Loss Aversion and the Dynamics of Political Commitment

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Summary *(1/2)*

Summary *(2/2)*

- Next to last period $(T-1)$
- Previous to next to last $(T-2)$
- Equilibrium characterization
- Finite horizon equilibrium: discussion
- Infinite horizon

- Forward-looking loss-aversion
  - Forward looking Reference Dynamics
  - Equilibrium Definition
  - Last Period (T)
  - Next to last period $(T-1)$
  - Previous to next to last $(T-2)$
  - Equilibrium characterization
  - Discussion
- What have we learn?

Political commitment

- At least since the work of Kydland and Prescott, it is well known that the ability to commit is very important for political outcomes and welfare. Optimal sequence of taxes is typically time inconsistent, capital taxation example:
  - At t fix future sequence of taxes, in particular τ_{t+s}.
  - Planner accounts at t the distortionary effects that has on investment between t and $t+s$. Thus, optimally relatively low τ_{t+s}.
  - At $t+s$ the tax is lump sum... it is optimal to set τ_{t+s} large... unlike what was optimal s periods before.
- The (discretionary) Markov equilibrium predicts unrealistically high taxes. In general, a big policy failure whenever there is time inconsistency.
- **How do governments achieve (at least partial) commitment?**

Traditional Commitment Technologies

- Classical explanations;
  - Delegation to a person with suitably chosen preferences.
  - Repeated interaction and non-Markovian strategies.
- The first begs the question and the second would typically involve complicated coordination between voters of different generations.
- Formally, the "threat" of a long punishment phase can sustain "good" equilibria with e.g., low taxation on sunk capital.
- But are these punishment phases credible threats, particularly in OLG settings? Renegotiation proofness takes away most (all?) of these non-Markovian equilibria.
- We argue there is a need for other (complementary) explanations relying less on intergenerational voter coordination.

Our Contribution

- Study the dynamics of commitment:
  - **Procrastination Principle**
    - If short run costs versus long run benefits.
    - Simply “to commit” is not a markov equilibrium.
    - To commit takes time.
    - No Markov eq. in pure strategies

- Entitlement as a Commitment Technology.
  - introduce prospect theory in a dynamic political economy setting
  - natural and general environment that in practice provides governments with a commitment technology

Our explanation: Entitlement

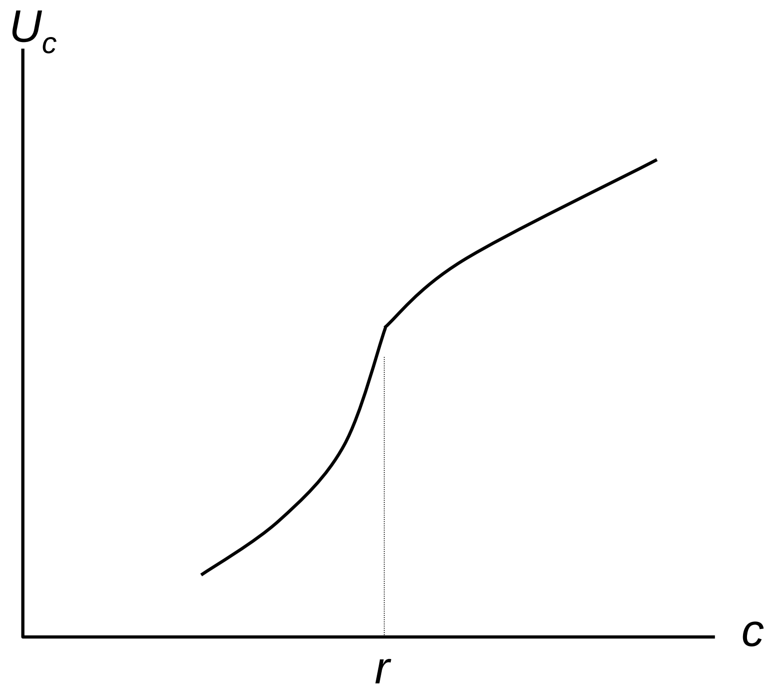
- Entitlement effects – people have a distaste for feeling **cheated**, not getting what they feel entitled to.
- More specifically, individuals form reference levels for consumption.
- Individuals are loss averse with respect to reference levels (in the sense of Kahneman and Tversky)
  - losses relative to a reference point are valued strictly higher than gains.
- Loss-aversion can provide a commitment mechanism, complementing other ones.

Loss-aversion in Brief. *(1/2)*

- Following Kahneman and Twersky we assume individuals have *loss-aversion*. Key features are that individuals:
  - care more about losses relative to a certain reference point than about gains,
    Formally, there is an $\varepsilon > 0$ such that
    $\frac{u(r;r,i)-(r-x;r,i)}{x} - \frac{u(r+x;r,i)-u(r)}{x} \geq \varepsilon \ \forall x > 0.$
  - are risk-loving in losses – a 50/50 chance of loosing x or zero is better than a certain loss of $x/2$.
    $$pu\,(r-x;r,i) + (1-p)\,u\,(r;r,i) > u\,(r-px;r,i)\,\forall x > 0, p \in (0,1)$$

Loss-aversion in Brief. *(2/2)*

- This implies that utility has a kink at a possibly time-varying but pre-determined reference point, and that utility is concave (convex) above (below) the reference point.



Dynamic reference point formation *(1/2)*

- Dynamics of reference points not much explored.
- Kahneman and Tversky (implicitly) used the past, *status quo*, as the reference point.
- But, reference points (entitlements) may be also partially forward-looking and determined by expectations about the future (Köszegi and Rabin, QJE'07).
- We allow for them to be either FORWARD or BACKWARD looking.

Dynamic reference point formation *(2/2)*

- BACKWARD LOOKING:
  - Based on last period's experiences. To establish commitment for *tomorrow* has a cost *today* for the government.
  - It has a short run cost to implement.
  - The Procrastination Principle applies: it takes time to implement commitment.
- FORWARD LOOKING:
  - An important part of politics is to affect reference levels.
  - In our model, political candidates run only once and cannot make any *formally* binding commitments. But, they are allowed to make a "promise" about the future tax rate, although they will not be around to implement the latter.
  - If rationally believed, the "promise" can affect future reference levels and thereby be self-fulfilling. A seemingly empty promise with commitment value.
  - Commitment is implemented much faster.

Model without loss-aversion *(1/6)*

- Two-period OLG structure.

- In each generation, there are two types of agents
  - workers and
  - entrepreneurs.

- Time starts at $t = 0$ and is potentially infinite.

- Workers have a simple private life.
  - Exogenous wage in their second period of life,
  - consumption only in second period, we normalize the private income to zero.
  - Utility of young at t is $\beta u\left(d_{t+1}\right) = \beta d_{t+1}$
  - Utility of old at t is $u\left(d_t\right) = d_t$,
  - d_t: consumption of old worker in period t.

- Young entrepreneurs invest.
  - Choose i_t with (gross) return of 1 at $t+1$
  - Investment utility cost i_t^2
  - Consume only in second period: c_{t+1}.

+ They observe τ_t before choosing i_t, but only affects them insofar
  - has information on τ_{t+1}
  - (with loss aversion) affects their reference point for $t+1$

- Given a tax-rate τ_t, an entrepreneur born in period $t-1$ solves

$$U_t = \max_{c_{t+1}, i_t} -\frac{i_t^2}{2} + \beta u\left(c_{t+1}\right) \;\; s.t. \, c_{t+1} = i_t\left(1-\tau_{t+1}\right).$$

  - $u\left(c_{t+1}\right) = c_{t+1}$.

