Classical Labor Supply with Micro Data

ECON 34430: Topics in Labor Markets

T. Lamadon (U of Chicago)

Winter 2016

What is labor supply?

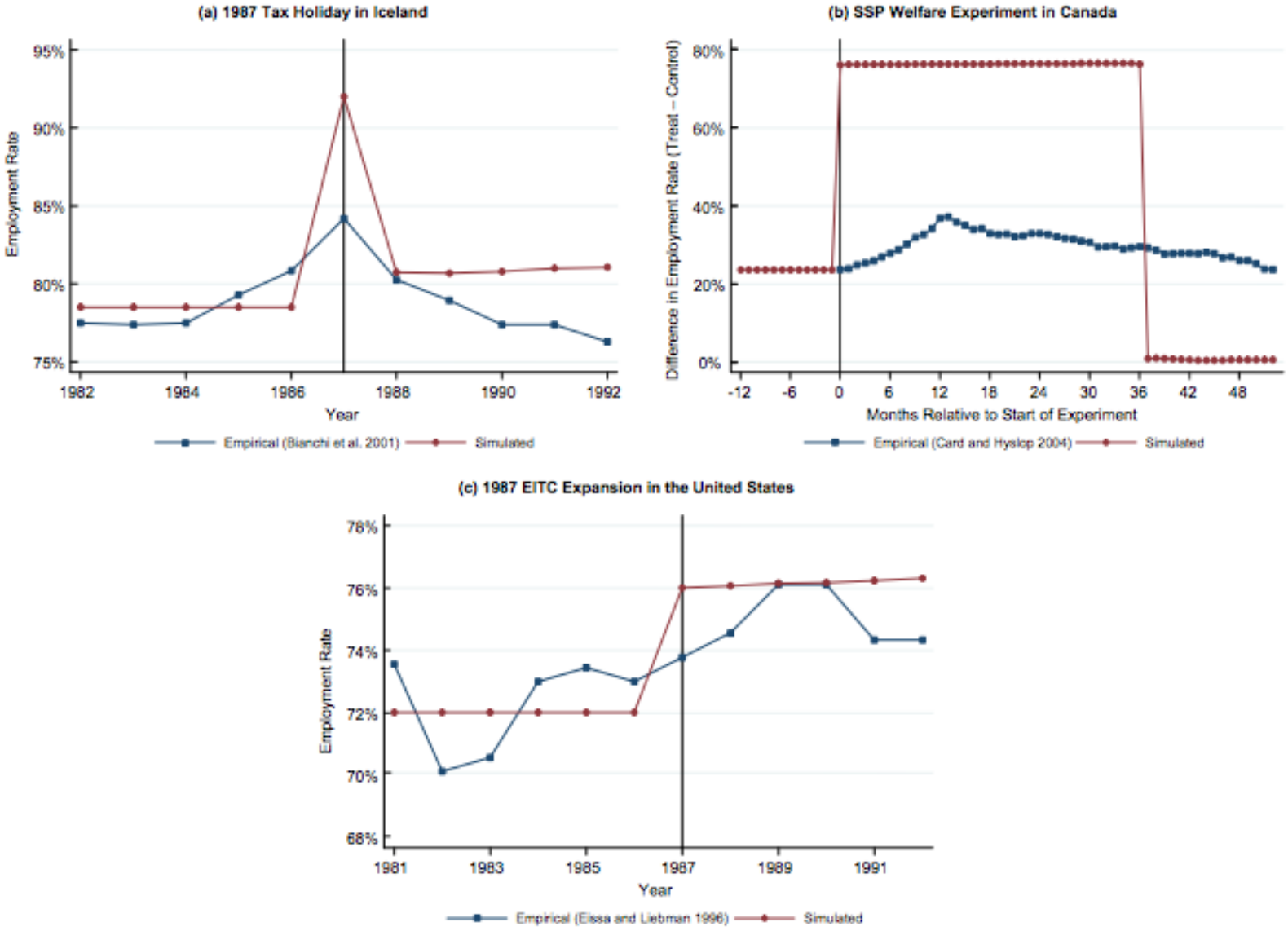
- Goal seems simple, how do individuals **choose to work** when **conditions change** ?
  - Yet it is a very complicated object.

