Les 6èmes

« TOULOUSE LECTURES IN ECONOMICS »

17-18-19 MARS 2008

Sixth Toulouse Lectures in Economics
March 17-19, 2008

The New Dynamic Public Finance

Narayana Kocherlakota

University of Minnesota, FRB-Minneapolis, and NBER

INSTITUT D'ECONOMIE INDUSTRIELLE

PARTENAIRE MAIRIE DE TOULOUSE www.toulouse.fr

PRINCETON

Lecture 3

Intergenerational Redistribution

- In Lecture 2, we studied the properties of dynamic optimal taxation.

- Agents are hit by skill shocks over their lifetimes.

- All (explicit) shock insurance is provided by tax system.

- This assumption (of zero private insurance) is troubling to many.

- In Mirrlees' static model, the role of the government is *redistribution.*

- It is easy to see why this role must be played by the government.

- But why does the government have special role in *insurance*?

- Private markets can handle insurance just as well as governments can.

- Under this libertarian view, agents should face only period 1 taxes.

- After that, all skill insurance would be provided by the private market.

Structure of Lecture 3

- In this lecture: another (more natural?) dynamic generalization of Mirrlees.
- At each date, agents die and are replaced by a child with random skills.
- It is natural to assume that newborns cannot engage in pre-natal trades.
- Government has a role to play in intergenerational redistribution and in within-generation insurance.

- I apply the same basic NDPF approach in this setting.
- I solve for optimal allocations.
- Then, I construct a tax system that implements this allocation.
- In this setting, the "wealth" taxes are really "estate taxes".

- The optimal estate taxes have three key properties.

- First, estate taxes are ex-post "regressive".
  - estate tax rates are higher on low-ability children.
  - deters a "high-bequest + shirk" double deviation.

- Second, a parent faces a *negative* expected estate tax rate.
  - planner puts double weight on children ...
  - once indirectly - through ancestors - and once directly.
  - so the planner *subsidizes* transfers from parents to children.

- Finally, estate taxes are ex-ante "progressive".
  - low-consumption parents face a higher expected subsidy rate.

- I then look at properties of optimal allocations.
- Recall that in long-lived agent case, Pareto optimal allocations exhibit:
  - history dependence
  - growing inequality
  - zero consumption mobility in long run
- Now, in dynastic model, if planner weights future newborns enough, optima exhibit:
  - history dependence
  - long-run stable inequality
  - long-run consumption mobility

- History dependence: child's outcomes depends on parent's.
  - this provides better incentives for altruistic parents.

- Long-run consumption mobility ... future generations can't get stuck in a bad outcome.

1. Environment with Dynasties

- There is a countable infinity of periods.

- There is a unit measure of *dynasties*.

- At each date, old dynasty member dies and new one is born.

- Each dynasty member lives for one period.

- This is a *non-overlapping generations* model.

- An agent born in period t has expected utility preferences, with utility function:

$$u(c_t) - v(l_t) + \beta V_{t+1}, 0 < \beta < 1$$

where:

c_t is period t consumption

l_t is period t labor (measured in terms of effort).

V_{t+1} is the utility of the agent born in period $(t+1)$.

β is the agent's altruism factor

Dynasty Heterogeneity

- At each date and for each dynasty, Nature draws θ^t from finite set Θ.

- The draws are iid across dynasties.

- Let $\mu(\theta^t)$ be ex-ante probability of θ^t; as before, μ is arbitrary.

- Assume that $\mu(\theta^t) > 0$ for all t, θ^t.

- LLN: fraction of dynasties with history θ^t equals $\mu(\theta^t)$.

Economic Impact of θ's

- An agent knows all past θ's for his dynasty.
- An agent learns his own θ_t at the beginning of period t.
- An agent with realization θ_t can produce y_t units of consumption:

$$y_t = \theta_t l_t$$

- As before: y_t is public information.
- Skill θ_t and effort l_t are privately known to the family.

