Neoclassical Labor Supply

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Basic Macro Building Blocks

- Consumption-Savings Decision
- Labor-Leisure Decision
- Capital Accumulation
- Factor Demand
- Price and Wage Setting (Phillips Curve)
- Etc.

Labor Market

Plausible (likely) that "frictions" are important in the labor market:

- Jobs and workers are very heterogeneous,
  suggesting that search frictions may be important
- Monopsony power may be important
- Monopoly power may be important (unions)
- Unemployment (the market doesn't clear)

Nevertheless, useful to understand neoclassical labor market theory (i.e., perfectly competitive labor market) as one benchmark

- Neoclassical labor market theory may make sense for "big" questions

Neoclassical Labor Economics

- Labor Demand:

$$W_t = F_L(L_t, \cdot)$$

  - Ignores hiring and firing costs
  - Views labor market as a spot market

Neoclassical Labor Economics

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  - Ignores hiring and firing costs
  - Views labor market as a spot market

- Labor Supply:
  - Household's intratemporal labor-leisure choice

$$\max U(C_t, L_t)$$

$$\text{subject to: } C_t = W_t L_t$$

  - First order condition:

$$\frac{U_{Lt}}{U_{Ct}} = W_t$$

  - Ignores participation margin for simplicity

- Let's assume for simplicity that

$$U(C_t, L_t) = U(C_t) - V(L_t)$$

- What properties should U and V have?

Labor Supply

- Let's assume for simplicity that

$$U(C_t, L_t) = U(C_t) - V(L_t)$$

- What properties should U and V have?
  - U should be upward sloping and concave
  - V should be upward sloping and convex

- V sometimes formulated in terms of leasure: $V(1 - L_t)$

- Labor supply becomes

$$\frac{V'(L_t)}{U'(C_t)} = W_t$$

Effect of Wage on Labor Supply

$$\frac{V'(L_t)}{U'(C_t)} = W_t$$

- How does an increase in the wage affect labor supply?

Effect of Wage on Labor Supply

$$\frac{V'(L_t)}{U'(C_t)} = W_t$$

- How does an increase in the wage affect labor supply?
- Two effects!!
- Substitution effect:
  - Higher wage makes working more attractive. Increases labor supply.
  - Holding C_t fixed, if W_t goes up on RHS, L_t has to go up on LHS
- Income effect:
  - But increase in W_t affects C_t since $C_t = W_t L_t$ (one period model for simplicity)
  - Holding RHS fixed, increase in C_t reduces U', so L_t must got down to leave LHS fixed.

How Strong Are Income Effects?

How Strong Are Income Effects?

- Are income effects something we need to take seriously from a quantitative perspective?
- Keynes thought so!
  - Economic Possibilities for Our Grandchildren (1930)
  - “Suppose that a hundred years hence we are all of us, on the average, eight times better off in the economic sense than we are to-day.” (i.e., 2% annual growth)
  - “Absolute needs ... satisfied.”
  - “Prefer to devote our further energies to non-economic purposes.”
  - Main worry “general ‘nervous breakdown’”
  - “need to do some work ... to be contented”
  - “Three hour shifts of fifteen hour week.”

Real Wages in England

Source: Clark (2005, 2010)

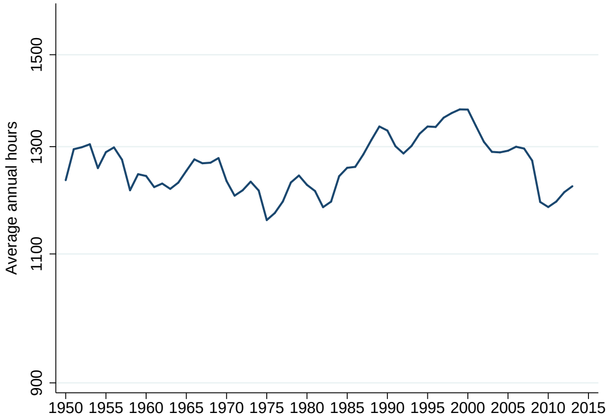

Figure 2: **U.S. average annual hours per capita aged 15–64, 1950–2013**

Notes: Source: GGDC Total Economy Database for total hours worked and OECD for the data on population aged 15–64. The figure is comparable to the ones in Rogerson (2006). Regressing the logarithm of hours worked on time gives an insignificant slope coefficient.