1. It tends to be highly heterogeneous across people
   - already by observables (gender, education, age, ...)
   - but also unobservables such as wealth, ability, ...
2. Within individual:
   - "changes in conditions" can be high-dimensional (change in full tax schedule)
   - working can have path dependence (search frictions / human capital accumulation)
3. Identification measurement is difficult
   - participation/selection censors wage observations
   - observed quantities are outcome of supply/demand equilibrium

The elasticities of interest:

- At some level, classical labor supply can be summarized by 4 major elasticities (Chetty, 2005)
- 2 available margins:
  - **extensive**: work or stay at home
  - **intensive**: how many hours to work
- 2 time horizons:
  - **permanent**: how do workers adjust to permanent wage/tax changes
  - **inter-temporal (or Frisch)**: how do workers substitute between period when relative prices change?

Motivating examples:



The elasticities of interest:

- Macro is concerned mainly with business cycle fluctuations and aggregate hours, it is then interested in both margins, and mostly in inter-temporal decisions.
- Optimal taxation is concerned with steady state equilibrium, permanent shifts will mainly be interested in long-term elasticities.
- Yet, all margins of adjustment might affect the outcome of a policy if:
  - taxes are age specific
  - the extensive margin is important (for female for instance)

Take simple two period model:

- First I want to focus mainly on the study of the intensive margin, subject of most of the early empirical literature.
- The plan:
  1. revisit the static and dynamics model and define elasticities
  2. consider the effect of changes in elasticities on a ridiculously simple optimal taxation problems
  3. follow MaCurdy (1982); Altonji (1986) and derive estimating equation for the different elasticities
  4. consider possible extensions (Pistaferri, 2003), review broad results on elasticities

Simple Static Model

- consider a linear utility function ($\gamma \geq 0$, $\eta \leq 0$):

$$U(c,h) = \frac{c^{1+\eta}}{1+\eta} - \beta \frac{h^{1+\gamma}}{1+\gamma} + Q$$

- and simple budget constraint:

$$c = w(1-\tau)h + N + R$$

- N is non labor income (includes changes in saving decisions)
- τ is tax, Q is financed public good, R is lump-sum payment (for most of the analysis we can bundle R into N)

- think of this static model as a dynamic model where we want to make some comparative static (because changes affect all periods, no inter-temporal considerations)

FOC and elasticities 1

- MRS gives:

$$\frac{MUL(h)}{MUC(h)} = \frac{\beta_t h_t^{\gamma}}{[w_t h_t(1-\tau) + N_t]^{\eta}} = w_t(1-\tau)$$

- define S as the share of earned income to total income

$$S = \frac{w_t h_t(1-\tau)}{w_t h_t(1-\tau) + N_t}$$

FOC and elasticities 2

- The Marshallian, uncompensated elasticity is defined as:

$$e = \frac{\partial \ln h_{it}}{\partial \ln w_{it}}|_{N_{it}} = \frac{1 + \eta \cdot S}{\gamma - \eta \cdot S}$$

- the Hicksian compensated elasticity is given by:

$$e_H = \frac{\partial \ln h_{it}}{\partial \ln w_{it}}|_{U} = \frac{1}{\gamma - \eta \cdot S}$$

- the Income elasticity, or income effect:

$$ie = \frac{\partial \ln h_{it}}{\partial \ln N_{it}}|_{w_{it}} = \frac{\eta \cdot (1 - S)}{\gamma - \eta \cdot S}$$

- Remember that:

$$e_M = e_H + ie$$

Effect of simple policy 1

- Effect of increasing taxes, while redistributing through public good Q
- Q enters additively and so does not affect decision
- h will respond according to e
- The relevant measure is the **Marshallian** demand

Effect of simple policy 2

- Effect of increasing taxes, while redistributing through lump sum R
- The tax decreases incentive to work through
  - higher marginal rate
  - higher non-earned income.
- because the policy affects both τ and R
- The relevant measure is the **Hicksian** demand
- It appears that the litterature has mostly focused on the **Hicksian** elasticity

Quantifying the size of these Elasticities

- Evaluate the sensitivity of policy analysis to e
- Consider a revenue maximizing policy when

$$h = [w(1-\tau)]^e$$

- What is the value of τ that maximizes revenue?

$$R = (wh)\tau = w\left[w(1-\tau)\right]^e \cdot \tau$$

- for which the optimal tax rate is:

$$\tau^* = \frac{1}{1+e}$$

- what does this mean for different values of e ?