- τ_{t+1} determined in the beginning of period $t+1$, when i_t are sunk.
- Taxes are used for transfers benefiting the workers.
- The policymakers budget constraint: $T_{t+1} = i_t \tau_{t+1}$

Model without loss-aversion *(3/6)*

- Two sets of decisions are taken.
  - **Private decision – investment**
    - chosen privately by young entrepreneurs after observing current tax rates.

$$i_t = \arg\max_{i_t} -\frac{i_t^2}{2} + \beta i_t \left(1 - E_t \tau_{t+1}\right) = \beta \left(1 - E_t \tau_{t+1}\right)$$

  - **Collective decision – taxes.**
    - If at t policies are not previously commited, chosen in every period t in order to maximize a weighted sum of the utility of old and young living individuals.
    - Two interpretations of the collective decision making.
      - The outcome of probabilistic voting.
      - OR planner that maximizes expected utility of **living** individuals without commitment.

- We assume that there is a political incentive to use taxes to transfer resources to the poor workers.

    - Extra weight $\gamma > 0$ to workers.

    - Poor workers have higher marginal utility than entrepreneurs.

$$
\begin{aligned}
d_t &= \tau_t i_{t-1}, \\
d_{t+1} &= \tau_{t+1} i_t, \\
c_t &= i_{t-1}\left(1 - \tau_t\right) \\
c_{t+1} &= i_t \left(1 - \tau_{t+1}\right)
\end{aligned}
$$

Model without loss-aversion *(5/6)*

- Political objective function as the weighted sum of utility of living generations of entrepreneurs and workers

$$W_t = W\left(\tau_t, i_t, \tau_{t+1}, i_{t-1}\right)$$
$$= i_{t-1}(1-\tau_t) + (1+\gamma)\tau_t i_{t-1} - \frac{i_t^2}{2} + \beta i_t\left(1-\tau_{t+1}\right) + \beta(1+\gamma)\tau_{t+1} i_t.$$

- Equilibrium: Markov equilibria.
  - Limit of final horizon T when $T \to \infty$ (no trigger-strategies eq.)
- No young is born in final period T,
  - Political objective in T is simply $i_{T-1}(1+\gamma\tau_T)$.
- Maximized with $\tau_T = 1$, implying $i_{T-1} = 0$.

Model without loss-aversion *(6/6)*

- Key for the analysis is that there is **tension** between:

  + **ex post incentive to tax** and the

  + **ex ante cost of distorting investments**,

  ... a **time inconsistency** in taxation.

In the absence of any commitment technology (and in partcular of loss aversion) the only finite horizon equilibrium feature $i_t = 0$ and $\tau_t = 1$ for all t. Clearly, this is the only infinite horizon Markov equilibrium that is a limit of a finite horizon equilibrium.

Taxes under commitment *(1/2)*

- Sequence of tax rates that maximize political welfare if there is full commitment over the two period planning horizon subject to private rationality.

- **Full commitment:** τ_1 and τ_2 can be set independently.

$$\arg\max_{\tau_1,\tau_2} W(\tau_1, i_1, \tau_2, i_0)$$
$$s.t.\;\; i_1 = \beta(1-\tau_2)$$

  - i_0 is sunk, so:

$$\tau_1 = 1$$
$$\tau_2 = \frac{\gamma}{1+2\gamma} \equiv \tau_c.$$

  - Time inconsistent: New policymaker in $t = 2$ wopuld set $\tau_2 = 1$ since i_1 is then sunk.

Taxes under commitment *(2/2)*

- **Restricted commitment:** same tax has to be set for all future periods.
  - Commitment is costly.
  - To put low taxes tomorrow you need low taxes today... even if i_0 is sunk
    - Price of future commitment in terms of current payoffs.
  - Maximizing under the restriction $\tau_1 = \tau_2$,

$$\tau_1 = \gamma \frac{i_0 + \beta^2}{\beta^2 (1 + 2\gamma)}.$$

  - If at $t = 0$ agents did anticipate this:

$$i_0 = \beta \left(1 - \gamma \frac{i_0 + \beta^2}{\beta^2 (1 + 2\gamma)}\right) \implies i_0 = \beta^2 \frac{1 + \gamma}{\beta + 2\beta\gamma + \gamma}$$

$$\tau_1 = \frac{(1 + \beta)\gamma}{\beta (1 + \gamma) + \gamma (1 + \beta)} \equiv \tau_f.$$

The commitment game *(1/6)*

- *Commitment game*: commitment to a constant tax rate forever **including the one in the current period** can be introduced at any point in time $t \geq 1$.

- Tempting to conjecture that $\tau_1 = \tau_f$ is a Markov equilibrium in this game.
  - ... this is **not the case**

- ψ_t denote the commitment decision in period t,
  - If $\psi_t = 1$ and $\psi_{t-1} = 0$, commitment is introduced in period t
    - τ_{t+s} will be equal to τ_t for all $s \geq 1$.
    - Requires that $\psi_{t+s} = 1$ if $\psi_t = 1$ for all $s \geq 1$.

Definition: A Markov equilibrium is a tax function $\tau(i_t)$, a commitment decision rule $\psi_t = \psi(i_t)$ applying when $\psi_{t-1} = 0$ and a rational investment rule $i_t = \beta\left(1 - E_t\tau_{t+1}\right)$ such that

1. taxes and the commitment decision are set to maximize the political payoff:

   $$\{\tau(i_t), \psi(i_t)\} = \arg\max_{\tau_t, \psi_r} \{(1-\psi_t) W(\tau_t, i_t, \tau(i_t), i_{t-1}) + \psi_t W(\tau_t, i_t, \tau_t, i_{t-1})\},$$

   subject to

2. investments are done individually rationally

   $$i_t = \beta(1 - ((1-\psi_t)\tau(i_t) + \psi_t\tau_t))$$

There is no Markov equilibrium with $\psi(i_t) = 1$ in the game with an infinite horizon. That is, introducing the commitment technology for sure is not an equilibrium.

- **Procrastination Principle**
  - If the next policymaker will commit to a low tax rate, the current policymaker has no incentive to commit itself: the private agents know it and will make large investments even if current taxes are set high.
  - Also, if the current policymaker **knows** that the next policymaker **will not commit**, then there is an **incentive to commit in the current period** and set $\tau_t = \gamma \frac{i_t + \beta^2}{\beta^2(1+2\gamma)}$, which if anticipated would result in $\tau_t = \tau_f$.

The commitment game *(4/6)*

- **Finite horizon.**
  - Last period, no incentive for the policymaker to restrain taxation: $\tau_T = 1$ if $\psi_{T-1} = 0$.
  - Policymaker in period $T-1$ knows that the next policymaker *will not* restrain taxation and this creates an incentive be forward-looking and commit (if commitment has not already been introduced).

$$\tau_{T-1} = \gamma \frac{i_{T-2} + \beta^2}{\beta^2 (1 + 2\gamma)}$$

    - If agents in period $T-2$ expected this, the equilibrium outcome is $\tau_{T-1} = \tau_f$.
  - Policymaker in period $T-2$ now knows that commitment will be introduced in the next period
    - No incentive to introduce it and will instead behave *myopically*.
  - ...
  - Policy functions never converge
  - Oscillate between being myopic and forward-looking

- **Infinite horizon**
  - Markov equilibrium with pure strategies cannot be sustained.
  - **A mixed strategy equilibrium**
    - commitment is introduced (if it is not already introduced) with a constant probability p
      - and taxes are then set to τ_x.
    - If commitment is not introduced, $\tau = 1$.
  - Intuition: the more likely it is that the next policymaker will commit, the weaker is the incentive to commit today, and viceversa.
  - For an intermediate value of p, the current policymaker is indifferent between committing and randomizing with probability p.

