## The Political Economy of Nonlinear Capital Taxation

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Iván Werning

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The Political Economy of Nonlinear Capital Taxation

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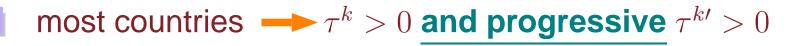


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 $\triangleright$   $\tau^{K} > 0$ : corporate tax, capital gains, income tax

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\$\nabla^K > 0\$: corporate tax, capital gains, income tax
 \$\nabla^{K'} > 0\$: income tax

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most countries  $\rightarrow \tau^k > 0$  and progressive  $\tau^{k'} > 0$ 

\$\tau^K > 0\$: corporate tax, capital gains, income tax
 \$\tau^{K'} > 0\$: income tax

- ► Atkinson-Stiglitz:  $\tau^k = 0$
- **Chamley-Judd:**  $\tau^k = 0$
- ▶ others:  $\tau^k \neq 0$  (Non-Separability / Inverse Euler)

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# **Q:** Equilibrium Capital Taxation **?**

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# **Q:** Equilibrium Capital Taxation **?**

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- **positive** theories?  $\rightarrow \tau^{K} > 0$ , silent on  $\tau^{K'}$
- time-inconsistency (Kydland-Prescott)
- representative agent
- linear taxes
- ex-post: capital = lump-sum
- no-commitment

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**positive** theories?  $\rightarrow \tau^{K} > 0$ , silent on  $\tau^{K'}$ 

- time-inconsistency (Kydland-Prescott)
  - representative agent
- linear taxes
- ex-post: capital = lump-sum
- no-commitment capital taxation
- redistribution
  - commitment but heterogenous agents
  - linear tax on capital + lump-sum rebate
  - mediant voter + skewed distribution

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    - capital taxation

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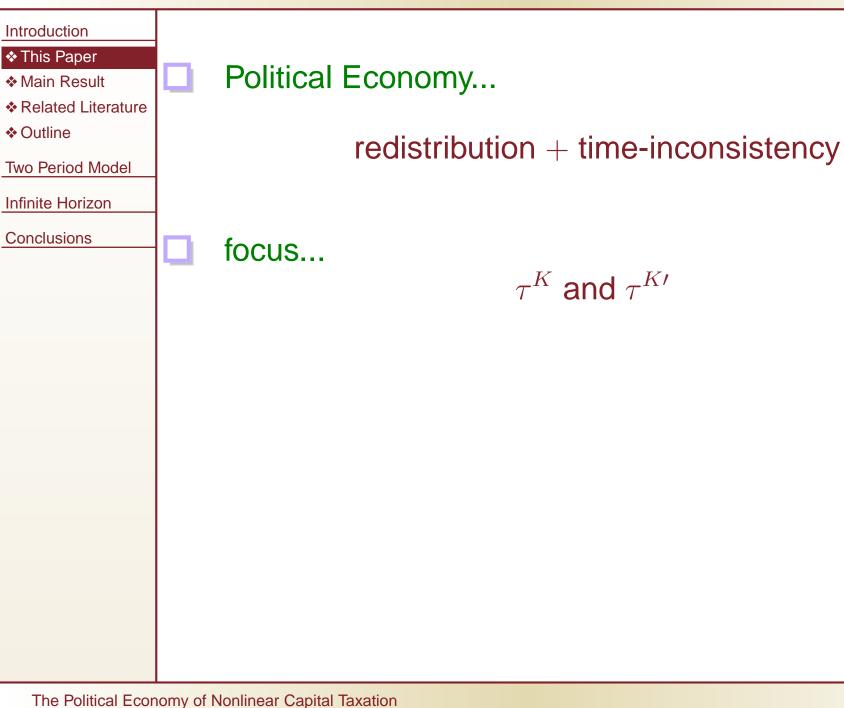
Two Period Model