TABLE 2
REVENUE MAXIMIZING FLAT TAX RATES GIVEN DIFFERENT LABOR SUPPLY ELASTICITIES

Elasticity (e)	Optimal tax rate (τ)	
	$g = 0$	$g = 0.5$
2.0	33%	20%
1.0	50%	33%
0.67	60%	43%
0.5	67%	50%
0.3	77%	63%
0.2	83%	71%
0.1	91%	83%
0.0	100%	100%

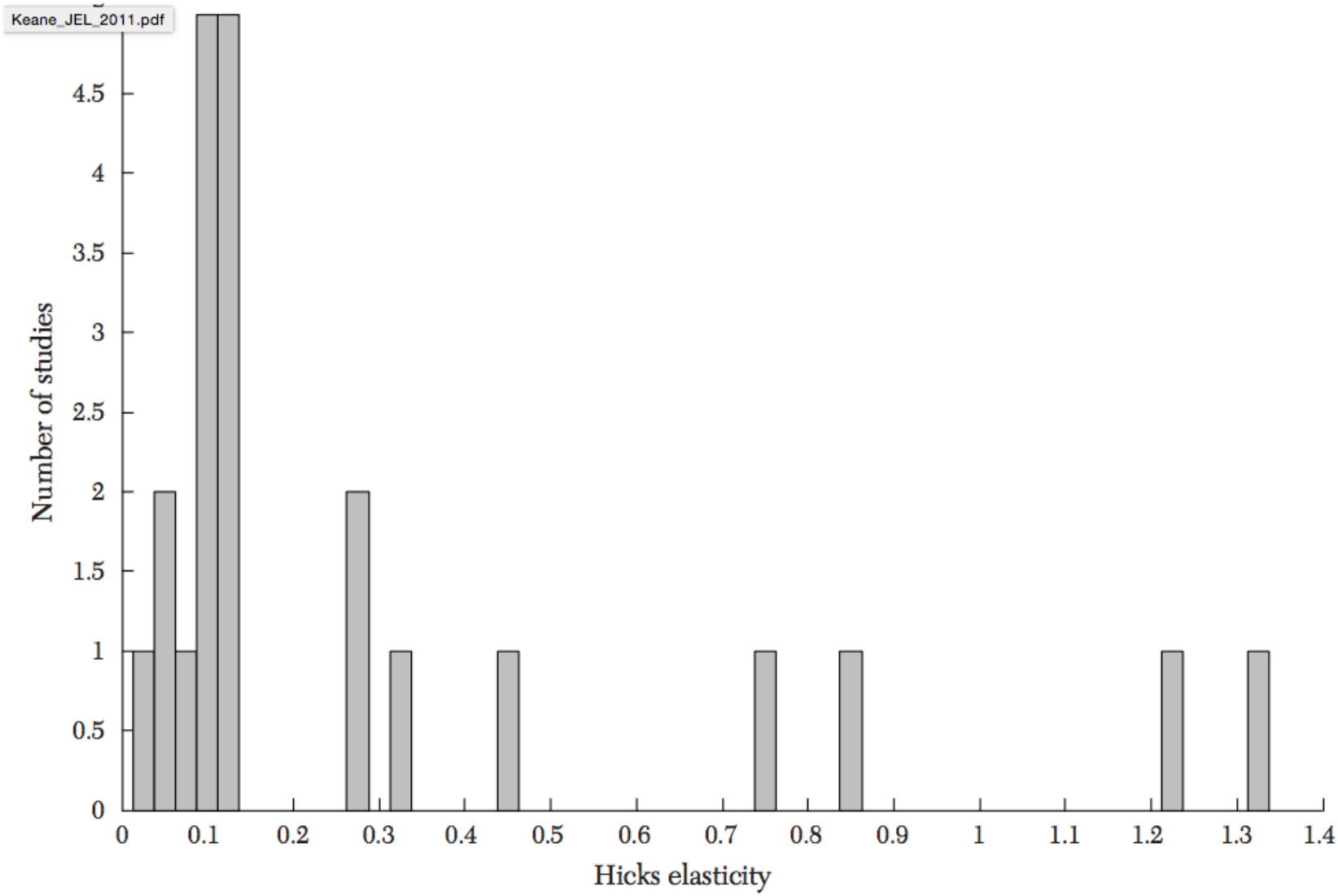


Figure 5. Distribution of Hicks Elasticity of Substitution Estimates

Quantifying the size of these Elasticities

- The value of the elasticity affects enormously the tax choice in this simple setting!
- The literature reports an important range of values
- The public finance literature has settled on using values close to 0 for taxation purposes of high income

What about inter-temporal decisions: Frisch elasticities

- We can augment the model to 2 periods:

$$\sup_{c_i,h_i,b} U_1(c_1,h_1) + \rho U_2(c_2,h_2)$$
$$\text{s.t.} c_1 = w_1(1-\tau_1)h_1 + N_1 + b$$
$$c_2 = w_2(1-\tau_2)h_2 + N_2 - (1+r)b$$

- where b is borrowing, r the interest rate and ρ the time preference
- Reworking the equations gives:

$$\ln \frac{h_2}{h_1} = \frac{1}{\gamma}\left[\ln \frac{w_2(1-\tau_2)}{w_1(1-\tau_1)} - \ln \rho(1+r) - \ln \frac{\beta_2}{\beta_1}\right]$$

- this will be important for
  - responses to transitory shocks (Macro for instance)
  - taxation that forces time reallocation (pensions for instance)

What about inter-temporal decisions: Frisch elasticities

- We can augment the model to 2 periods:

$$\sup_{c_i,h_i,b} U_1(c_1,h_1) + \rho U_2(c_2,h_2)$$
$$\text{s.t.} c_1 = w_1(1-\tau_1)h_1 + N_1 + b$$
$$c_2 = w_2(1-\tau_2)h_2 + N_2 - (1+r)b$$