The commitment game *(6/6)*

The following is an equilibrium in the commitment game. If $\psi_{t-1} = 0$ *(no commitment has yet been introduced)*

$$\{\tau(i_{t-1}), \psi(i_{t-1})\} = \begin{cases} \left\{\tau_c\left(1 + \frac{i_{t-1}}{\beta^2}\right), 1\right\} & \text{with probability } p(\gamma, \beta) \\ \{1, 0\} & \text{otherwise} \end{cases}$$

where

$$p(\gamma, \beta) = \begin{cases} \frac{\beta(1+2\gamma) - \sqrt{2\gamma\beta(1+2\gamma)}}{\beta - 2\gamma(1-\beta)} & \text{if } \gamma \neq \frac{1}{2}\frac{\beta}{1-\beta} \\ \frac{1}{2} & \text{if } \gamma = \frac{1}{2}\frac{\beta}{1-\beta} \end{cases}$$

where we note that $\lim_{\gamma\to 0} p(\gamma, \beta) = 1$ *and* $\lim_{\gamma\to\infty} p(\gamma, \beta) = \frac{\sqrt{\beta}-\beta}{1-\beta}$, *and* $\lim_{\gamma\to\infty} p(\gamma, \beta) = \lim_{\beta\to 1}(\lim_{\gamma\to\infty} p(\gamma, \beta)) = \frac{1}{2}$. *Along the equilibrium path, investments are* $i_x \equiv \frac{p\beta^2(1+\gamma)}{\gamma(p+\beta)+\beta(1+\gamma)}$ *until commitment to* $\tau_x = \frac{\gamma(p+\beta)}{\gamma(p+\beta)+\beta(1+\gamma)}$ *is achieved when they increase to* $\frac{i_x}{p}$.

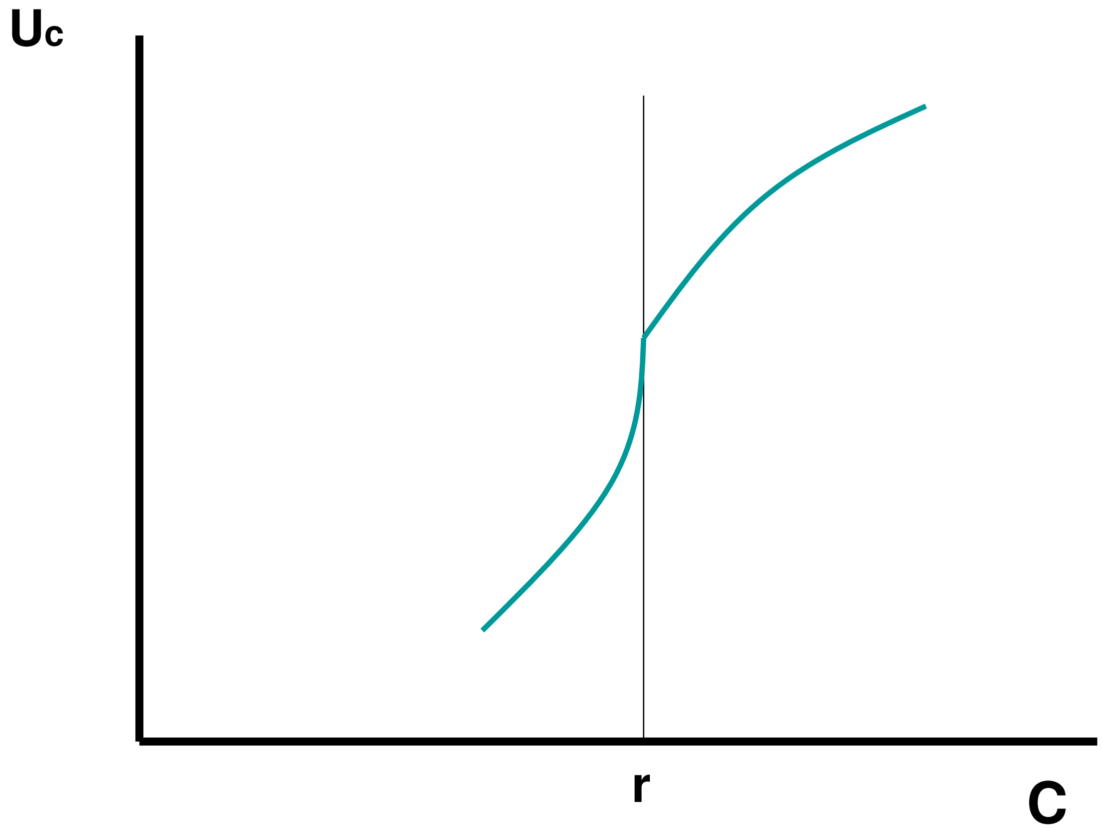
Loss aversion *(1/7)*

- Given expectations of next period tax-rate τ_{t+1}, an entrepreneur born in period t solves

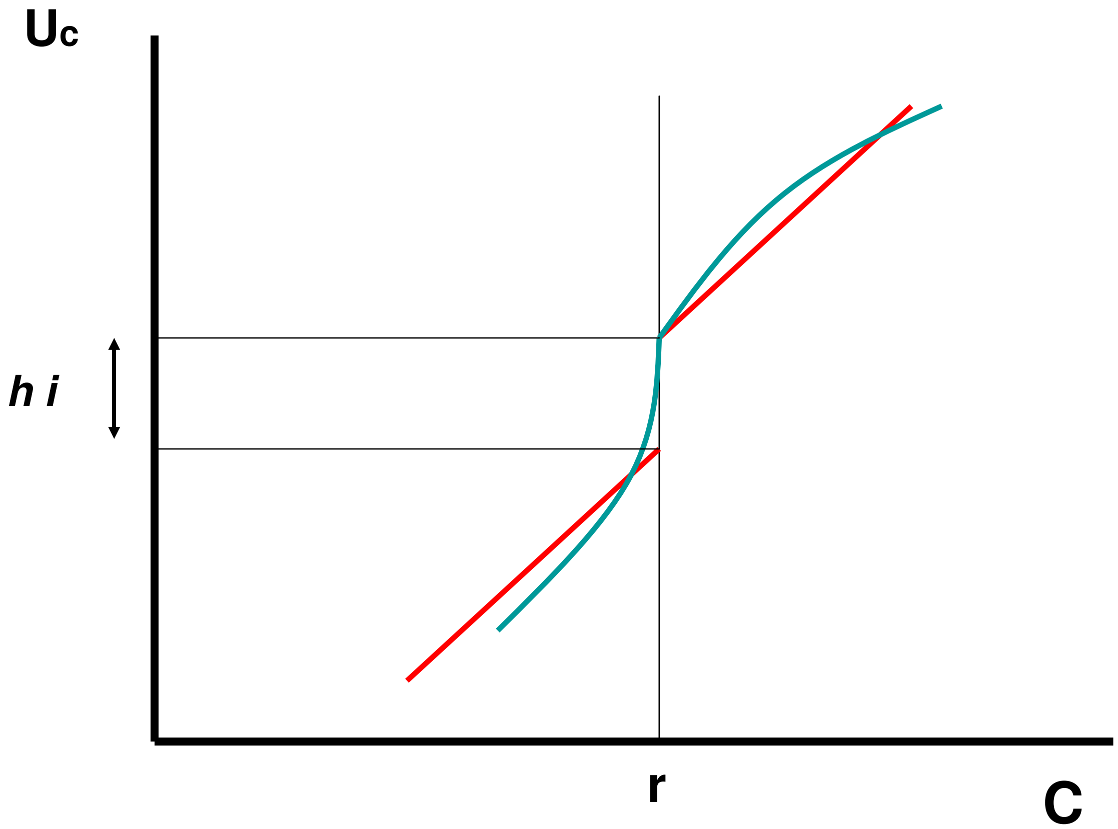
$$\begin{aligned} U_t &= \max_{c_{t+1}, i_t} -\frac{i_t^2}{2} + E_t \beta U_e \left(c_{t+1}, r_{t+1}, i_t\right) \\ s.t. c_{t+1} &= i_t \left(1 - \tau_{t+1}\right) \end{aligned}$$

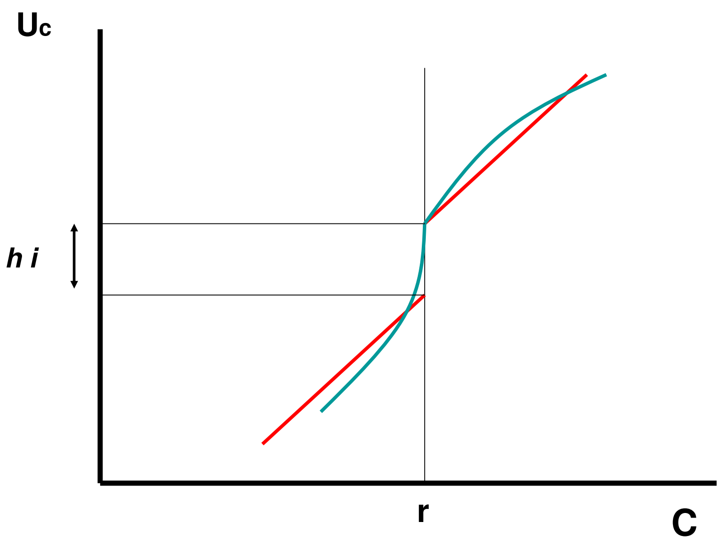
U_e is a loss-averse utility function, depending on c_{t+1}, i_t and the reference point r_{t+1}.