Feasibility

- An allocation is $(c_t, y)_{t=1}^{\infty}$, where:

$$c_t : \Theta^t \longrightarrow R_+$$
$$y_t : \Theta^t \longrightarrow R_+$$

- The economy can borrow and lend at gross interest rate $R > 1$.

- Then, an allocation is feasible if for all t.

$$\sum_{t=1}^{\infty} R^{-t} \sum_{\theta^t \in \Theta^t} \mu(\theta^t) c_t(\theta^t) \leq \sum_{t=1}^{\infty} R^{-t} \sum_{\theta^t \in \Theta^t} \mu(\theta^t) y_t(\theta^t)$$

Incentive-Compatibility

- Information about θ is private.
- Hence, achievable allocations must also respect IC constraints.
- We can generate these as in Lecture 1 by using the Revelation Principle.

- Define a reporting strategy to be $\sigma = (\sigma_t)_{t=1}^{\infty}$ where $\sigma_t : \Theta^t \to \Theta$.

- Let Σ be the set of all σ.

- Then, an allocation (c, y) is *incentive-compatible* if and only if:

$$\sum_{t=1}^{\infty} \sum_{\theta^t \in \Theta^t} \mu(\theta^t)\beta^{t-1}[u(c_t(\theta^t)) - v(\frac{y_t(\theta^t)}{\theta_t})]$$
$$\geq \sum_{t=1}^{\infty} \sum_{\theta^t \in \Theta^t} \mu(\theta^t)\beta^{t-1}[u(c_t(\sigma^t(\theta^t))) - v(\frac{y_t(\sigma^t(\theta^t))}{\theta_t})] \text{ for all } \sigma \in \Sigma$$

- Note: the def'n of IC assumes dynasty chooses reporting strategy ex-ante.

- We can do this because a dynasty's preferences are time-consistent.

Optimality

- We consider a planner who maximizes the expected value of:

$$\sum_{t=1}^{\infty} \sum_{\theta^t \in \Theta^t} \rho^{t-1} V_t(\theta^t)\mu(\theta^t), 0 < \rho < 1$$

- where:
  - $\mu(\theta^t)$ is the fraction of dynasties with skill history θ^t.
  - $V_t(\theta^t)$ is the utility of an agent born in period t into a dynasty with history θ^t

- This objective means that the planner puts weight on a period t agent in two ways.

- Directly: through ρ^{t-1}.

- And indirectly: b/c agents' ancestors care about the period t agent.

- Hence, we can rewrite the planner's objective as:

$$\sum_{t=1}^{\infty} \sum_{\theta^t \in \Theta^t} \mu(\theta^t)\widehat{\rho}_t[u(c_t(\theta^t)) - v(y_t(\theta^t)/\theta_t)]$$

where:

$$\begin{aligned}\widehat{\rho}_1 &= 1 \\ \widehat{\rho}_t &= \beta^{t-1} + \rho\beta^{t-2} + \rho^2\beta^{t-3} + \ldots + \rho^{t-2}\beta + \rho^{t-1}, t > 1\end{aligned}$$

or, equivalently:

$$\widehat{\rho}_t = \sum_{s=0}^{t-1} \beta^{t-1-s}\rho^s$$

- The planner's problem is to find IC and feasible (c, y) to max. this objective.

- What makes this problem novel is that the planner is always more patient than a dynasty:

$$
\begin{aligned}
\widehat{\rho}_{t+1}/\widehat{\rho}_t &= \beta + \frac{\rho^t}{\Sigma_{s=0}^{t-1} \beta^{t-1-s} \rho^s} \\
&> \beta
\end{aligned}
$$

- Intuitively: the planner always puts extra weight on an agent beyond agent's ancestors.

- The discount factor in the objective > the discount factor in the IC constraint.

2. Another "Reciprocal" Euler Equation

Theorem: Suppose (c, y) is an optimal allocation.

