Income Taxation in a Life Cycle Model with Human Capital

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Introduction

- Male labor supply literature (mostly):
  - Treats wages as exogenous (depend on age, education)
  - Saving is main source of dynamics
  - Interior solution for hours, which are continuous
  - Small labor supply elasticities
- Female labor supply literature (mostly):
  - Treats wages as endogenous (depend on work experience)
  - Ignores saving, work experience main source of dynamics
  - Discrete hours (e.g., 0, part-time, full-time)
  - Large labor supply elasticities

Introduction

- Prior work has rarely included both saving and human capital accumulation in one model
- It is computationally difficult to do so
- But recent advances make it feasible (computer speed, solution methods)

Introduction

- Goal of this research is to study effects of introducing human capital in the standard life-cycle model
- Effects of taxes on labor supply are of particular interest.
- Imai-Keane (IER, 2004) extended the life-cycle model to include HC.
- But they only looked at the response of hours to transitory tax changes

Motivation for Additional Work

- Elasticities with respect to permanent tax changes (especially Hicks) are more relevant for tax policy
- Here I look at how accounting for human capital alters the impact of permanent tax changes

Preview of main points:

- With HC, the Wage no longer equals the opportunity cost of time (OCT).
- This has important implications for how workers respond to taxes:
  - Permanent tax changes can have larger effects on current labor supply than transitory
  - Human Capital dampens labor supply responses in the short run
  - Human Capital amplifies labor supply responses in the long run

Effect of Introducing Human Capital

Bellman equation:

$$V(c_t, h_t \mid A_t, K_t) = u(c_t, h_t) + \delta E_t V(A_{t+1}, K_{t+1})$$

Laws of motion (Assets and Human Capital):

$$A_{t+1} = (1+r)\left[A_t + w_t h_t - c_t\right] \qquad K_{t+1} = f(K_t, h_t)$$

First order conditions:

$$\frac{\partial V_t}{\partial h_t} = u_{h_t} + \delta(1+r) w_t \frac{\partial E_t V_{t+1}}{\partial A_{t+1}} + \delta \boxed{\frac{\partial K_{t+1}}{\partial h_t}} \frac{\partial E_t V_{t+1}}{\partial K_{t+1}} = 0$$

$$\frac{\partial V_t}{\partial C_t} = u_{c_t} - \delta(1+r) \frac{\partial E_t V_{t+1}}{\partial A_{t+1}} = 0$$

Effect of work hours on next period's Human Capital

Effect of Introducing Human Capital

FOCs again:

$$\frac{\partial V_t}{\partial h_t} = u_{h_t} + \delta(1+r)w_t \frac{\partial E_t V_{t+1}}{\partial A_{t+1}} + \delta \frac{\partial K_{t+1}}{\partial h_t} \frac{\partial E_t V_{t+1}}{\partial K_{t+1}} = 0$$

$$\frac{\partial V_t}{\partial C_t} = u_{c_t} - \delta(1+r) \frac{\partial E_t V_{t+1}}{\partial A_{t+1}} = 0$$

Take ratio:

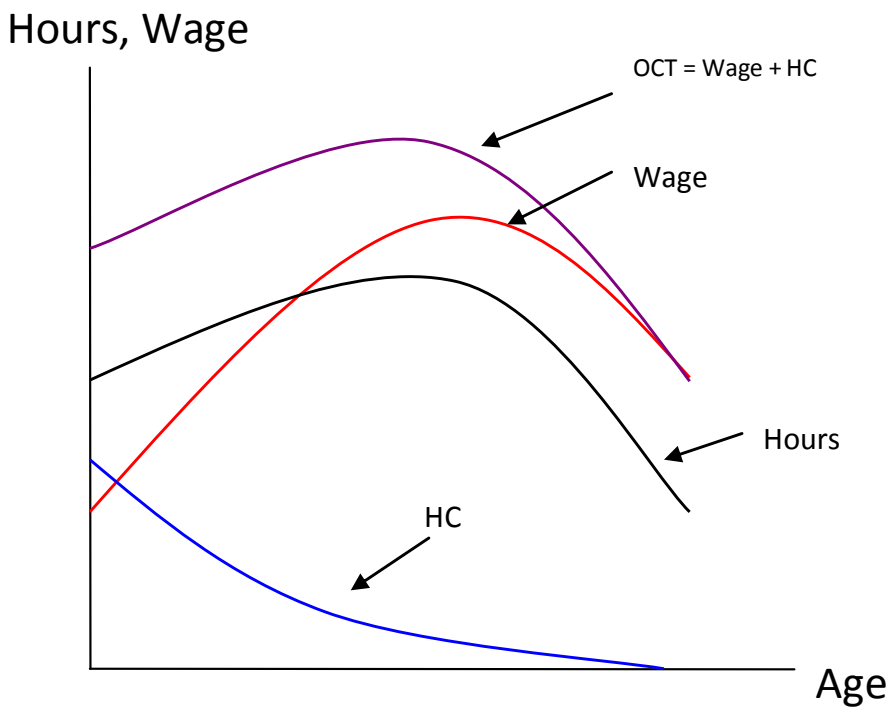
$$MRS_{c,l} = -\frac{u_{h_t}}{u_{c_t}} = w_t + \frac{1}{1+r}\left[\frac{\partial K_{t+1}}{\partial h_t}\right] \frac{\partial E_t V_{t+1} / \partial K_{t+1}}{\partial E_t V_{t+1} / \partial A_{t+1}}$$