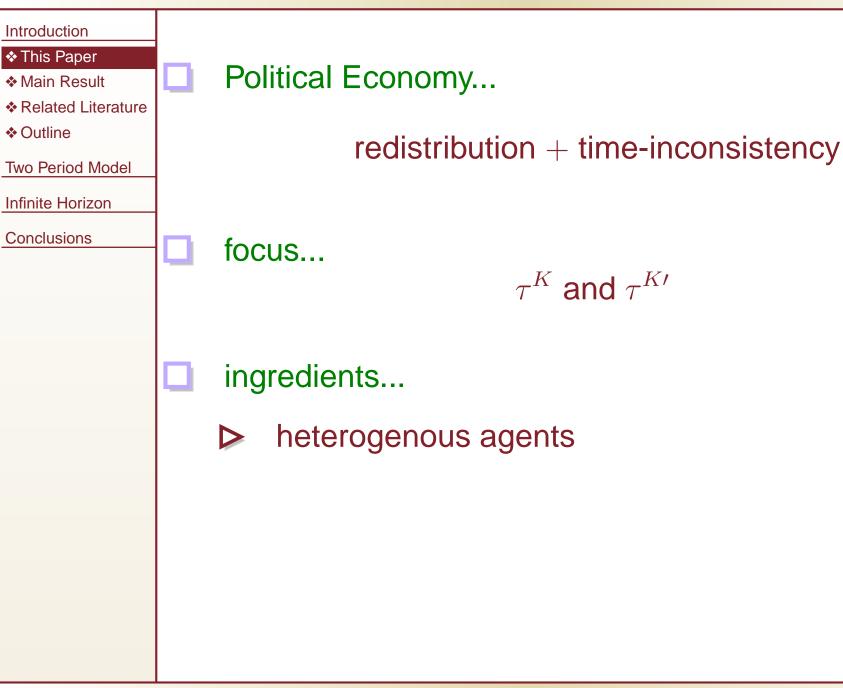
Infinite Horizon

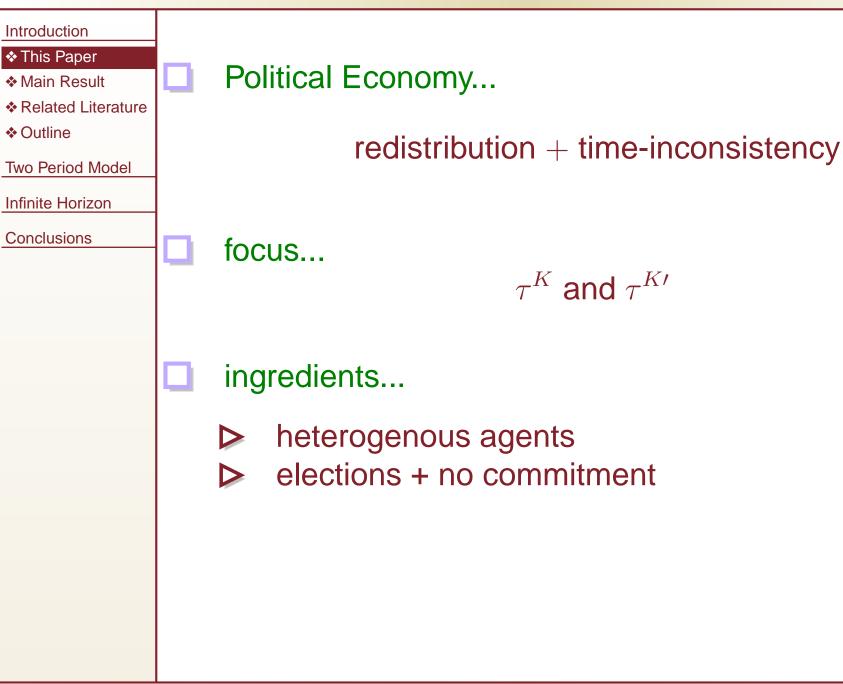
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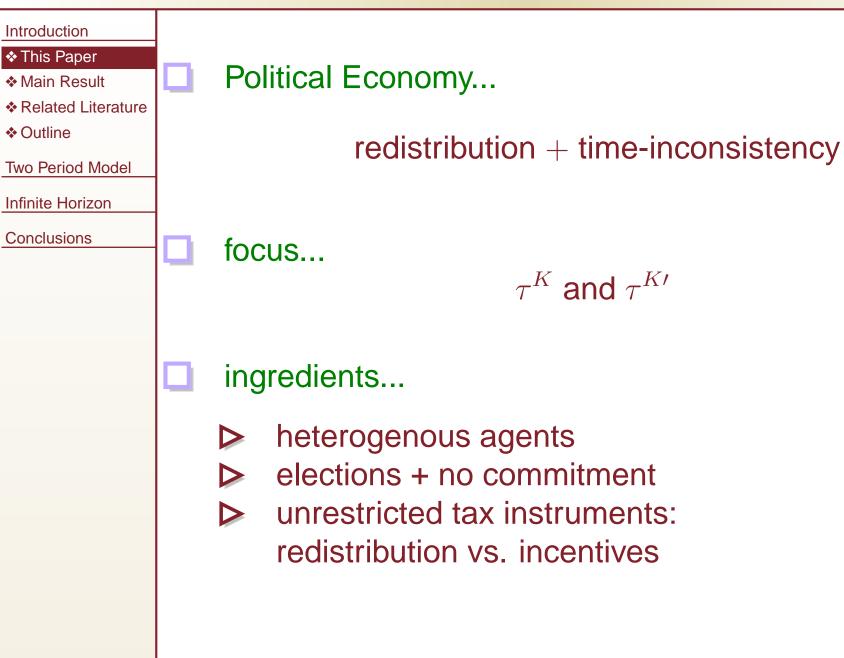
Political Economy...