Loss aversion *(2/7)*



Loss aversion *(3/7)*





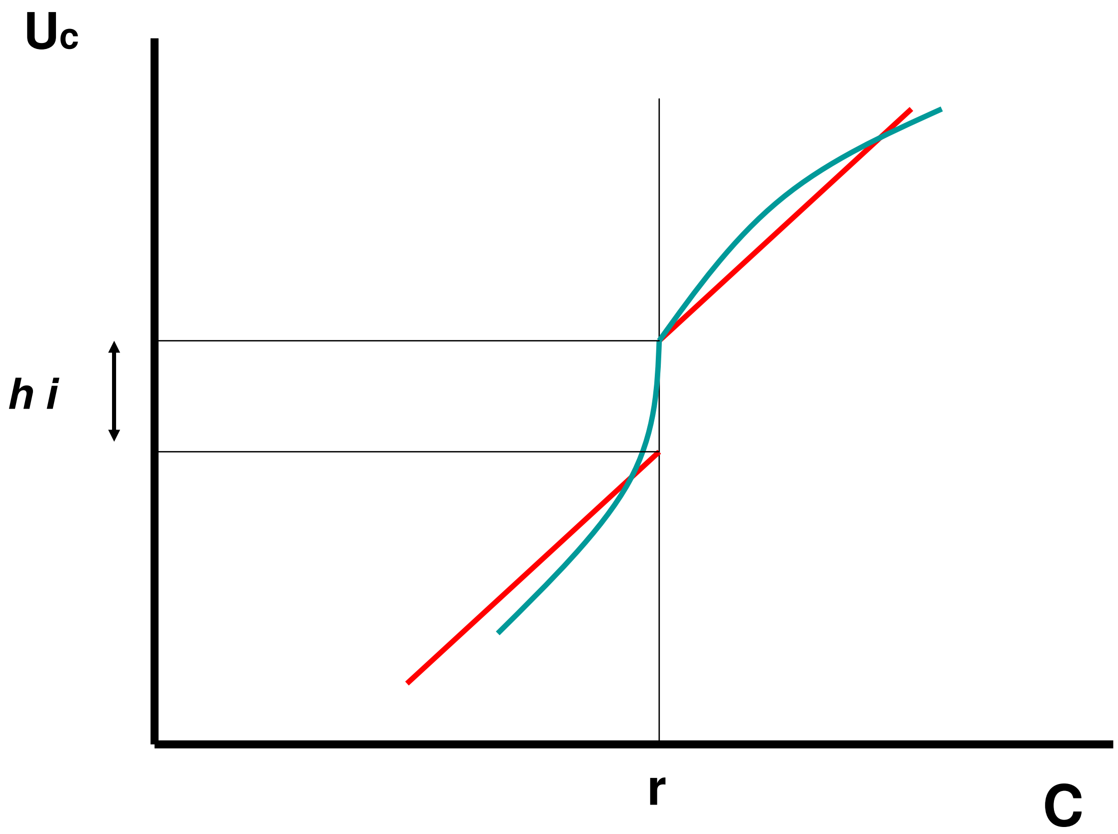
- **Discontinuity at r**;

  $U_e\left(c_{t+1}, r_{t+1}, i_t\right) = c_{t+1} - h \cdot I\left(c_{t+1} < r_{t+1}\right) i_t,$

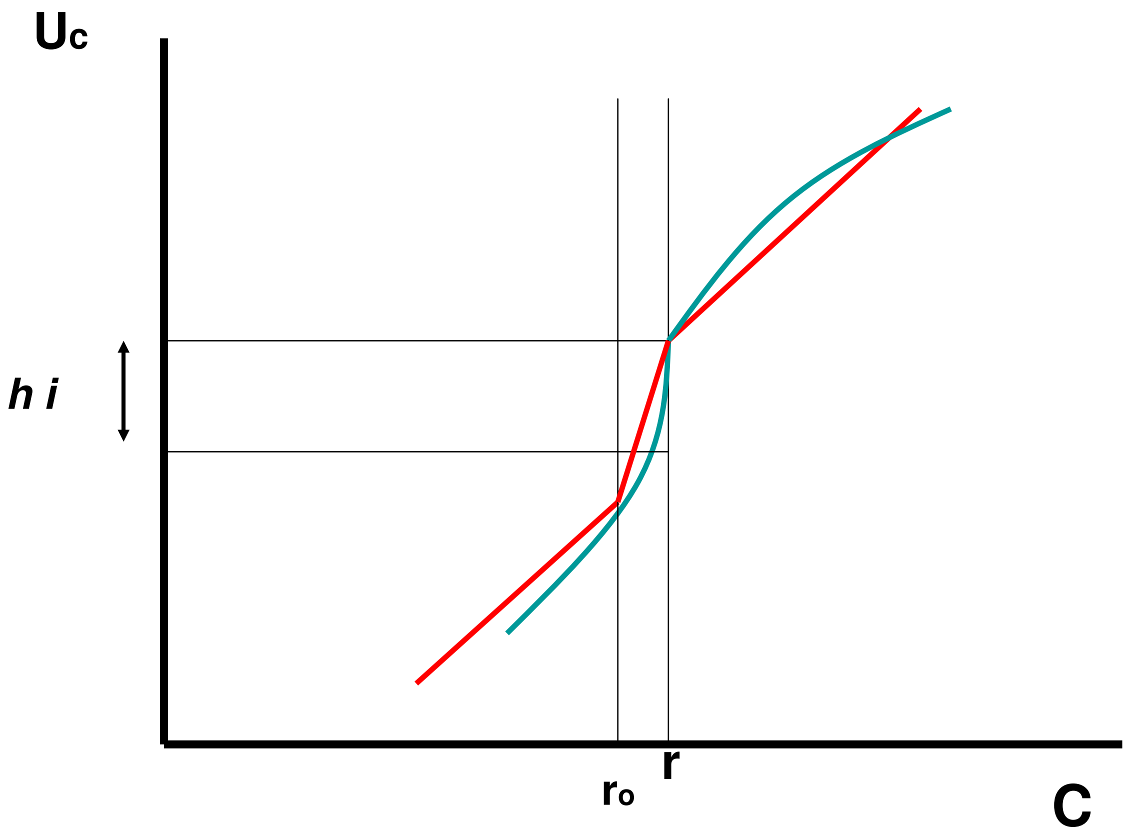
- $h \geq 0$ parameterizes the degree of loss-aversion. Marginal utility, when existing, is unity.

- The loss associated with being "cheated" is proportional to pre-tax income. As investment and pre-tax return approach zero, loss associated with "too high" taxes goes to zero smoothly.

- We can smooth it a bit.



- We can smooth it a bit.



- $h > 0$ implies utility is *loss-averse risk-neutral*. A mean-preserving spread does not affect expected marginal utility, but all key implications of loss aversion discussed above remain.

Reference consumption and reference taxes

- It seems reasonable that reference consumption may depend on individual investments – if an individual invests more, she might feel entitled to more consumption.