Usual MRS = wage condition

"human capital term"

= hc_t

Figure 1: Hours, Wages and Price of Time over the Life-Cycle



Note: HC denotes the return to an hour of work experience, in terms of increased present value of future wages. The opportunity cost of time is Wage + HC.

Intuition for Imai-Keane's Large Response of Hours to OCT

- Regressing hours changes on wage changes, using polynomials in Age and education as IV's, is like taking ratio of the slope of the hours line to the wage line
- This ratio is about 1/3, which is why most prior studies found an ***ies* ≈ 1/3**.
- But Imai-Keane (in effect) take the ratio of the hours slope to the OCT = Wage+HC slope
- This is why they get ***ies* ≈ 3.**

New Stuff

- Now let's look at elasticities with respect to permanent tax changes (Hicks, Marshall)
- Start with a very simple model just to illustrate key ideas
- Then simulate Hicks and Marshall elasticities in the full Imai-Keane model

A Very Simple Model

Utility function (Same as MaCurdy (1981)):

$$U_t = \frac{C_t^{1+\eta}}{1+\eta} - \beta \frac{h_t^{1+\gamma}}{1+\gamma} \qquad \eta \leq 0, \gamma > 0$$

A Very Simple Wage Process (*Just to illustrate ideas*):

$$w_{t+1} = (1 + \alpha \sum_{\tau=1}^{t} h_\tau) w_1$$

Here w_1 is the skill endowment, and an extra hour at t raises the wage in all future periods by αw_1.

Permanent vs. Transitory Tax Changes

- With no human capital (α=0) we get the familiar:

$$MRS = \frac{\beta h_t^{\gamma}}{C_t^{\eta}} = w_t(1-\tau_t)$$

- But with human capital we get:

$$MRS = \frac{\beta h_t^{\gamma}}{C_t^{\eta}} = w_t(1-\tau_t) + E_t \sum_{\tau=0}^{T-t} \frac{(\alpha w_1) h_{t+1+\tau} (1-\tau_{t+1+\tau})}{(1+r)^{1+\tau}}$$

- **Key point: A transitory tax change hits only the <u>current</u> wage part of the OCT, but a permanent tax change hits the human capital return as well.**

Permanent vs. Transitory Tax Changes

- So, a permanent tax cut has a larger effect on the OCT = (wage + HC effect) than a temporary tax cut, because it affects wages in all future periods.
- So, surprisingly, with HC, we see that permanent tax cuts **may** have larger effects on **current** labor supply than transitory
- But a permanent tax cut also has a larger income effect (which works in the opposite direction)

Simulating Effects of Tax Changes

- Whether a permanent or transitory tax cut has a larger effect on ***current*** hours depends on the size of the HC effect vs. the income effect
- This is an empirical question
- To shed light on this question I'll look at new simulations of the Imai-Keane (IER, 2004) model
  - Of course, this also allows us to learn about Hicks and Marshall elasticies

Some Details of Imai-Keane Model

- Same Utility function as MaCurdy
- Generalizes the simple HC production function given earlier to include, e.g.,
  - diminishing returns to experience
  - depreciation of skills (if you don't work)
  - complimentarity between human capital and work hours in production of HC (because returns to work experience are lower for the less skilled)
- Includes a bequest motive (to fit assets)
- Model Ages = 20, …., 65
- Data: White Males 20-36 (Born 1958-65)
- Assumes interior solutions for hours

Some Details of Imai-Keane Model

- Observed heterogeneity – preference and HC production function parameters differ by four education levels and by age
- With age effects in HC production, we nest the model with exogenous wages.
- We do not allow for unobserved heterogeneity,
- Nevertheless, the model generates substantial persistence in wages, hours, and assets from persistent shocks to the human capital production function. (I like this feature).