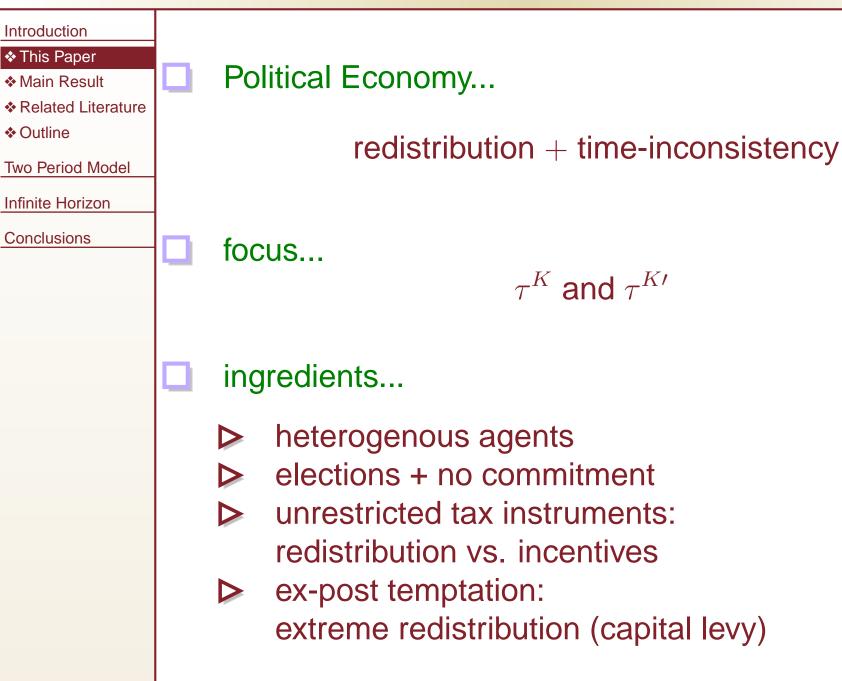
redistribution + time-inconsistency

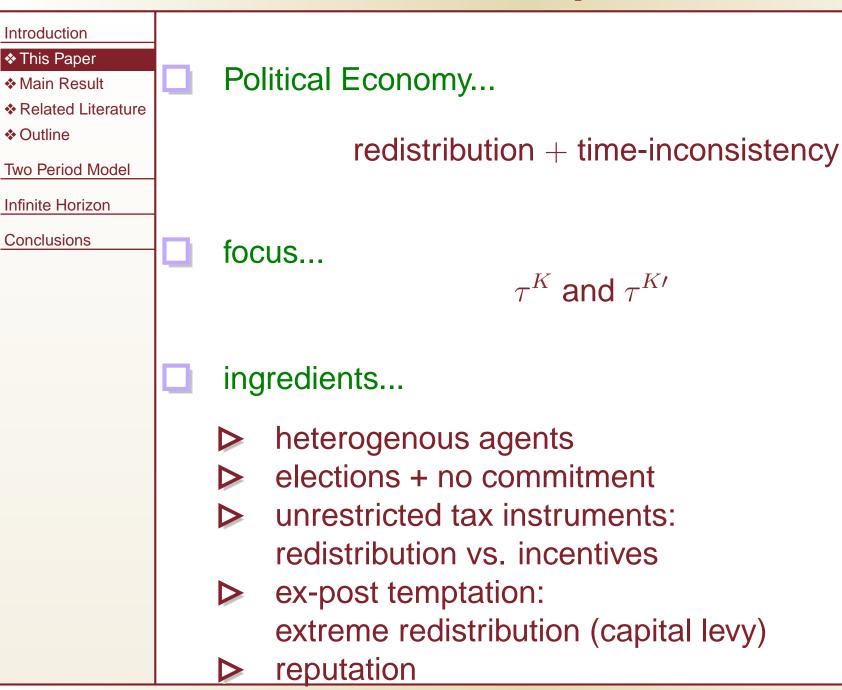


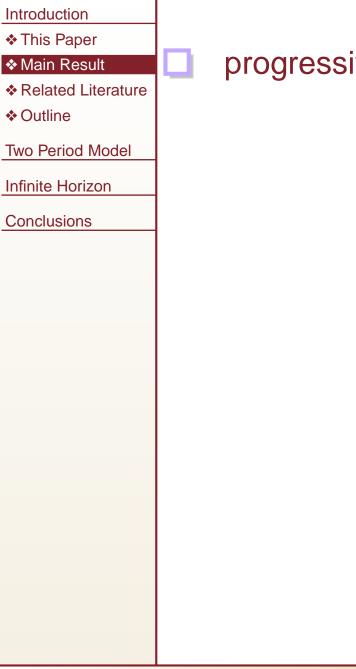




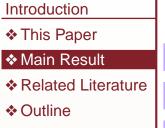








progressive capital tax:  $\tau^{K\prime} > 0$ 

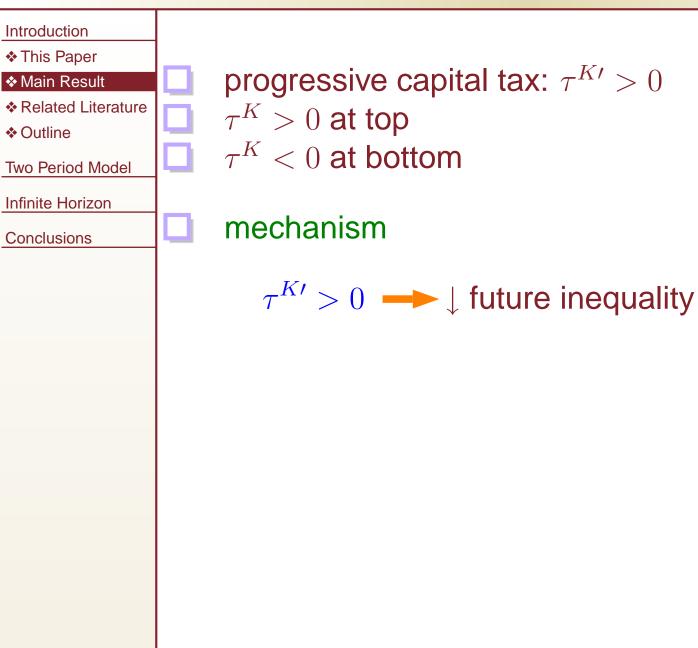


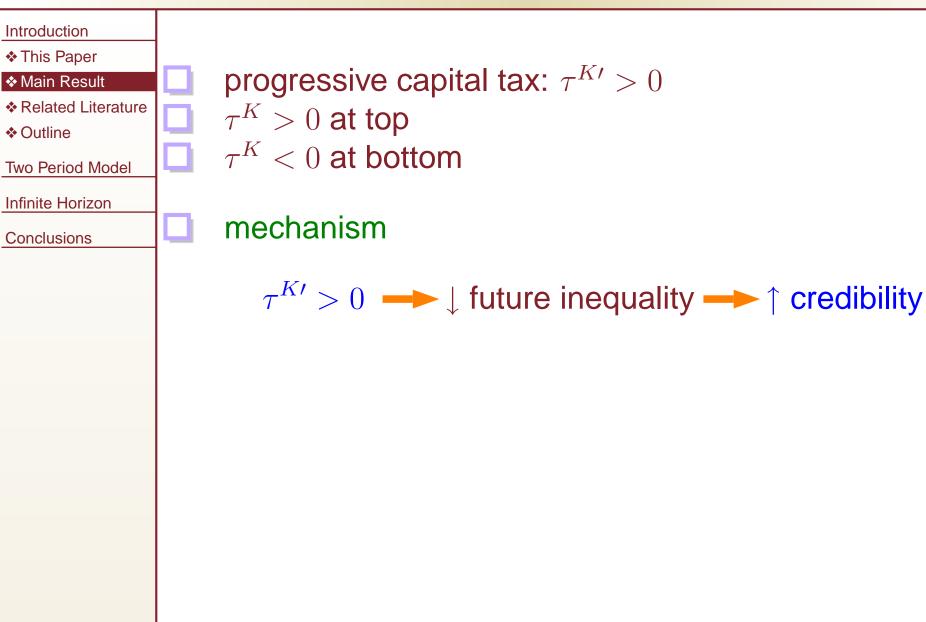
```
progressive capital tax: \tau^{K'} > 0
\tau^{K} > 0 at top
\tau^{K} < 0 at bottom
```