- We assume simply

$$r_{t+1} = i_t \left(1 - \tau^r_{t+1}\right),$$

where τ^r_{t+1} is a period t determined reference level for τ_{t+1}

- Implies $c_{t+1} < r_{t+1} \Leftrightarrow \tau_{t+1} > \tau^r_{t+1}$

Investments

- Entrepreneurs choose investments at t to maximize utility,
  - given expectations about taxes at $t+1$
  - and given the reference level for taxes at $t+1$.
- FOC for investment is

$$i_t = \beta E_t \left[1 - \tau_{t+1} - h \cdot I\left(\tau_{t+1} > \tau_{t+1}^r\right)\right].$$

- Note that expectations of becoming "cheated" *reduces* the marginal value of investments.

Utility of workers

- It is “good” to give consumption to workers:

$$U_w(G) = (1 + \gamma)G$$

  with $\gamma > 0$

- γ determines the short run benefit of taxation and redistribution, as workers have a large marginal utility.

- To simplify the presentation, we disregard loss-aversion for workers. If we assume instead:

$$U_w(G_t) = (1 + \gamma)G_t - gI(G_t < G_t^r)$$

  Assuming politicians also promise a level of transfer, reproduces the same result.

  - Intuition: there is no *ex post* political incentive to under-provide transfers.

Tax determination

- Political objective function (alt. social welfare function)

$$W_t \equiv U_e(c_t, r_t, i_{t-1}) + U_w(G_t) - \frac{i_t^2}{2} + \beta U_e\left(c_{t+1}, r_{t+1}, i_t\right) + \beta U_w\left(G_{t+1}\right),$$

subject to the resource constraints

$$\begin{aligned} G_t &= \tau_t i_{t-1}, \\ G_{t+1} &= \tau_{t+1} i_t, \\ c_t &= i_{t-1}(1-\tau_t), \\ c_{t+1} &= i_t\left(1-\tau_{t+1}\right), \end{aligned}$$

and

$$i_t = max\left\{\beta E_t\left[1 - \tau_{t+1} - h \cdot I\left(\tau_{t+1} > \tau_{t+1}^r\right)\right], 0\right\}$$

Equilibrium: *(1/2)*

- Optimizing private behavior, taking into account the rational expected public behavior.

- "Optimizing" public behavior, given rational private behavior.

- Taking into account that future reference points (and political preferences) are determined by today's policies.

Equilibrium: *(2/2)*

- Backward-looking reference formation:

$$\tau_{t+1}^{r} = \tau_t$$

- A Markov equilibrium is a collection of functions $\langle \tau, i \rangle$, such that $\tau_t = \tau\left(i_{t-1}, \tau_t^r\right)$, and $i_t = i\left(\tau_t, \tau_{t+1}^r\right)$,where $\tau : R^+ \otimes [0,1] \to [0,1]$ and i: $[0,1] \otimes [0,1] \to R^+$ satisfying simultaneously

1.- $\tau\left(i_{t-1}, \tau_t^r\right) = \arg\max_{\tau_t} W\left(\tau_t, \tau_{t+1}^r, i\left(\tau_t, \tau_{t+1}^r\right), \tau\left(i\left(\tau_t, \tau_{t+1}^r\right), \tau_{t+1}^r\right), \tau_{t+1}^r; i_{t-1}, \tau_t^r\right)$ s.t.

- $\tau_{t+1}^r = \tau_t$.

2.- $i\left(\tau_t, \tau_{t+1}^r\right) = \max\left\{0, \beta\left(1 - \tau_{t+1} - h \cdot I\left(\tau_{t+1} > \tau_{t+1}^r\right)\right)\right\}$, where

(a).- $\tau_{t+1} = \tau\left(i_t, \tau_{t+1}^r\right)$ and

(b).- $\tau_{t+1}^r = \tau_t$.

Backward-Looking Reference Point Dynamics

- We proceed by backward induction.
  - **Last Period (T)**
  - **Next to last period ($T-1$)**
  - **Previous to next to last ($T-2$)**
  - **Equilibrium characterization**
  - **Finite horizon equilibrium: discussion**
  - **Infinite horizon**

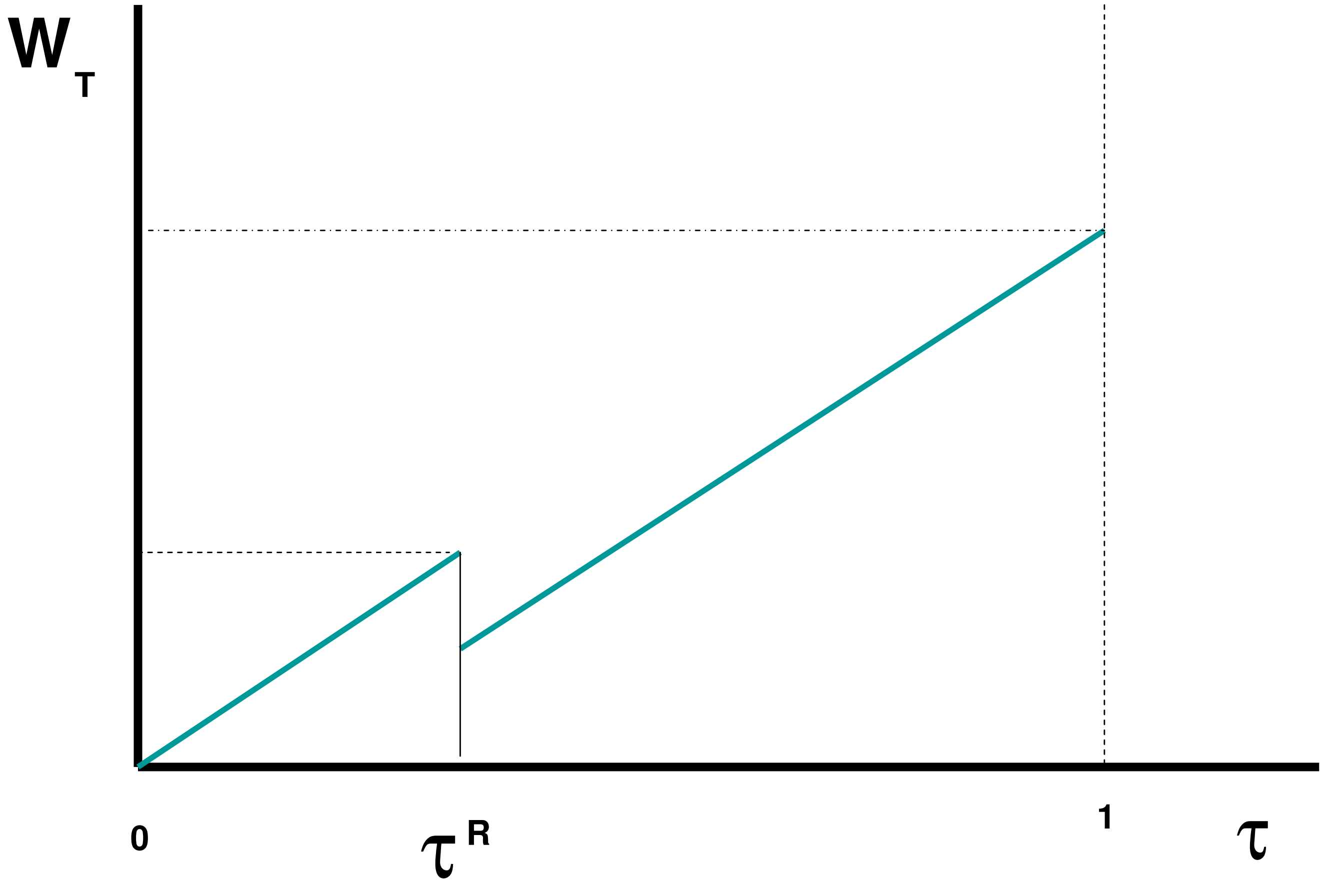
Last Period (T) *(1/5)*

- In final period, the reference point is predetermined and the political objective is

$$\begin{aligned} W_T &= c_T - h \cdot I\left(\tau_T > \tau_T^r\right) i_{T-1} + i_{T-1}\tau_T \left(1+\gamma\right) \\ &= i_{T-1}\left(1 + \gamma\tau_T - h\left(\tau_T > \tau_T^r\right)\right). \end{aligned}$$

