dependence and loss aversion.
    - The model is however concave in the domain of losses.
    - Creates a bridge between reference dependence and habit formation.
    - Allows for both backward looking and expectations reference point.
- The method can be used for other models e.g. DSGE models or Ramsey, Cass and Koopmans model (Ramsey 1928; Cass 1965; Koopmans 1963).
- Model predictions can be compared through a calibration (Popper 1959).

- Extend the habit formation parameter to capture loss aversion:

$$U = \sum_{t=0}^{\infty} \beta^t u(C_t - \gamma(C_t, X_t)X_t),$$

Where:

$$\gamma(C_t, X_t) = \begin{cases} \gamma_H & \text{if } C_t < X_t \\ \gamma_L & \text{if } C_t \geq X_t \end{cases}.$$

- $\gamma_H \in [0, \infty) :=$ reference dependence term in the domain of losses.
- $\gamma_L \in [0, \infty) :=$ reference dependence term in the domain of gains.
- $\gamma_H \geq \gamma_L$.

Method - Assumptions

Reference point formation:

- For the backward looking reference dependence model and habit formation model, $X_t \equiv C_{t-1}$.

- For the expectations reference dependence model $X_t \equiv \mathbb{E}_{t-1}(C_t)$.

Key assumptions:

1. For the reference dependence models, it is assumed that households take the level of reference dependence as given.

2. For backward looking reference points, it is assumed that expectations of future reference points equal future consumption levels.

- By solving the household problem subject to the budget constraint and relevant structural equations of the economy, it can be shown that:

$$C_t = (1 - \theta(C_t, X_t))\hat{C}_t + \theta(C_t, X_t)X_t$$

Where:

$$\theta(C_t, X_t) = \begin{cases} \theta_H = \frac{\gamma_H}{1+\gamma_H} & \text{if } \hat{C}_t < X_t \\ \theta_L = \frac{\gamma_L}{1+\gamma_L} & \text{if } \hat{C}_t \geq X_t \end{cases}.$$

- $\hat{C}_t :=$ solution to the household problem for status quo agent.
- $\theta(C_t, X_t) :=$ effective reference dependence/ habit formation term.
- For habit formation $\theta_H \equiv \theta_L$.

Comparing the models

To understand the relative merits of classical (NCL), habit formation (HF) and reference dependence aggregate consumption models (RDB, RDX), a simple simulation is run on an original RCK growth model inspired static CGE model with three sectors, two regions and a government.

- A five period 10% unexpected adverse supply side TFP shock is introduced to the model. The shock dissipates at the historical TFP correlation rate after period 5.
- Households know that adverse supply side shocks are imperfectly correlated and expect these to dissipate by the historical rate.
- The initial reference point is the steady state consumption level.
- The consumption impulse response curves of the respective models are compared.
- $\gamma_H = 0.6$, $\gamma_L = 0.3$, $\gamma_{HF} = 0.45$.

Impulse response curve
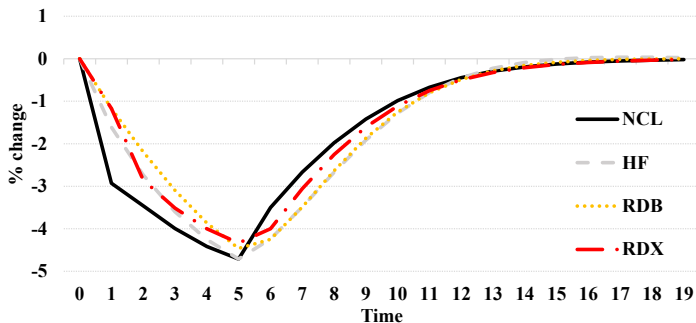
Consumption deviation from steady state.

Validation

- The second half of my paper deals with the validation of the respective consumption models.
- I use a within model calibration exercise on Eurostat 2021 data.
- Preliminary findings suggest that consumption habits of the form presented improve the consumption predictions.
- Backward-looking reference dependence added little to the habit formation model.
- The expectations reference dependence model's calibrated parameters are in line with theory but the prediction performance is worse than the habit formation model.

Thank you for your attention!
Do you have questions?

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