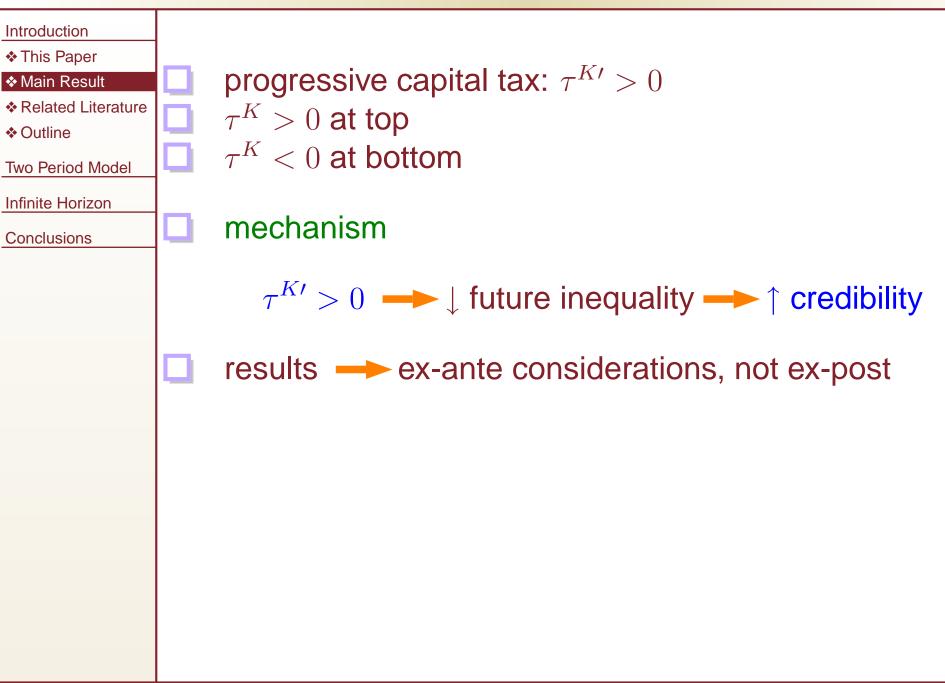
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## **Related Literature**

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time-inconsistency: Kydland-Prescott (1977); Fischer (1980); Klein-Rios-Rull (2003)

Reputation: Kotlikoff-Persson-Svensson (1988); Chari-Kehoe (1990); Benhabib-Rustichini (1996)

Ramsey...

## **Related Literature**

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### Redistribution...

Ramsey...

median voter + commitment: Persson-Tabellini (1994); Alesina-Rodrick (1994); Bertola (1993)

## **Related Literature**

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- time-inconsistency: Kydland-Prescott (1977); Fischer (1980); Klein-Rios-Rull (2003)
- Reputation: Kotlikoff-Persson-Svensson (1988); Chari-Kehoe (1990); Benhabib-Rustichini (1996)

### Redistribution...

Ramsey...

- median voter + commitment: Persson-Tabellini (1994); Alesina-Rodrick (1994); Bertola (1993)
- Mirrleesian economies...
  - Political economy: Sleet-Yeltekin (2007); Acemoglu-Golosov-Tsyvinski (2007)
  - intergenerational optimum: Farhi-Werning (2007, 2008)

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| Introduction  | 1. | Two Period Model       |  |
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### **Outline**

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### Two Period Model

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### **Two Period Model**

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### continuum of agents $\theta$

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# continuum of agents $\theta$ preferences

$$v_0 = u(c_0) - \theta h(n_0) + \beta u(c_1)$$

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# continuum of agents $\theta$ preferences

$$v_0 = u(c_0) - \theta h(n_0) + \beta u(c_1)$$

### resource constraint

$$\int c_0(\theta) \, dF(\theta) + k_1 \le \int n_0(\theta) \, dF(\theta)$$

$$\int c_1(\theta) \, dF(\theta) \le Rk_1$$
[RC]

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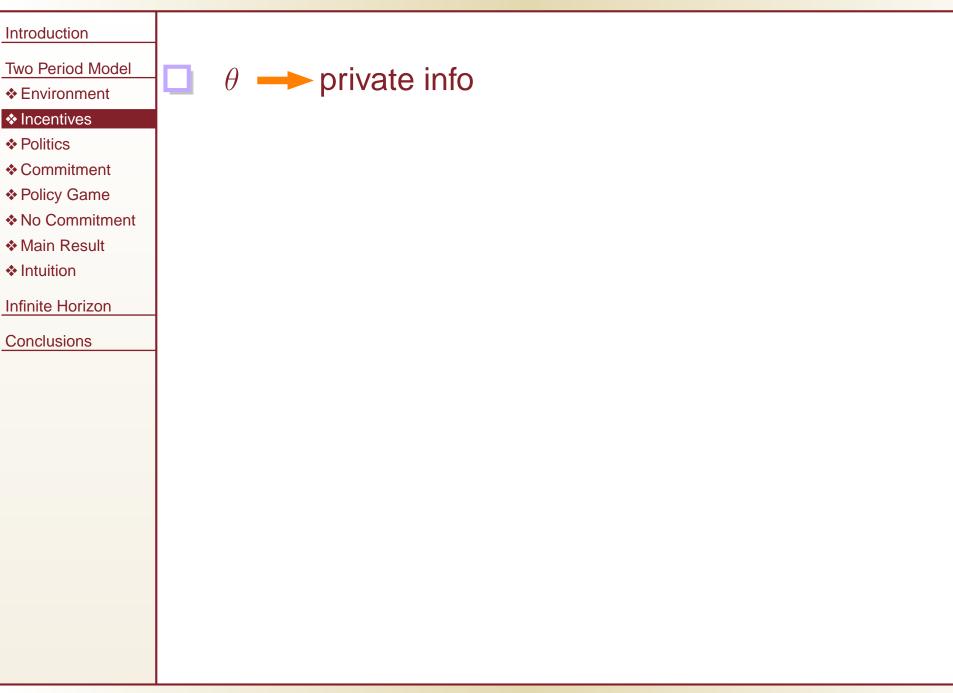
# continuum of agents $\theta$ preferences

$$v_0 = u(c_0) - \theta h(n_0) + \beta u(c_1)$$

### resource constraint

$$\int c_0(\theta) \, dF(\theta) + \frac{1}{R} \int c_1(\theta) \, dF(\theta) \le \int n_0(\theta) \, dF(\theta)$$
[RC]

### Incentives



## Incentives

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## $\theta \longrightarrow$ private info incentive compatibility: $(c_0(\theta), n_0(\theta), c_1(\theta))$ :

$$u(c_0(\theta)) - \theta h(n_0(\theta)) + \beta u(c_1(\theta)) \ge u(c_0(\theta')) - \theta h(n_0(\theta')) + \beta u(c_1(\theta'))$$
[IC]

## Incentives

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[IC]

### budget constraints:

$$c_0 + a_0 \le n_0 - T^n(n_0)$$
  
 $c_1 \le Ra_0 - T^a(a_0)$  [BC]

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## $\theta \longrightarrow \text{private info}$ incentive compatibility: $(c_0(\theta), n_0(\theta), c_1(\theta))$ :

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 $c_1 \le Ra_0 - T^a(a_0)$  [BC]

**Proposition.** [Implementation]

[IC] ← [BC]

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Probabilistic voting

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### **Probabilistic voting**