Then, for all t, θ^t:

$$\frac{1}{u'(c_t(\theta^t))} = E[\frac{\beta^{-1}R^{-1}}{u'(c_{t+1}(\theta^{t+1}))}|\theta^t]$$
$$+[1-\beta^{-1}\widehat{\rho}_{t+1}/\widehat{\rho}_t]E[\frac{1}{u'(c_t)}]$$

where $E[1/u'(c_t)]$ is the unconditional expectation.

Content of Theorem

- Suppose $\rho = 0$.

- Then, $\beta = \widehat{\rho}_{t+1}/\widehat{\rho}_t$, and the theorem becomes:

$$\frac{1}{u'(c_t(\theta^t))} = E[\frac{\beta^{-1}R^{-1}}{u'(c_{t+1}(\theta^{t+1}))}|\theta^t]$$

which is the original reciprocal Euler equation from Lecture 1.

- If $\rho > 0$, then $\widehat{\rho}_{t+1}/\widehat{\rho}_t > \beta$, and:

$$u'(c_t(\theta^t)) > \beta R[E\{\frac{1}{u'(c_{t+1}(\theta^{t+1}))}|\theta^t\}]^{-1}$$

- The planner puts more weight on future consumption than before.

- Interesting case: suppose $\mu(\theta^t) > 0$ if and only if $\theta_t = \theta_1$ for all t.
  - that is, every dynasty's skill level is fixed over time.

- Then:

$$\frac{1}{u'(c_t(\theta_1))} = \frac{\beta^{-1}R^{-1}}{u'(c_{t+1}(\theta_1))} + [1 - \beta^{-1}\widehat{\rho}_{t+1}/\widehat{\rho}_t]E[\frac{1}{u'(c_t)}]$$

and:

$$u'(c_t(\theta_1)) > \beta R u'(c_{t+1}(\theta_1))$$

- Agents would like to borrow at interest rate R from offspring.

Proof of Theorem

- As in Lecture 1, we set up the following maximization problem:

$$\max_{c'_t, c'_{t+1}, k} \widehat{\rho}_t \sum_{\theta^t \in \Theta^t} \mu(\theta^t) u(c'_t(\theta^t)) + \widehat{\rho}_{t+1} \sum_{\theta^{t+1} \in \Theta^{t+1}} \mu(\theta^{t+1}) u(c'_{t+1}(\theta^{t+1}))$$

$$s.t.$$

$$u(c'_t(\theta^t)) + \beta u(c'_{t+1}(\theta^{t+1})) = k + u(c_t(\theta^t)) + \beta u(c_{t+1}(\theta^{t+1})) \ \forall \theta^{t+1}$$

$$\sum_{\theta^t \in \Theta^t} \mu(\theta^t) c'_t(\theta^t) + R^{-1} \sum_{\theta^{t+1} \in \Theta^{t+1}} \mu(\theta^{t+1}) c'_{t+1}(\theta^{t+1})$$

$$= \sum_{\theta^t \in \Theta^t} \mu(\theta^t) c_t(\theta^t) + R^{-1} \sum_{\theta^{t+1} \in \Theta^{t+1}} \mu(\theta^{t+1}) c_{t+1}(\theta^{t+1})$$

- We are maximizing the planner's objective over a class of perturbations ...
  - that satisfy incentives
  - and feasibility

- If (c, y) is optimal, then $(c_t, c_{t+1}, 0)$ solves this problem.

- Theorem collects resulting FONC.

3. Properties of Optimal Estate Taxes

- In this world, an agent's accumulated wealth is, in fact, his estate.
- In Lecture 2, we constructed optimal wealth taxes by satisfying ex-post Euler equations.
- We now do the same with regards to optimal estate taxes.
- Thus, if (c, y) is optimal, we define the estate tax rate τ so that:

$$\frac{\beta R u'(c_{t+1}(\theta^{t+1}))(1 - \tau_{t+1}(\theta^{t+1}))}{u'(c_t(\theta^t))} = 1$$

for all θ^{t+1} in Θ^{t+1}.