- If τ_T^r is low, you choose $\tau_T = 1$

- If it is large, you choose τ_T^r.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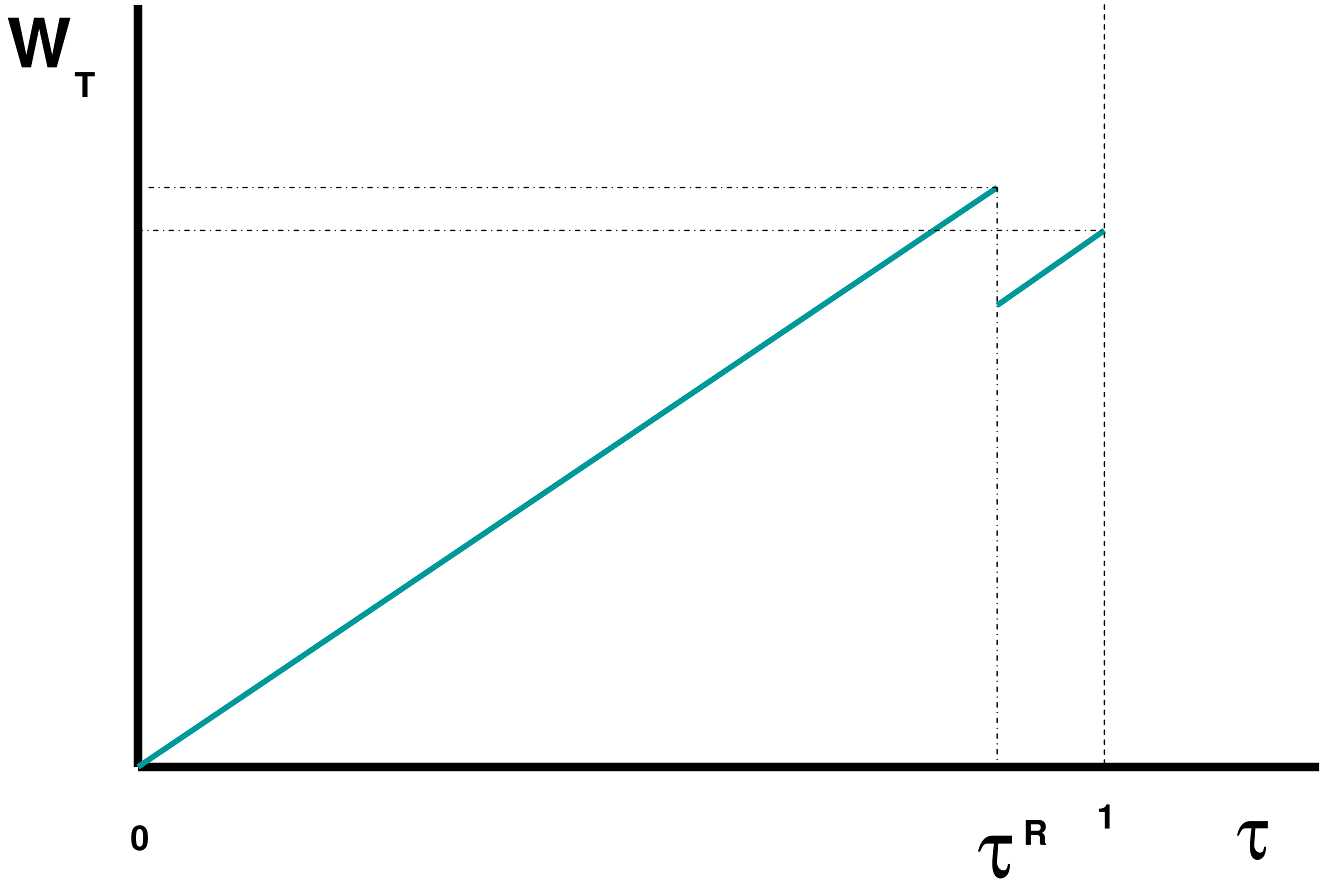
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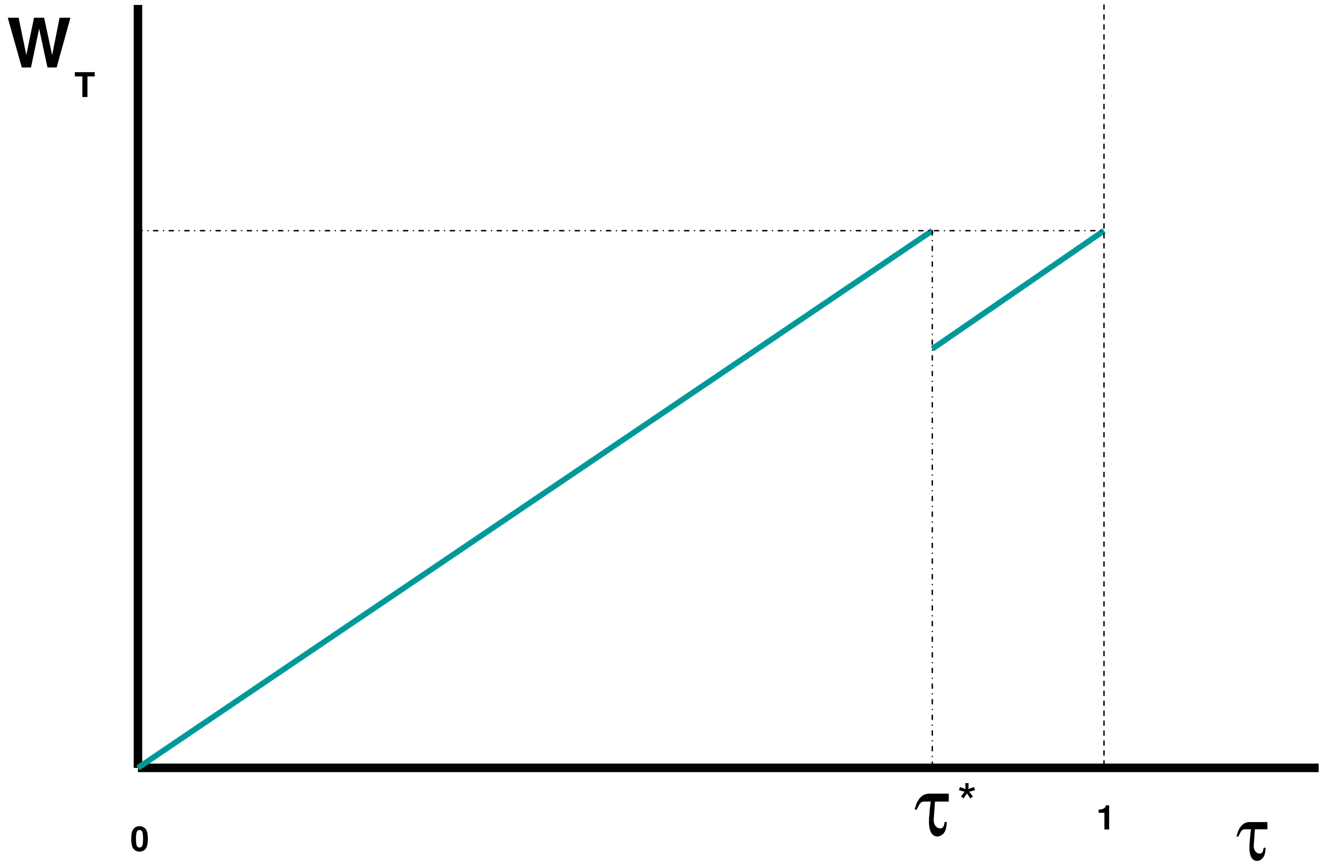
Last Period (T) *(4/5)*