- two candidates: A vs. B
- **>** propose policies  $\rightarrow v_0^i(\theta)$  for i = A, B

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### **Probabilistic voting**

- two candidates: A vs. B
- **>** propose policies  $\rightarrow v_0^i(\theta)$  for i = A, B
- agents vote, comparing

 $v_0^A(\theta) + \varepsilon^A \quad \text{VS.} \quad v_0^B(\theta) + \varepsilon^B$ 

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$$v_0^A(\theta) + \varepsilon^A$$
 vs.  $v_0^B(\theta) + \varepsilon^B$ 

 $\varepsilon^A - \varepsilon^B$ : uniform and i.i.d.
 result --> maximize

$$\int v_0(\theta) \, dF(\theta)$$

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crucial: values equality in consumption

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## Commitment benchmark

 $\max \int v_0(\theta) \, dF(\theta) \quad \text{s.t.} \quad \text{IC and RC}$ 

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## Commitment benchmark

$$\max \int v_0(\theta) \, dF(\theta) \quad \text{s.t.} \quad \text{IC and RC}$$

### define marginal tax

```
u'(c_0(\theta)) = \beta R(1 - \tau(\theta))u'(c_1(\theta))
```



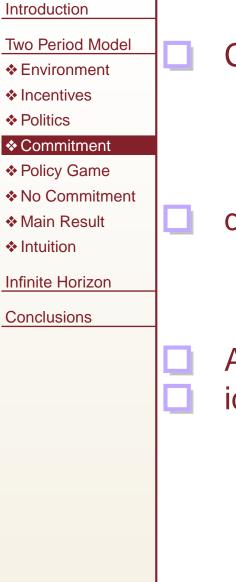
## Commitment benchmark

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\max \int v_0(\theta) \, dF(\theta) \quad \text{s.t.} \quad \text{IC and RC}
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### define marginal tax

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u'(c_0(\theta)) = \beta R(1 - \tau(\theta))u'(c_1(\theta))
```

```
Atkinson-Stiglitz \rightarrow \tau^k(\theta) = 0
```



## **Commitment benchmark**

```
\max \int v_0(\theta) \, dF(\theta) \quad \text{s.t.} \quad \text{IC and RC}
```

### define marginal tax