Children's Skills and Estate Taxes

- We can readily deduce three key properties of estate tax rates from this formula.

- First, optimal estate taxes depend on the skill of the descendant.

$$(1-\tau_{t+1}(\theta^{t+1})) = \frac{u'(c_t(\theta^t))}{\beta R u'(c_{t+1}(\theta^{t+1}))}$$

- Children with surprisingly low incomes face high estate tax rates.

- This tax system deters a double deviation: leaving big estate + shirking offspring.

Expected Estate Tax Rates

- Now consider any agent with history θ^t.

- His expected estate tax rates are given by:

$$
\begin{aligned}
& E((1-\tau_{t+1}(\theta^{t+1}))|\theta^t) \\
= \ & E[\frac{u'(c_t(\theta^t))}{u'(c_{t+1}(\theta^{t+1}))}\beta^{-1}R^{-1}|\theta^t] \\
= \ & 1 - u'(c_t(\theta^t))[1-\beta^{-1}\widehat{\rho}_{t+1}/\widehat{\rho}_t]E[\frac{1}{u'(c_t)}]
\end{aligned}
$$

- Remember that the planner is more patient than individuals:

$$\beta^{-1}\widehat{\rho}_{t+1}/\widehat{\rho}_t > 1$$

- It follows that $E(1 - \tau_{t+1}|\theta^t) > 1$, and so $E(\tau_{t+1}|\theta^t) < 0$.

- An agent's expected estate taxes are *negative*.

- This result has nothing to do with private information.
- Planner always puts more weight on offspring than an agent does.
- Hence, it is socially optimal to *subsidize* estates.

Parent's Skills and Estate Taxes

- Recall that $E(1-\tau_{t+1}|\theta^t)$ equals:

$$1 - u'(c_t(\theta^t))[1-\beta^{-1}\widehat{\rho}_{t+1}/\widehat{\rho}_t]E[\frac{1}{u'(c_t)}]$$

- This expression is increasing in $c_t(\theta^t)$.

- Poor parents' estates are subsidized at a higher rate than rich parents'.

- A key benchmark is the Pigouvian subsidy rate: $(1 - \beta^{-1}\rho_{t+1}/\rho_t)$

- Suppose a parent's consumption is low enough that

.
$$u'(c_t(\theta^t))E[1/u'(c_t)] > 1$$

- Then the parent's subsidy rate is > than the Pigouvian subsidy rate.

$$E(\tau_{t+1}|\theta^t) < 1 - \beta^{-1}\widehat{\rho}_{t+1}/\widehat{\rho}_t$$

- Suppose a parent's consumption is high enough that

$$u'(c_t(\theta^t))E[1/u'(c_t)] < 1.$$

- Then the parent's estate subsidy rate is *less* than the Pigouvian subsidy rate.

- Intuition: the planner's discount factor has an extra term $\rho^t/\widehat{\rho}_t$.

- This means that the planner's rate of time preference has an extra term:

$$\frac{\widehat{\rho}_t u'(c_t(\theta^t))}{\rho^t}$$

- So: the planner's rate of time preference is decreasing in the parent's consumption.

4. The Long Run

- Recall that the planner's discount factor across utilities is given by:

$$\frac{\widehat{\rho}_{t+1}}{\widehat{\rho}_t} = \beta + \frac{\rho^t}{\Sigma_{s=0}^{t-1} \beta^{t-1-s} \rho^s}$$

- What happens to this discount factor in the long run?

$$\begin{aligned} \lim_{t \to \infty} \frac{\widehat{\rho}_{t+1}}{\widehat{\rho}_t} &= \beta + \frac{1}{\lim_{t \to \infty} \Sigma_{s=0}^{t-1} \beta^{t-1-s} \rho^{s-t}} \\ &= \beta + \frac{1}{\beta^{-1} \lim_{t \to \infty} \Sigma_{s=0}^{t-1} (\beta / \rho)^{t-s}} \end{aligned}$$

- The limit in the denominator depends on the relative size of β and ρ.