Some Validation of Imai-Keane Model

- Provides good in-sample fit to wages, hours and assets (both paths and persistence)
- Using simulated data from model, we closely replicate MaCurdy-Altonji type hours regressions →Corr(ΔH,ΔW) is not large
- Also provides good out-of-sample fit (to age 65)

Example: Drop in Hours from 45-54 to 55-64

McGrattan-Rogerson (CPS)	Imai-Keane
-47%	-53%

Table 7: Effect of Different Types of Tax Increases on Labor Supply in a Model with Human Capital (Imai-Keane)

	Transitory	Permanent (Unanticipated)	
Age	Anticipated	Uncompensated	Compensated
20	**-1.5**	-0.7	**-3.2**
25	**-1.8**	-0.6	**-2.7**
30	**-2.2**	-0.6	**-2.4**
35	-2.6	-0.5	-2.3
40	-3.3	-0.7	-2.3
45	-4.2	-1.0	-2.8
50	-5.3	-2.3	-4.2
55	-7.2	-5.3	-7.2
60	-9.8	-9.4	-10.5

Note: All figures are contemporaneous effects of a 5% tax increase. The "transitory" increase only applies for one year at the indicated age. The "permanent" tax increases take effect (unexpectedly) at the indicated age and last until age 65. In the "compensated" case the proceeds of the tax (in each year) are distributed back to agents in lump sum form.

Current Effects of Permanent vs. Transitory Tax Changes

- At young ages (up to 35) permanent tax cuts **do** have larger effects on current labour supply than transitory tax cuts
- This is not surprising given the theory:
  - Returns to work experience are very high at young ages, so the HC effect dominates the income effect
- At later ages the pattern is reversed

Elasticities Vary by Age

- Another key point is that transitory elasticities grow *substantially* with age (see Table 7)
- Transitory elasticity is greatly dampened at young ages because the wage is just a fraction of the OCT
- Uncompensated gets large at old ages too. This is because there is little income effect
  - If tax rate changes at age 60 you know your wage will only be affected for a few years).

Table 8: Effects of Permanent Tax Increases on Labor Supply At Different Ages in a Model with Human Capital (Imai-Keane Model)

Age	Age 25	
	Hours	Wage
25	**-2.7**	
30	**-2.9**	-0.4
35	**-3.2**	-0.7
40	**-3.8**	-1.0
45	**-5.1**	-1.3
50	**-7.9**	-2.0
55	**-13.3**	-3.6
60	**-19.3**	-7.5
65	**-29.2**	-11.6

Note: The tax increase is 5%. It takes effect (unexpectedly) at the indicated age and lasts until age 65. The proceeds of the tax (in each year) are distributed back to agents in lump sum form.

Long Run Effects of Permanent Tax Changes

- The Effect of Permanent tax increases grows over time
- They slow down the rate of human capital accumulation, creating a "snowball" effect:
- Slower wage growth → Lower wage in long run
- So human capital **amplifies** the effect of permanent tax changes in the long run
- Seeing a small short run effect may trick us into thinking elasticities are small

Long-Run Effects of Permanent Tax Changes

- Given our utility function, we have:
  - Compensated (Hicks) elasticity: $e_C = \frac{1}{\gamma - \eta}$
- Imai-Keane get: γ = .26 , η = -.74, which implies that e_C = **1.0**
- But if we simulate a permanent 5% tax increase, with proceeds distributed lump sum, labor supply falls by 6.5% over the whole life (20-65).
- So the compensated labor supply elasticity is **1.3**.
- Human capital **amplifies** the compensated effect.

Human Capital and Permanent vs. Transitory Tax effects

- The Imai-Keane estimate of γ=.26 implies a Frisch elasticity of $(1/\gamma)$= 3.8.
- But in we saw that transitory tax cuts have much <u>smaller</u> effects than that.
- So human capital **<u>dampens</u>** transitory tax effects because the current wage is only part of the OCT

Human Capital and Permanent vs. Transitory Tax Effects

- Human capital amplifies (dampens) effects of permanent (transitory) tax changes – Relative to what we would expect given the preference parameters
- Illustrates point of Keane-Rogerson (JEL, 2012) that HC breaks the link between preference parameters and labor supply elasticities that exists in the classic life-cycle model

Welfare Effects of Taxes

- The Imai-Keane model implies that welfare losses from a proportional (flat-rate) income tax are 20-40% of revenue raised.
- This compares to only 5% in the life-cycle model without human capital
- Given preference parameters γ=.26, η= -.74, combined with "snowball" effect of taxes on labor supply and human capital, it is not surprising that welfare losses are large

Conclusion

- Putting Human Capital in the Life-Cycle Labor Supply Model:
  - Dampens responses to transitory tax changes
  - Amplifies responses to permanent tax changes
  - Causes effects of permanent tax changes to grow over time because the rate of human capital accumulation is affected
- Seeing a small short-run tax effect may trick us into thinking elasticities are small, as we don't see them grow in the long-run