```
u'(c_0(\theta)) = \beta R(1 - \tau(\theta))u'(c_1(\theta))
```

Atkinson-Stiglitz  $\rightarrow \tau^k(\theta) = 0$ idea: separability

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### voting in each period

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### voting in each period

▶ t = 0: choose tax system to max  $\int v_0(\theta) dF(\theta)$ 

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### voting in each period

- ▶ t = 0: choose tax system to max  $\int v_0(\theta) dF(\theta)$
- ▶ t = 1: choose reform or not to max  $\int v_1(\theta) dF(\theta)$

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### voting in each period

- ▶ t = 0: choose tax system to max  $\int v_0(\theta) dF(\theta)$ ▶ t = 1: choose reform or not to max  $\int v_1(\theta) dF(\theta)$
- reform...
- $\triangleright$  cost:  $\rho$  lost output

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### voting in each period

► t = 0: choose tax system to max  $\int v_0(\theta) dF(\theta)$ ► t = 1: choose reform or not to max  $\int v_1(\theta) dF(\theta)$ 

### reform...

- $\triangleright$  cost:  $\rho$  lost output
- benefit: equalize consumption  $c_1(\theta) = Rk_1 \rho$

### compare...

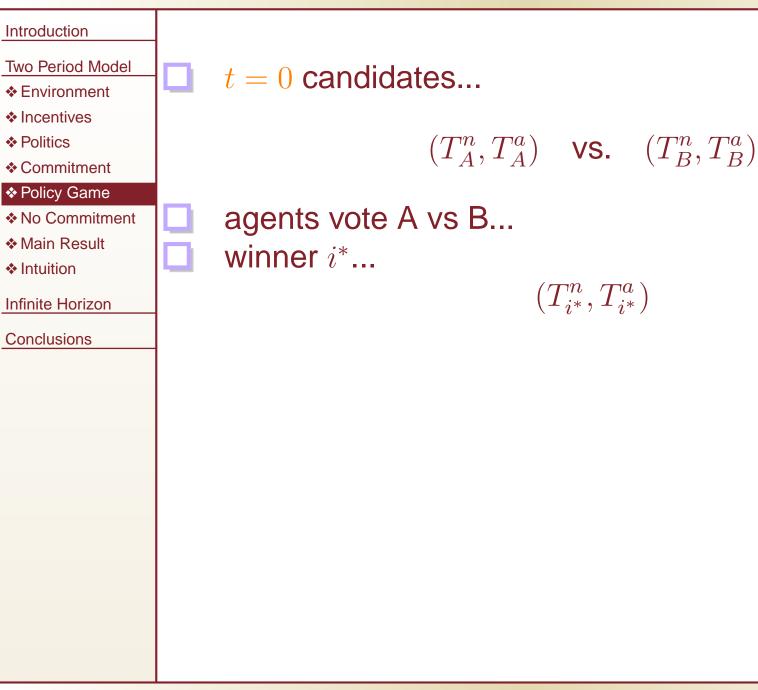
$$\int u(c_1(\theta)) \, dF(\theta) \quad \text{VS.} \quad u(Rk_1 - \rho)$$

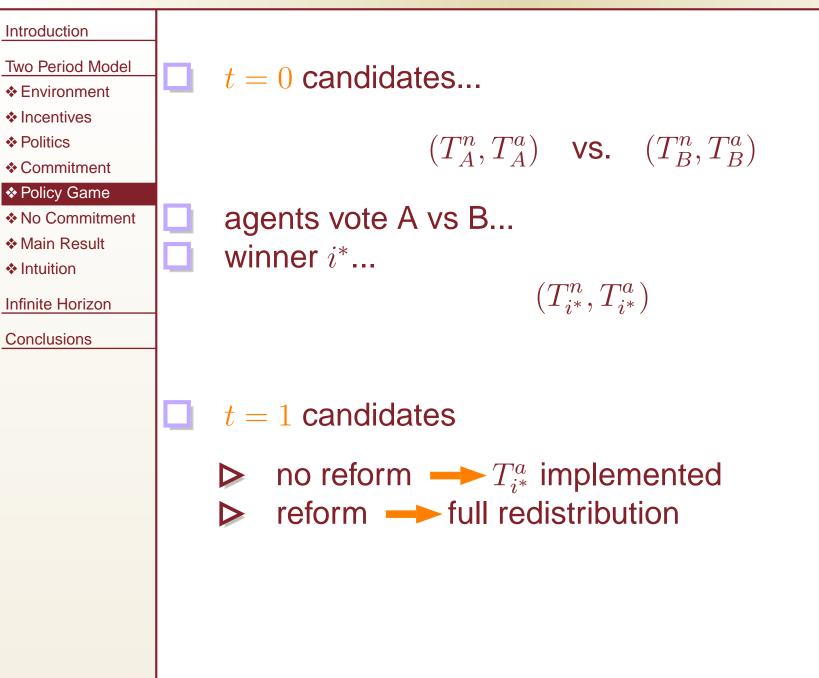
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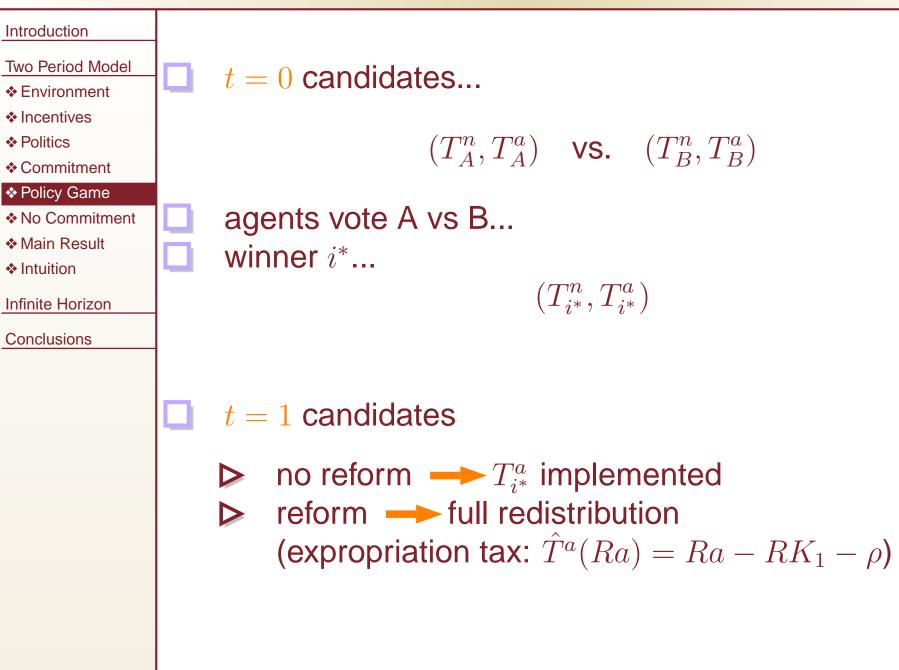
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### t = 0 candidates...

 $(T_A^n, T_A^a)$  VS.  $(T_B^n, T_B^a)$ 







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### solving backwards...

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solving backwards... t = 1: no reform if and only if

$$u(c_1(\theta)) dF(\theta) \ge u(Rk_1 - \rho)$$

strategy maps:  $T_0^a$  and  $a(\theta) \longrightarrow$  reform or not

t = 0: candidates always avoid reform... ... otherwise output  $\rho$  lost!

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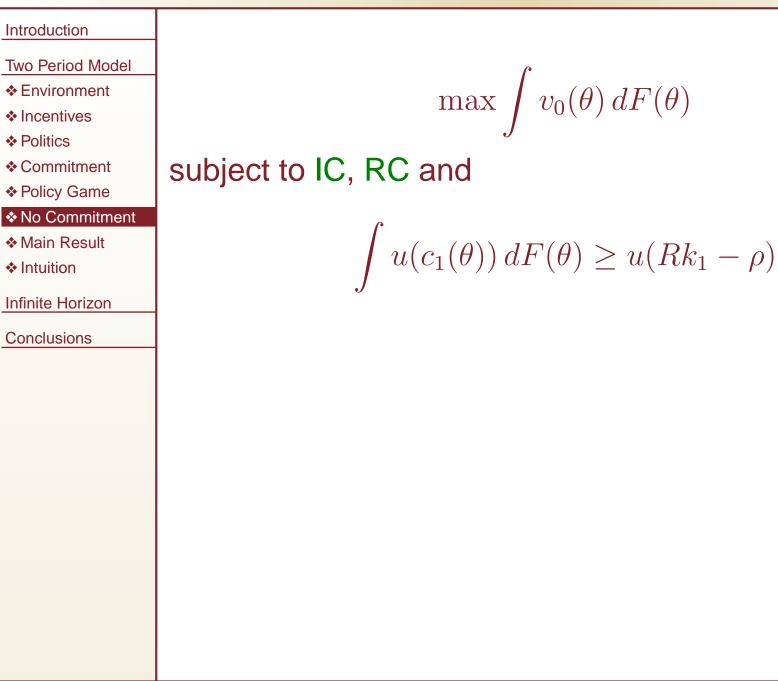
Conclusions

solving backwards... t = 1: no reform if and only if

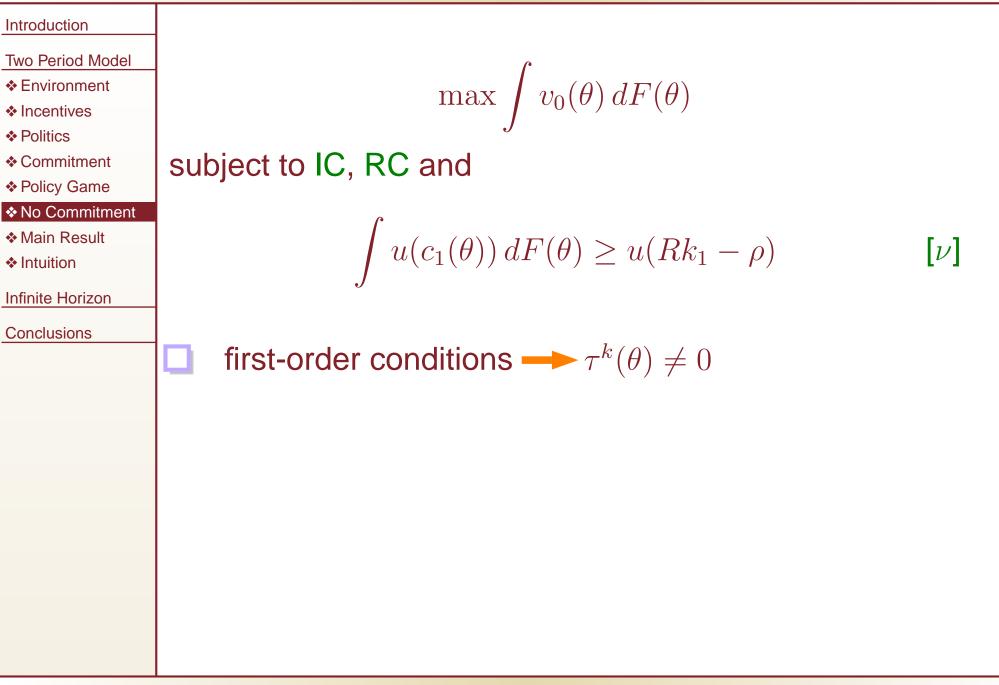
$$u(c_1(\theta)) dF(\theta) \ge u(Rk_1 - \rho)$$

strategy maps:  $T_0^a$  and  $a(\theta) \longrightarrow$  reform or not

- t = 0: candidates always avoid reform... ... otherwise output  $\rho$  lost!
  - constrained optimum problem



 $[\nu]$ 



## **Main Result**

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## Two formulas for capital taxes

## progressivity

$$\tau^k(\theta) = \frac{\beta R u'(Rk_1 - \rho) - u'(c_0(\theta))}{\mu_0 \nu^{-1} \beta + \beta R u'(Rk_1 - \rho)}$$

### level

$$\tau^{k}(\theta) = \frac{u'(Rk_{1} - \rho) - u'(c_{1}(\theta))}{\mu_{0}\nu^{-1}R^{-1} + u'(Rk_{1} - \rho) - u'(c_{1}(\theta))}$$

## **Main Result**

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## Two formulas for capital taxes

## progressivity

$$\tau^k(\theta) = \frac{\beta R u'(Rk_1 - \rho) - u'(c_0(\theta))}{\mu_0 \nu^{-1} \beta + \beta R u'(Rk_1 - \rho)}$$

level

$$\tau^{k}(\theta) = \frac{u'(Rk_{1} - \rho) - u'(c_{1}(\theta))}{\mu_{0}\nu^{-1}R^{-1} + u'(Rk_{1} - \rho) - u'(c_{1}(\theta))}$$

**Proposition.** (i)  $\tau^k$  progressive (ii) positive at top (iii) negative at bottom

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### no-commitment constraint

 $\int u(c_1(\theta)) \, dF(\theta) \ge u(Rk_1 - \rho)$ 

distortions



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### no-commitment constraint

 $\int u(c_1(\theta)) \, dF(\theta) \ge u(Rk_1 - \rho)$ 

distortions two effects

LHS — progressive subsidy



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LHS --> progressive subsidy
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distortions two effects

LHS --> progressive subsidy
 RHS --> constant tax