- If $\rho \leq \beta$, then the denominator limit converges to ∞, and:

$$\lim_{t \to \infty} \frac{\widehat{\rho}_{t+1}}{\widehat{\rho}_t} = \beta$$

- If $\rho > \beta$, then:

$$\begin{aligned} \lim_{t \to \infty} \frac{\widehat{\rho}_{t+1}}{\widehat{\rho}_t} &= \beta + \frac{1}{\beta^{-1} \frac{\beta/\rho}{1-\beta/\rho}} \\ &= \beta + \rho - \beta = \rho \end{aligned}$$

- Hence:

$$\lim_{t \to \infty} \frac{\widehat{\rho}_{t+1}}{\widehat{\rho}_t} = \max(\beta, \rho)$$

Long Run Estate Taxes

- We earlier identified three properties of optimal estate tax rates.

- Property 1: Surprisingly low-skilled children face higher estate tax rates.

- Property 2: For any parent, expected estate tax rate is negative.

- Property 3: Low-consumption parents face higher expected estate subsidy rates.

- In the long run, if $\beta < \rho$:

- All three properties are still valid, because:

$$\lim_{t\to\infty} \frac{\widehat{\rho}_{t+1}}{\widehat{\rho}_t} > \beta$$

- In the long run, if $\beta \geq \rho$, limiting planner's discount factor is the same as dynasty's.

- Only the first property is valid.

- Expected estate subsidy/tax rates are zero for all parents.

Long Run Properties of Optimal Allocations

- Recall from Lecture 1 about long-lived agents ...

- With private information about skills, Pareto optimal allocations satisfy:
  - intertemporal wedge
  - history dependence in allocations
  - growing inequality (if $\beta R = 1$)
  - zero mobility in the long run (if $\beta R = 1$ and $u'(\infty) = 0$)

- Do these properties carry over to the dynastic model?

- Case I: $\beta \geq \rho$.

- For large t, the planner's problem solution (c, y) approximately satisfies:

$$\frac{1}{u'(c_t(\theta^t))} = E[\frac{\beta^{-1}R^{-1}}{u'(c_{t+1}(\theta^{t+1}))}|\theta^t]$$

- This is the same reciprocal Euler equation as in the long-lived agent case (Lecture 1).

- As in the immortal case, optimal $u'(c_{t+1})$ is typically not known in period t.

- So: we again get a **long-run intertemporal wedge**.

$$u'(c_t(\theta^t)) < \beta R E[u'(c_{t+1}(\theta^{t+1}))|\theta^t]$$

- Also, we get **history dependence in allocations**.
  - child's consumption optimally depends on ancestors' skills.
  - in this sense: *inequality of opportunity* is desirable.
  - provides better incentives for altruistic parents

- Suppose $\beta R = 1$.

- As in Lecture 1, with long-lived agents: $1/u'(c_t)$ is a martingale.

- There is **growing inequality** of $1/u'(c_t)$.

- And, in the long run, **zero consumption mobility** if $u'(\infty) = 0$.

- Case II: $\beta < \rho$.

- For large t, the planner's solution (c, y) satisfies:

$$\frac{1}{u'(c_t(\theta^t))} = E[\frac{\beta^{-1}R^{-1}}{u'(c_{t+1}(\theta^{t+1}))}|\theta^t] + [1-\beta^{-1}\rho]E[\frac{1}{u'(c_t)}]$$

- Again, the optimal allocation displays **history dependence**.

- However, now the relative sizes of:

$$u'(c_t) \text{ and } \beta R E_t u'(c_{t+1})$$

are ambiguous.

- The **intertemporal wedge is ambiguous** b/c the planner puts more weight on future dynasties.

- Suppose $\rho R = 1$.

- Then, we can prove $E[1/u'(c_t)]$ is independent of t.