- where b is borrowing, r the interest rate and ρ the time preference
- Reworking the equations gives:

$$\ln \frac{h_2}{h_1} = \frac{1}{\gamma}\left[\ln \frac{w_2(1-\tau_2)}{w_1(1-\tau_1)} - \ln \rho(1+r) - \ln \frac{\beta_2}{\beta_1}\right]$$

- this will be important for
  - responses to transitory shocks (Macro for instance)
  - taxation that forces time reallocation (pensions for instance)

Relationship between elasticities

- $\frac{1}{\gamma}$ is referred to as the **Frisch elasticity** e_F
- Note that given $S > 0$, $\eta < 0$ and $\gamma > 0$ we get

$$\frac{1}{\gamma} > \frac{1}{\gamma - \eta \cdot S} > \frac{1 + \eta \cdot S}{\gamma - \eta \cdot S}$$

- or that

$$e_F > e_H > e_H$$

Estimation of the static model

- based on specifying the following equation:

$$\ln h_{it} = \beta + e \ln w_{it}(t - \tau_t) + \beta_l N_{it} + \epsilon_{it}$$

- the regression controls for non-labor income N_{it}
- ϵ_{it} is interpreted as a supply shock
- e delivers directly the Marshallian elasticity
- β_l delivers the $ie = w_{it}(1 - \tau)\beta_l$
- Finally the Hicksian elasticity is given by $e_h = e - ie$

Estimation of the static model

- based on specifying the following equation:

$$\ln h_{it} = \beta + e \ln w_{it}(t - \tau_t) + \beta_l N_{it} + \epsilon_{it}$$

- the regression controls for non-labor income N_{it}
- ϵ_{it} is interpreted as a supply shock
- e delivers directly the Marshallian elasticity
- β_l delivers the $ie = w_{it}(1 - \tau)\beta_l$
- Finally the Hicksian elasticity is given by $e_h = e - ie$