ex-ante: progressivity reduces inequality
 helps avoid ex-post reform



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### no-commitment constraint

 $\int u(c_1(\theta)) \, dF(\theta) \ge u(Rk_1 - \rho)$ 

distortions two effects

LHS --> progressive subsidy
 RHS --> constant tax

ex-ante: progressivity reduces inequality
 helps avoid ex-post reform

implementation:  $T^a(a)$  convex, increasing at the top, decreasing at the bottom

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mechanism...

asset distribution endogeneous

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### mechanism...

- asset distribution endogeneous
- policy not ex-ante redistribution

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### mechanism...

- asset distribution endogeneous
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- ...shift inequality across time

 $\triangleright$ 

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 $\triangleright$ 

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infinite horizon  $\rightarrow$  dynamic game no cost of reform ( $\rho = 0$ ) consumption and work each period

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infinite horizon  $\rightarrow$  dynamic game no cost of reform ( $\rho = 0$ ) consumption and work each period

two differences...

- 1. reputational equilibria  $\rightarrow$  "endogenize  $\rho$ "
- 2. commitment case *—* immiseration

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## preferences

$$v_t = \mathbb{E}_{t-1} [u(c_t) - \theta_t h(n_t) + \beta v_{t+1}],$$
$$= \sum_{s=0}^{\infty} \beta^s \mathbb{E}_{t-1} [u(c_{t+s}) - \theta_{t+s} h(n_{t+s})]$$

 $\{\theta_t\}$  i.i.d., private information

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 $\{\theta_t\}$  i.i.d., private information

Revelation principle on equilibrium path (Albanesi-Sleet, 2007; Acemoglu-Golosov-Tsyvinski, 2007)

## Incentives

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## Utility from strategy $\sigma$ ...

 $U(\lbrace c_t, n_t \rbrace, \sigma) \equiv \sum_{t, \theta^t} \beta^t [u(c_t(\sigma^t(\theta^t))) - \theta_t h(n_t(\sigma^t(\theta^t)))] \operatorname{Pr}(\theta^t)$ 

## incentive compatibility

$$U(\{c_t, n_t\}, \sigma^*) \ge U(\{c_t, n_t\}, \sigma) \qquad [IC]$$

for all  $\sigma$ 

# Technology

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### Conclusions

v = initial utility entitlement  $\psi =$  distribution of vresource constraint...

$$C_t + K_{t+1} \le F(K_t, N_t)$$
  $t = 0, 1, \dots$  [RC]

$$N_t \equiv \int \sum_{\theta^t} n_t^v(\theta^t) \operatorname{Pr}(\theta^t) d\psi(v)$$
$$C_t \equiv \int \sum_{\theta^t} c_t^v(\theta^t) \operatorname{Pr}(\theta^t) d\psi(v)$$

Feasible allocation.  $(\{c_t^v, n_t^v\}, K_t)$ :

IC, RC and  $v = U(\{c_t^v, n_t^v\}, \sigma^*)$ 

# **Policy Game**

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### Conclusions

- $H^t$  = public history entering period t
- ▶ past reports  $\sigma^{t-1,v}(\theta^{t-1})$ ▶ past allocations  $(\{c_s^v, n_s^v\}_{s \le t-1}, \{K_s\}_{s \le t})$

# **Policy Game**

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### Conclusions

- $H^t$  = public history entering period t
- ▶ past reports  $\sigma^{t-1,v}(\theta^{t-1})$ ▶ past allocations  $\left( \{c_s^v, n_s^v\}_{s \le t-1}, \{K_s\}_{s \le t} \right)$

### Timing within period...

- 1. agents: report  $\sigma_t^v(\theta^t)$  and work  $n_t^v(\sigma_t^v(\theta^t))$
- 2. candidates: platforms  $(\{c_t^v\}, K_{t+1})$  s.t. RC
- 3. voting: winning platform implemented
- 4. move to next period  $\rightarrow H_{t+1}$

# Credibility

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trigger strategy: deviation ----- worst

# Credibility



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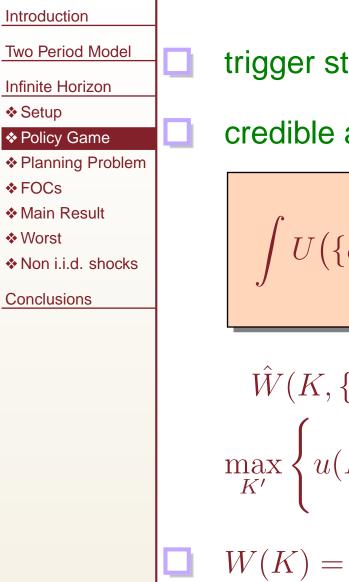
Conclusions

trigger strategy: deviation ----- worst

credible allocations: feasibile and...