Last Period (T) *(5/5)*

- τ^* is the value of reference point that makes the gov't indifferent between "cheating" and put $\tau_T = 1$ and keep the taxes equal to the reference point.
  - $\tau^* = 1 - \frac{h}{\gamma}$
  - Independent from β, depends only on:
    - the cost of disappointing per unit of investment (h)
    - and the benefits (γ)
- We assume $\tau_f < \tau^*$, you can not get your "second best". Partial commitment.
- Worthwhile to "cheat" people only if τ_T^r is sufficiently low.
  - Independently of period $T-1$ investments.

$$\tau_T = \arg \max_{\tau_T \in [0,1]} W_T = \begin{cases} \tau_T^r & \text{if } \tau_T^r \geq 1 - \frac{h}{\gamma} \\ 1 & \text{else,} \end{cases}$$

loss of "cheating" larger than gain

gain of "cheating" larger than loss

Next to last period $(T-1)$ *(1/3)*

- taxes at T:

$$\tau_T = \begin{cases} \tau_{T-1} & \text{if } \tau_{T-1} \geq \tau^* \\ 1 & \text{else,} \end{cases}$$

The loss of deviating is too large.
The loss of deviating is smaller than the gain.

- Knowing this, in **period $T-1$** individuals choose investment:

$$i_{T-1} = \begin{cases} \beta\left(1-\tau_{T-1}\right) & \text{if } \tau_{T-1} \geq \tau^* \\ 0 & \text{else,} \end{cases}$$

they know that $\tau_T = \tau_{T-1}$.
They know that $\tau_T = 1$.
Tomorrow's temptation will be too large!

- In $T-1$, a reduction in τ_{T-1} **increases** i_{T-1} in the range $\tau_{T-1} \in (\tau^*, 1]$ – **limited costly commitment**.

Next to last period $(T-1)$ *(2/3)*

- We can then show that;

$$\tau_{T-1}(\tau_{T-2}) = \tau^* \quad \forall \quad \tau_{T-2}, \quad i_{T-2}$$

- The tax is independent from the state variable $(\tau^r_{T-1} = \tau_{T-2})$!!!

- If smaller than τ^*, $i = 0$ as agents anticipate $\tau_T = 1$. That is bad. You do not do it.

- If larger than τ^*, you can do better by reducing taxes (as $\tau_f < \tau^*$ is your preferred once-and-for-all commitment tax, if unconstrained by loss aversion burden.

Next to last period $(T-1)$ *(3/3)*

- $\tau_f < \tau^*$, so W is decreasing $\forall \tau \in [\tau^*, 1]$.
  - Increase in taxes reduces investment.
  - So, taxes τ_{T-1} not larger than τ^*: $\tau_{T-1} \leq \tau^*$
- If $\tau_{T-1} < \tau^*$, investment i_{T-1} will be zero, since agents then rationally expect $\tau_T = 1$.
  - $i_{T-1}(\tau_{T-1})$ is discontinuous at τ^*!!!!!!
- If τ_{T-2} was large $(\tau^* < \tau_{T-2})$, then certainly $\tau_{T-1} = \tau^*$,
  - There is no loss aversion in reducing taxes to τ^*
  - and the investment would fall dramatically if you reduce it further.
- If $\tau_f \leq \tau_{T-2} < \tau^*$.
  - h (the utility loss due to an increase in taxes) is not large enough to prevent an increase to τ^*.
  - By increasing the taxes you incur in a loss,
  - But you also increase investment (it would be zero if $\tau_{T-1} < \tau^*$.
  - the same if $\tau_f \leq \tau_{T-2} < \tau^*$
  - So it can not be that $\tau_{T-1} < \tau^*$.

Previous to next to last $(T-2)$

- We now know that τ_{T-1} is set independently of τ_{T-2}, i.e.,
  - τ_{T-1} **is politically forward-looking only**.

- Since τ_{T-1} is set independently of τ_{T-2}, political decisions on τ_{T-2} can be taken without considerations about the future.

- The optimal choice of τ_{T-2} is therefore identical to that of period T.

$$\tau_{T-2} = T_{T-2}(\tau_{T-3}) = \begin{cases} \tau_{T-3} \text{ if } \tau_{T-3} \geq \tau^*, \\ 1 \text{ else,} \end{cases}$$

τ_{T-2} **is politically backward-looking** .

- Continuing backward, we establish:

The only finite horizon equilibrium features

$$\tau_{T-s} = \begin{cases} \tau_e\left(\tau_{T-s-1}\right) & = \begin{cases} 1 & \text{if } \tau_{T-s-1} < \tau^* \\ \tau_{T-s-1} & \text{if } \tau_{S-s-1} \geq \tau^* \end{cases} \text{ and } s \text{ is even.} \\ \\ \tau_o\left(\tau_{T-s-1}\right) & = \tau^* \text{ if } s \text{ is odd.} \end{cases}$$

Finite horizon equilibrium: discussion

- The equilibrium involves oscillation between forward-looking strategic behavior (the odd strategy) and complete "myopic" behavior, constrained by the previous tax rate. These oscillations are key to the equilibrium existence.

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- If voters and political candidates expect future voters to behave strategically, limiting next periods taxes in order to constrain later taxes, there is no need to be strategic already in the current period. Instead, it is better to **procastinate**, behaving myopically.
- Conversely, an expectation that future voters will behave myopically, creates an incentive to act strategically in the current period, despite its short run costs.
- Although tax policies must oscillate in equilibrium, the actual tax-rate does not. It is constant at $1 - \frac{h}{\gamma} \equiv \tau^*$ after the first period.

Infinite horizon *(1/2)*

- First, the finite horizon equilibrium does not converge to a Markov equilibrium as the horizon is extended backwards to infinity.

- The logic – that expectation of future myopia gives incentives for strategic behavior and *vice versa* – suggests the existence of a Markov equilibrium in mixed strategies.

- The conjecture is correct.

- A Markov equilibrium exists with the following characteristics:

$$\tau_t = \tau(\tau_{t-1}) = \begin{cases} \tau_e(\tau_{t-1}) & \text{with probability} \quad 1 - p(\tau_{t-1}) \\ \tau_o(\tau_{t-1}) & \text{with probability} \quad p(\tau_{t-1}) \end{cases},$$

$$i(\tau_t) = \begin{cases} 0 & \text{if} \quad \tau_t < \tau^* \\ \beta(1 - \tau_t + p(\tau_{t-1})(\tau_t - \tau^*)) & \text{if} \quad \tau_t \geq \tau^* \end{cases}$$

  with $i'(\tau_t) < 0 \; \forall \tau_t > \tau^*$.

- Starting from any $\tau_0 \in [0,1]$ and $i_0 = i(\tau_0)$, the equilibrium tax-rate converges with probability 1 to τ^*.

$$p(\tau_t^r) = \begin{cases} 1 \text{ for } \tau_t^r = 1, \\ \frac{p_1 + \frac{1}{2}\sqrt{\left((2p_1)^2 - 4p_2(2(p_1+\gamma h) - p_2)\right)}}{p_2} \text{ for } 1 > \tau_t^r > \tau^* \\ < \gamma \text{ for } \tau < \tau^* \end{cases},$$

$$\begin{aligned} p_1 &= \gamma(\gamma(1+\beta)(1-\tau) - \beta\tau(1+\gamma) - h) \text{ and} \\ p_2 &= \beta(\gamma(1-\tau) - h)(1+2\gamma). \end{aligned}$$

- Starting from any $\tau_0 \in [0,1]$ and $i_0 = i(\tau_0)$, the equilibrium tax-rate converges with probability 1 to τ^*.