Estimation of the static model - limitations

1. endogeneity of wage and non labor income
2. endogeneity due to simultaneity
3. treatment of taxes
4. measurment error
5. participation margin (do not oberve wages for unemployed)
6. dynamic consideration like saving, human capital

see Keane (2011) for overview

Male labor supply - static model - Keane review

TABLE 6
SUMMARY OF ELASTICITY ESTIMATES FOR MALES

Authors of study	Year	Marshall	Hicks	Frisch
Static models				
Kosters	1969	−0.09	0.05	
Ashenfelter-Heckman	1973	−0.16	0.11	
Boskin	1973	−0.07	0.10	
Hall	1973	n/a	0.45	
Eight British studies[a]	1976–83	−0.16	0.13	
Eight NIT studies[a]	1977–84	0.03	0.13	
Burtless-Hausman	1978	0.00	0.07–0.13	
Wales-Woodland	1979	0.14	0.84	
Hausman	1981	0.00	0.74	
Blomquist	1983	0.08	0.11	
Blomquist-Hansson-Busewitz	1990	0.12	0.13	
MaCurdy-Green-Paarsch	1990	0.00	0.07	
Triest	1990	0.05	0.05	
Van Soest-Woittiez-Kapteyn	1990	0.19	0.28	
Ecklof-Sacklen	2000	0.05	0.27	
Blomquist-Ecklof-Newey	2001	0.08	0.09	

Estimating Dynamic Labor Supply

- follow MaCurdy (1982); Altonji (1986)
- we take the life cycle model over many periods:

$$U_t(c,h) = \frac{c^{1+\eta}}{1+\eta} - \beta_t \frac{h^{1+\gamma}}{1+\gamma}$$

$$c_t = w_t(1-\tau_t)h_t + N_t + b_t - (1+r)b_t$$

- where the first order condition gives us

$$\frac{\beta_t h_t^{\gamma}}{[w_t(1-\tau_t)h_t + N_t + b_t]^{\eta}} = \frac{\beta_t h_t^{\gamma}}{c_t^{\eta}} = w_t(1-\tau_t)$$

Estimating Dynamic Labor Supply - MaCurdy Method 1

- MaCurdy (1982) proposes to use the expression directly by introducing a tast shifter:

$$\beta_{it} = exp(X_{it}\alpha - \epsilon_{it})$$

- this results in the following equation:

$$\ln w_{it}(1 - \tau_{it}) = \gamma \ln h_{it} - \eta \ln c_{it} + X_{it}\alpha - \epsilon_{it}$$

- this reflects the optimality in the choices of hours
- all variables are correlated and endogenous.
- Note that the method does not need a panel dimension

Estimating Dynamic Labor Supply - MaCurdy Method 1

- MaCurdy (1982) proposes to use IV approach to estimate this equation
- he uses for X_{it}: number of children and race
- he uses for the instruments: education interacted with age polynomial
  - the hump shape of wages and hours guarantees explanatory power
  - the exogenity of age and education with respect ϵ_{it} is a strong restriction
- the paper reports $\gamma = 0.16$ and $\eta = -0.66$
- using our past formula, ignoring non-labor income, we get:

$$e_M = 0.42, \quad e_H = 1.22, \quad ie = -0.80, \quad e_F = 6.25$$

- this values appear larger than for static models

Estimating Dynamic Labor Supply - MaCurdy Method 1

- MaCurdy (1982) proposes to use IV approach to estimate this equation
- he uses for X_{it}: number of children and race
- he uses for the instruments: education interacted with age polynomial
  - the hump shape of wages and hours guarantees explanatory power
  - the exogenity of age and education with respect ϵ_{it} is a strong restriction
- the paper reports $\gamma = 0.16$ and $\eta = -0.66$
- using our past formula, ignoring non-labor income, we get:

$$e_M = 0.42, \quad e_H = 1.22, \quad ie = -0.80, \quad e_F = 6.25$$

- this values appear larger than for static models

Estimating Dynamic Labor Supply - Altonji

- Altonji (1986) rewrites this equation to

$$\ln h_{it} = \frac{1}{\gamma} \ln w_{it}(1 - \tau_{it}) + \frac{\eta}{\gamma} \ln c_{it} - X_{it}\frac{\alpha}{\gamma} + \frac{\epsilon_{it}}{\gamma}$$