 $\int U(\{c_{t+s}^v, n_{t+s}^v\}_{s\geq 0}, \sigma^*)d\psi(v) \geq \hat{W}(K_t, \{n_t^v(\theta^t)\})$ 

# Credibility



trigger strategy: deviation ----- worst

credible allocations: feasibile and...

$$\int U(\{c_{t+s}^{v}, n_{t+s}^{v}\}_{s\geq 0}, \sigma^{*})d\psi(v) \geq \hat{W}(K_{t}, \{n_{t}^{v}(\theta^{t})\})$$

$$\hat{W}(K, \{n_{\theta}\}) \equiv \max_{K'} \left\{ u(F(K, N) - K') - \sum_{\theta} \int \theta h(n_{\theta}) \Pr(\theta) + \beta W(K') \right\}$$

W(K) =worst equilibrium payoff

# **Planning Problem**

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best equilibrium  $\triangleleft$  Dual planning problem:

min  $K_0$  s.t.  $(\{c_t^v, n_t^v\}; \{K_t\})$  credible

# **FOCs**



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$$\frac{\mu_{t+1}}{\mu_t} \beta F_K(K_{t+1}, N_{t+1}) - \frac{\nu_{t+1}}{\mu_t} \beta \hat{W}_K(K_{t+1}, \{n_{t+1}^v\}) = 1$$
$$\frac{1}{u'(c^v(\theta^t))} - \frac{\nu_{t+1}}{\mu_{t+1} - \mu_t} = \frac{\mu_{t+1}}{\mu_t} \left( \mathbb{E}_t \Big[ \frac{1}{u'(c^v(\theta^{t+1}))} \Big] - \frac{\nu_{t+1}}{\mu_{t+1} - \mu_t} \right)$$

## **Main Result**

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average capital tax:

$$1 - \bar{\tau}_t(v_t) \equiv \sum_{\theta} \left( 1 - \tau(v_t, \theta) \right) p(\theta)$$

average capital tax is progressive:

$$\bar{\tau}_{t+1}(v_{t+1}) = \frac{\beta \hat{W}_K(K_{t+1}, \{n_{t+1}^v\}) - u'(c^v(\theta^t))}{\beta R_{t+1}} \frac{\nu_{t+1}}{\mu_{t+1}}$$

or

$$\bar{\tau}_{t+1}(v_{t+1}) = \frac{\beta \hat{W}_K(K_{t+1}, \{n_{t+1}^v\}) - \beta R_{t+1} (\mathbb{E}_t \left[ u'^{-1} (c^v(\theta^{t+1})) \right] )}{\beta R_{t+1} \frac{\mu_{t+1}}{\nu_{t+1}} - \beta R_{t+1} (\mathbb{E}_t \left[ u'^{-1} (c^v(\theta^{t+1})) \right] )}$$

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## what is the worst?

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### Conclusions

## what is the worst?

 $W(K) = \min_{n \in [0,\bar{n}]} \max_{K'} \left\{ u(F(K,n) - K') - h(n) + \beta W(K') \right\}$ 

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## two implications...

- 1. W(K) is nondecreasing and concave
- 2.  $\hat{W}(K, \{n_{\theta}\})$  is increasing, concave, and differentiable.

back to sign...

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$$\bar{\tau}_{t+1}(v_{t+1}) = \beta R_{t+1} \frac{u'(\hat{C}_{t+1}) - \left(\mathbb{E}_t \left[u'^{-1} \left(c^v(\theta^{t+1})\right)\right]\right)^{-1}}{\beta R_{t+1} \frac{\mu_{t+1}}{\nu_{t+1}} - \beta R_{t+1} \left(\mathbb{E}_t \left[u'^{-1} \left(c^v(\theta^{t+1})\right)\right]\right)}$$

# Non i.i.d. shocks

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potential rachet effects...

... revelation principle doesn't hold

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potential rachet effects...

- ... revelation principle doesn't hold
- 1. general mechanisms  $\rightarrow m^t$

# Non i.i.d. shocks

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potential rachet effects...

- ... revelation principle doesn't hold
- 1. general mechanisms  $\rightarrow m^t$
- 2. assume
  - ▶ there exists w > 0 s.t.  $min_{N \ge 0} F_N(K, N) > w$
  - $\begin{array}{ll} \blacktriangleright & K \in \left[0, \bar{K}\right] \text{ and } n \in \left[0, \bar{n}\right] \text{ where } \bar{K}, \bar{N} < \infty \\ \hline & u'(F(\bar{K}, \bar{n})) > (\bar{\theta}h(\bar{n}) h(0))/w \end{array}$

revelation principle on equilibrium path



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Main Result: Political economyredistribution + no commitment

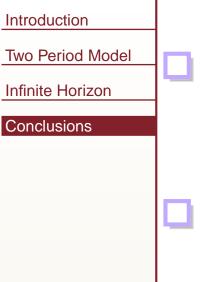


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Main Result: Political economy
 redistribution + no commitment
 progressive capital tax



Main Result: Political economy
redistribution + no commitment
progressive capital tax

key idea: progressivity helps credibility