Forward-looking loss-aversion

- We proceed by backward induction.
  - **Forward looking Reference Dynamics**
  - **Equilibrium Definition**
  - **Last Period (T)**
  - **Next to last period ($T-1$)**
  - **Previous to next to last ($T-2$)**
  - **Equilibrium characterization**
  - **Discussion**

Forward looking Reference Dynamics

- … Framing
- Like Köszegi and Rabin, we assume that reference points are rational expectations.
- We require τ^r_{t+1} to be in the set of equilibrium tax rates for $t+1$.
- We allow politicians to affect reference points by making "promises" about the future. But remember that the promise is empty – the politician does not remain in office nor runs again and he has no formal commitment power.
- The promise can affect the future if it is believed, in which case it becomes the the reference point.
- It is believed if it is done by the winning candidate and is in the set of equilibria for next period. If the promise is not an equilibrium, τ^r_{t+1} is some element of the set of equilibrium tax rates.
- If the promise is not an equilibrium outcome, then it is not believed. In that case they believe taxes will be some (any) credible value.

A Markov equilibrium is a collection of functions $\langle \tau, \tau^p, i \rangle$, such that $\tau_t = \tau(i_{t-1}, \tau_t^r)$, $\tau_{t+1}^p = \tau(i_{t-1}, \tau_t^r)$ and $i_t = i\left(\tau_t, \tau_{t+1}^p\right)$,where $\tau : R^+ \otimes [0,1] \to [0,1]$ and i: $[0,1] \otimes [0,1] \to R^+$ satisfying simultaneously

1.- $\tau(i_{t-1}, \tau_t^r) = \arg\max_{\tau_t} W\left(\tau_t, \tau_{t+1}^p, i\left(\tau_t, \tau_{t+1}^p\right), \tau\left(i\left(\tau_t, \tau_{t+1}^p\right), \tau_{t+1}^r\right), \tau_{t+1}^r; i_{t-1}, \tau_t^r\right)$ s.t.

- τ_{t+1}^r satisfying **F**.

2.- $\tau^p(i_{t-1}, \tau_t^r) = \arg\max_{\tau_{t+1}^p} W\left(\tau_t, \tau_{t+1}^p, i\left(\tau_t, \tau_{t+1}^p\right), \tau\left(i_t, \tau_{t+1}^r\right), \tau_{t+1}^r; i_{t-1}, \tau_t^r\right)$ s.t.

- τ_{t+1}^r satisfying **F**.

3.- $i\left(\tau_t, \tau_{t+1}^p\right) = \max\left\{0, \beta\left(1 - \tau_{t+1} - h \cdot I\left(\tau_{t+1} > \tau_{t+1}^r\right)\right)\right\}$, where

(a).- $\tau_{t+1} = \tau\left(i_t, \tau_{t+1}^r\right)$ and

(b).- τ_{t+1}^r satisfying **F**.

- 1 and 2 imply that the policy maker explicitly takes into account that the choice of τ_t and τ^p_{t+1} can affect next periods taxes, **since** $\tau_{t+1} = \tau\left(i\left(\tau_t, \tau^p_{t+1}\right), \tau^r_{t+1}\right)$

- The private choice (3) is taken for a given τ_{t+1} and 3(a) requires that this value satisfies rational expectations.

Last Period (T)

- Exactly like before:
- τ^* is the value of reference point that makes the gov't indifferent between "cheating" and put $\tau_T = 1$ and keep the taxes equal to the reference point.
  - $\tau^* = 1 - \frac{h}{\gamma}$
  - Independent from β, depends only on:
    - the cost of disappointing per unit of investment (h)
    - and the benefits (γ)
- Worthwhile to "cheat" people only if τ_T^r is sufficiently low.
  - Independently of period $T - 1$ investments.

$$\tau_T = \arg \max_{\tau_T \in [0,1]} W_T = \begin{cases} \tau_T^r & \text{if } \tau_T^r \geq 1 - \frac{h}{\gamma} \\ 1 & \text{else,} \end{cases}$$

loss of "cheating" larger than gain

gain of "cheating" larger than loss

Next to last period ($T-1$) *(1/2)*

- The reference point at T is determined by the promises made at $T-1$.

  Promises at or above τ^* would have been believed, forming the reference point:

$$\tau_T^r = \begin{cases} \tau_T^p & \text{if } \tau_T^p \geq \tau^* \quad \text{If the promise can be believed} \\ \bar{\tau} & \text{else.} \quad \text{If the promise can **not** be believed} \end{cases}$$

where $\bar{\tau} \in [\tau^*, 1]$ is the (out of equilibrium) belief if $\tau_T^p < \tau^*$

- Given period T tax decisions, investments in $T-1$ are

$$i_{T-1} = \begin{cases} \beta\left(1-\tau_T^p\right) & \text{if } \tau_T^p \geq \tau^* \quad \text{the promise is believed} \\ \beta(1-\bar{\tau}) & \text{else.} \quad \text{the promise is **not** believed} \end{cases}$$

  - Notice! They do not depend on the taxes placed at $T-1$, only on the promises made at $T-1$ on the taxes at T.

Next to last period ($T-1$) *(2/2)*

- In period $T-1$ political competition maximizes voter welfare.
  - The problem of choosing τ_{T-1} is identical to that at T,
    - The investment is not affected by it!

$$\tau_{T-1} = \begin{cases} \tau^r_{T-1} & \text{if } \tau^r_{T-1} \geq \tau^*, \\ 1 & \text{else.} \end{cases}$$

  - The "promise" at $T-1$ on T that maximizes voter welfare is

$$\tau^p_T = \max\{\tau_c, \tau^*\}$$

+ Nothing below τ^* is believed
+ Going below the commitment tax rate is suboptimal.

Previous to next to last ($T-2$)

The problem is perfectly identical to the one at $T-1$.

- The reference point for $T-1$ depends on if the promise made at $T-2$ is believed...
  - On whether it is larger than $\tau*$
  - because τ_{T-1} depends only on this.
- The investment level depends only on the promise for $T-1$, not on τ_{T-2}
- The political decision on τ_{T-2} does not affect the investment.
  - Thus, it depends only on whether τ_{T-2} is larger than the reference for $T-2$ (a state variable).
- The political decision on the promise is the max of
  - $\tau*$ (nothing lower is believed) or
  - τ_c (it is the global max, and you want it **if it is believable**)

Equilibrium characterization

- There is a unique equilibrium in the finite horizon case.
- This equilibrium is also a Markov equilibrium in the infinite horizon
- and features

$$\begin{aligned} \tau_t &= \tau\left(\tau_t^p\right) = \begin{cases} \tau_t^p & \text{if} \tau_t^p \geq \tau^* \\ 1 & \text{else.} \end{cases} \\ \tau_{t+1}^p &= \tau^p\left(\tau_t^p\right) = \max\left\{\tau_c, \tau^*\right\} \\ i_t &= i\left(\tau_{t+1}^p\right) = \begin{cases} \beta\left(1-\tau_{t+1}^p\right) & \text{if } \tau_{t+1}^p \geq \tau^* \\ \beta\left(1-\bar{\tau}\right) & \text{else.} \end{cases} \end{aligned}$$

for $\tau^* \equiv 1 - \frac{h}{\gamma}$ and any $\bar{\tau} \in [\tau^*, 1]$

- **Thus**, given any starting $\left[i_0, \tau_1^p\right]$, then $\forall t > 1$ the tax is

$$\tau_t = \max\left\{\tau_c, \tau^*\right\}$$

Discussion

- Equilibrium
  - Renegotiation proof.
  - Does not rely on strategies with long memory.
  - Independent of β, because it hinges on the gain today.
  - Tomorrow's things are determined by the promises.
  - Promises need to be credible.
- Equilibrium provides with the equivalent of partial commitment.
- With worker loss-aversion, the equilibrium is identical.

What have we learn?

1. **Procrastination Principle:**

   - If there are short run cost of future commitment, **It takes time to achieve commitment in equilibrium**.

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4. In the measure that **Reference point dynamics** are **backward looking** (experience), slow commitment

Loss Aversion and the Dynamics of Political Commitment

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June 4, 2010