- he uses for X_{it}: number of children, race, region, year dummies

- for the instruments
  - defines w as ratio of earnings to hours
  - for the instrument, uses direct question on wage in the survey
  - supplement with a second instrument that measures "permanent wage"

Estimating Dynamic Labor Supply - Altonji

- Altonji (1986) reports $\gamma = 5.81$ and $\eta = -3.10$
  ($1/\gamma = 0.172(0.119)$ and $\eta/\gamma = -0.534(0.386)$)
- using our past formula, ignoring non-labor income, we get:

$$e_M = -0.24, \quad e_H = 0.11, \quad ie = -0.35, \quad e_F = 0.17$$

- this values are quite different from MaCurdy

$$e_M = 0.42, \quad e_H = 1.22, \quad ie = -0.80, \quad e_F = 6.25$$

- Keane (2011) reports that no replication study has been able to reconcile these findings!

Directly measuring the Frisch Elasticity - MaCurdy

- MaCurdy also proposes a method to measure the Frisch elasticity directly

- recall the intertemporal decision

$$\frac{\beta_t h_t^{\gamma}}{c_t^{\eta}} = w_t(1-\tau_t)$$

- and the Euler equation under uncertainty

$$c_t^{\eta} = E_t \rho(1 + r_{t+1} c_{t+1}^{\eta})$$

- rewrite in logs with unexpected shock ξ_t

$$\eta \Delta \ln c_t = -\ln \rho(1 + r_{t+1}) + \xi_t$$

- we take log-differences, substitute in the taste shifter $\beta_{it} = exp(X_{it}\alpha - \epsilon_{it})$ to get:

$$\Delta \ln h_{it} = \frac{1}{\gamma}\Delta \ln w_{it}(1-\tau_{it}) - \frac{1}{\gamma}\rho(1+r_t) - \frac{\alpha}{\gamma}\Delta X_{it} + \frac{1}{\gamma}\xi_{it} + \frac{1}{\gamma}\Delta\epsilon_{it}$$

Directly measuring the Frisch Elasticity - MaCurdy

- this allows to not rely on consumption data
- the error term is composed of 2 components and
  - ξ_{it}: the surprise change in marginal utility of consumption
  - $\Delta\epsilon_{it}$: change in taste of work
- MaCurdy assumes perfect foresight
  - the instrument is the deviation from predicted wage growth
  - in practice first stage regresses wage growth on set of observables
- wages are not adjusted for taxes
- the paper reports a Frisch elasticity of $0.15(0.98)$
- using our past formula, ignoring non-labor income, we get:

$$e_M = 0.42, \quad e_H = 1.22, \quad ie = -0.80, \quad e_F = 6.25$$

Directly measuring the Frisch Elasticity - MaCurdy

- this allows to not rely on consumption data
- the error term is composed of 2 components and
  - ξ_{it}: the surprise change in marginal utility of consumption
  - $\Delta\epsilon_{it}$: change in taste of work
- MaCurdy assumes perfect foresight
  - the instrument is the deviation from predicted wage growth
  - in practice first stage regresses wage growth on set of observables
- wages are not adjusted for taxes
- the paper reports a Frisch elasticity of $0.15(0.98)$
- using our past formula, ignoring non-labor income, we get:

$$e_M = 0.42, \quad e_H = 1.22, \quad ie = -0.80, \quad e_F = 6.25$$

Estimating Frisch direclty - Pistaferi

- Pistaferri (2003) proposes to use subjective expectations to differentiate expected from unexpected wage gains
- uses data from Italy which contains information about individual expectations about their earning growth
- Pistaferri modifies the previous expression to contain observed expected and unexpected wage growth
- the paper finds a Frisch elasticity of $0.704(0.093)$ and an income effect of $-0.199(0.091)$
- and reports that a 5% increase in hours to a 10% increase in permanent wages (this was 0.8 in MaCurdy)