- The law of motion for $1/u'(c_t)$ is:

$$\frac{1}{u'(c_{t+1}(\theta^{t+1}))} = [1 - \beta\rho^{-1}]\xi + \frac{\beta\rho^{-1}}{u'(c_t(\theta^t))} + \varepsilon_{t+1}(\theta^{t+1})$$

where $\{\varepsilon_t\}_{t=0}^{\infty}$ is a martingale difference and $\xi = E[1/u'(c_t)]$.

- This process is mean-reverting, because $\beta\rho^{-1} < 1$.

- Suppose that

$$\sum_{t=0}^{T} \beta^t \rho^{-t} \varepsilon_t$$

converges in distribution to a c.d.f. F as T goes to infinity.

- Then:

$$\lim_{\tau\to\infty} \Pr(\frac{1}{u'(c_{t+\tau})} \in A | \theta^t = \overline{\theta}^t) = F(A)$$

for any $\overline{\theta}^t$.

- We have both **long-run mobility** and **stable inequality**.

- Intuition?

- Long-run immobility and growing inequality expose future unborn to great risk.

- A patient planner eliminates these risks for the future unborn generations.

- In summary ...
- Suppose $\beta \geq \rho$.
- In the long run, the planner's solution is such that:
  - average estate subsidies disappear
  - there is an intertemporal wedge.
  - optimal inequality of opportunity.
  - growing inequality of outcomes.
  - no consumption mobility.
- Properties are the same as in the immortal agent case.

- Suppose $\beta < \rho$.

- In the long run:
  - "progressive" estate subsidies persist.
  - intertemporal wedge may change sign
  - optimal inequality of opportunity.
  - stable inequality of outcomes
  - long-run consumption mobility

- Properties are quite different from long-lived agent case.

5. Conclusions

- The New Dynamic Public Finance is well-suited for intergenerational issues.

- The key conclusions are that estate taxes should be:
  - regressive ex-post
  - negative ex-ante
  - progressive ex-ante

- Long-run tax properties depend on planner's discount factor.

- Overall conclusions ...

- The NDPF provides important new principles of optimal taxation.

- One key lesson is the importance of "regressive" wealth/estate taxes.

- These taxes deter the double deviation: saving and shirking.

- Important point: results are valid for any d.g.p. of skill shocks.

- There are many possible fruitful areas for future research.

1. Preferences

- In these talks: preferences are additively separable:
  - over dates/states and between consumption/labor
- Grochulski and I consider preferences that are:
  - additively separable over states
  - weakly separable between consumption/labor
  - arbitrarily nonseparable over dates
- For these preferences, we derive a optimal tax system for any skill dgp μ.

- What about Epstein-Zin preferences?
- Farhi and Werning derive an analog of reciprocal Euler equation.
- But: we still don't know how to construct a general tax system.

2. Quantitative Analyes

- An individual's skill shocks are persistent.
- It is difficult to find fast and accurate computational methods for this case.
- With i.i.d. skill shocks, problem is recursive in promised utility.
  - when R is exogenous: scalar state variable.
  - with endogenous R, still hard to solve.

- With Markov skill shocks: problem is recursive in a vector.
  - last period's skill
  - and $\{U(\theta)\}_{\theta \in \Theta}$ - promised utility for *every* θ.
  - so-called *threat-keeping* constraints.
  - hard to solve even with exogenous R.

- It is possible to use sequence methods on problems with small T and Θ.

- Also: continuous-time methods (Y. Zhang; N. Williams) may offer hope.

3. More on Labor Income Taxes

- We still know little about properties of labor income taxes in dynamic settings.

- There are many open questions.

- Here's one that I find particularly interesting.

- Saez (2001) delivers a beautiful formula for the optimal asymptotic tax rate.

- The formula depends on tail behavior of skill distribution and elasticity of labor supply.

- Can we extend this formula to allow for secret skill accumulation?

- The answer will now depend on the *dynamic elasticity of labor supply*.

- More generally: getting answers about labor income taxes will require useful computational methods.