Estimating Frisch direclty - Pistaferi

- important caveats to keep in mind:
- the period consider by the paper includes rescession in Italy in 1993
- the data is from Italy (would expect to go the other way)
- surveyed expectations are about earnings, not wages

Male labor supply - dynamic - Keane review

TABLE 6
SUMMARY OF ELASTICITY ESTIMATES FOR MALES

Authors of study	Year	Marshall	Hicks	Frisch
Dynamic models				
MaCurdy	1981	0.08[b]		0.15
MaCurdy	1983	0.70	1.22	6.25
Browning-Deaton-Irish	1985			0.09
Blundell-Walker	1986	−0.07	0.02	0.03
Altonji[c]	1986	−0.24	0.11	0.17
Altonji[d]	1986			0.31
Altug-Miller	1990			0.14
Angrist	1991			0.63
Ziliak-Kniesner	1999	0.12	0.13	0.16
Pistaferri	2003	0.51[b]		0.70
Imai-Keane	2004	0.40[e]	1.32[e]	0.30–2.75[f]
Ziliak-Kniesner	2005	−0.47	0.33	0.54
Aaronson-French	2009			0.16–0.61
Average		0.06	0.31	0.85

Extensions

- progressive taxation (Ziliak and Kniesner, 1999)
- Non-separable preferences (Ziliak and Kniesner, 2005)
- Family labor supply (we will cover this in the next course topic on consumption smoothing)
- adding human capital (Heckman)
- tied wage-hours offers (Aaronson and French 2009)
- other important sets of papers:
  - fully structural approach
  - fully experimental or quasi experimental (kinks...)
  - female labor supply

Non separable preferences

- Ziliak and Kniesner (2005) proposes to change preferences to

$$U(c,h) = G\Big(\frac{c^{1+\eta}}{1+\eta} - \beta\frac{h^{1+\gamma}}{1+\gamma}\Big)$$

- with $G(x) = (1+\sigma)^{-1}x^{1+\sigma)}$
- simulate the effect of changing σ on resulting Frisch estimate
- as $\sigma \to -\infty$, consumer cares about minimizing the min value, Frisch $\to 1$

TABLE 4
HOW FRISCH ELASTICITY VARIES WITH WILLINGNESS TO SUBSTITUTE UTILITY OVER TIME

σ	Frisch elasticity	Changes in hours		Changes in consumption		Changes in utility	
		Hours(1)	Hours(2)	C(1)	C(2)	G(X(1))	G(X(2))
0.0	2.00	+1.03%	−0.96%	+0.97%	+0.97%	−0.05%	+1.44%
−0.5	1.40	+0.82%	−0.58%	+1.18%	+0.58%	+0.27%	+0.87%
−1.0	1.25	+0.76%	−0.48%	+1.24%	+0.48%	+0.38%	+0.72%
−2.0	1.14	+0.73%	−0.41%	+1.27%	+0.42%	+0.41%	+0.62%
−5.0	1.06	+0.70%	−0.36%	+1.30%	+0.36%	+0.45%	+0.54%
−10.0	1.03	+0.69%	−0.34%	+1.31%	+0.34%	+0.46%	+0.51%
−40.0	1.01	+0.68%	−0.33%	+1.32%	+0.33%	+0.48%	+0.49%

Table of content

References

Altonji, J. G. (1986): "Intertemporal Substitution in Labor Supply: Evidence from Micro Data," *J. Polit. Econ.*, 94(3), S176–S215.

Chetty, R. (2005): "Why do unemployment benefits raise unemployment durations? Moral hazard vs. liquidity," *NBER Work. Pap. Ser.*

Keane, M. P. (2011): "Labor Supply and Taxes: A Survey," *J. Econ. Lit.*, 49(4), 961–1075.

MaCurdy, T. E. (1982): "The use of time series processes to model the error structure of earnings in a longitudinal data analysis," *J. Econom.*, 18(1), 83–114.

Pistaferri, L. (2003): "Anticipated and Unanticipated Wage Changes, Wage Risk, and Intertemporal Labor Supply," *J. Labor Econ.*, 21(3), 729–754.