Source: Boppart and Krusell (2016)

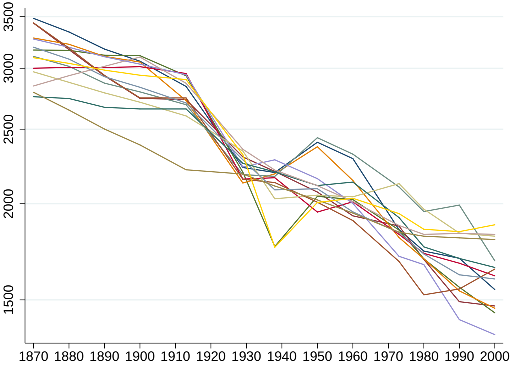

Figure 1: **Hours worked per worker**

Notes: The figure shows data for the following countries: Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland, the U.K., Australia, Canada, and the U.S. The scale is logarithmic which suggests that hours fall at roughly 0.57 percent per year. Source: Huberman and Minns (2007). Maddison (2001) shows a similar systematic decline in hours per capita.

Source: Boppart and Krusell (2018)

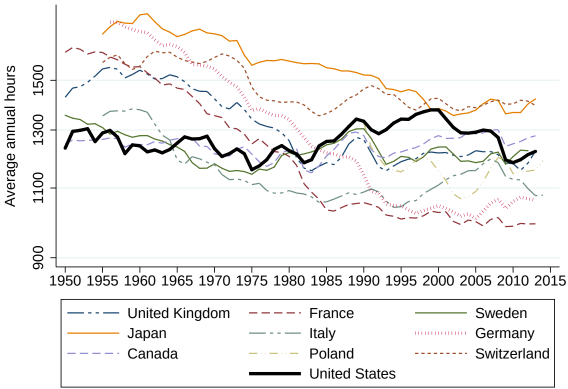

Figure 3: **Selected countries average annual hours per capita aged 15–64, 1950–2015**

Notes: Source: GGDC Total Economy Database for total hours worked and OECD for the data on population aged 15–64. The figure is comparable to the ones in Rogerson (2006). Regressing the logarithm of hours worked on time gives a slope coefficient of -0.00393.

Source: Boppart and Krusell (2018)

Balanced Growth

- Long-run trends on real wages and hours suggest that income effects are (a little bit) stronger than substitution effects
- More traditional view: Labor supply constant as wages rise
- "Balanced growth preferences" (King, Plosser, and Rebelo, 1988):

$$U(C_t, L_t) = \begin{cases} \frac{(C_t v(L_t))^{1-\sigma} - 1}{1-\sigma} & \text{if } \sigma \neq 1 \\ \log(C_t) + \log v(L_t) & \text{if } \sigma = 1 \end{cases}$$

  Imply that income and substitution effects exactly cancel out in response to permanent increase in wage

Balanced Growth

- Common choice for preferences:

$$\log(C_t) - \psi \frac{L_t^{1+1/\nu}}{1+1/\nu}$$

- Falls into balanced growth preference set with $v(L_t) = \exp(-\psi \frac{L_t^{1+1/\nu}}{1+1/\nu})$
- Implied labor supply:

$$\psi L_t^{1/\nu} C_t = W_t$$

Balanced Growth

- Suppose constant (gross) growth rates for:
  - Consumption: g_C
  - Labor: g_L
  - Wages: g_W
- Labor supply curve $\psi L_t^{1/\nu} C_t = W_t$ implies $g_L^{1/\nu} g_C = g_W$
- Resource constraint $W_t L_t = C_t$ implies $g_L g_W = g_C$
- Solving this system yields:

$$g_C = g_W \quad \text{and} \quad g_L = 1$$

MaCurdy (1981) Preferences

- MaCurdy (1981) assumed

$$\frac{C_t^{1-\sigma}-1}{1-\sigma}-\psi\frac{L_t^{1+1/\nu}}{1+1/\nu}$$

- Consumption term generalization of $\log C_t$
- When $\sigma \neq 1$, growth not balanced
- Labor supply becomes

$$\psi L_t^{1/\nu} C_t^{\sigma} = W_t$$

MaCurdy (1981) Preferences

- In growth rates we have:

$$g_L^{1/\nu} g_C^{\sigma} = g_W \quad \text{and} \quad g_L g_W = g_C$$

- Which implies:

$$g_L = g_W^{\frac{\nu(1-\sigma)}{1+\nu\sigma}} \quad \text{and} \quad g_C = g_W^{\frac{1+\nu}{1+\nu\sigma}}$$

- So $g_L < 1$ (i.e., falling hours) if $\sigma > 1$
- σ governs strength of the income effect
- In other contexts, σ is:
  - Coefficient of relative risk aversion
  - Reciprocal of elasticity of intertemporal substitution

- Generalized “balanced growth” preferences:

$$U(C_t, L_t) = \begin{cases} \dfrac{\left(C_t v\left(L_t C_t^{\frac{\theta}{1-\theta}}\right)\right)^{1-\sigma} - 1}{1-\sigma} & \text{if } \sigma \neq 1 \\ \log(C_t) + \log v\left(L_t C_t^{\frac{\theta}{1-\theta}}\right) & \text{if } \sigma = 1 \end{cases}$$

- Yield balanced growth with trending hours
- Balanced growth:
  - Output, consumption, hours, investment, and capital grow at a constant rate in response to constant growth in productivity

Why Do Americans Work So Much More Than Europeans?

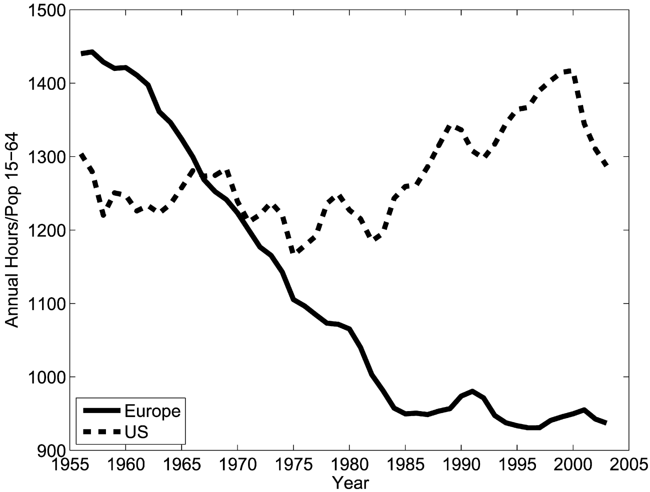

FIG. 1.—Aggregate hours in the United States and Europe

Source: Rogerson (JPE 2008). “Europe”: Belgium, France, Germany, Italy, and the Netherlands.

Table 1

Output, Labor Supply, and Productivity

In Selected Countries in 1993–96 and 1970–74

		Relative to United States (U.S. = 100)		
Period	Country	Output per Person*	Hours Worked per Person*	Output per Hour Worked
1993–96	Germany	74	75	99
	France	74	68	110
	Italy	57	64	90
	Canada	79	88	89
	United Kingdom	67	88	76
	Japan	78	104	74
	United States	100	100	100
1970–74	Germany	75	105	72
	France	77	105	74
	Italy	53	82	65
	Canada	86	94	91
	United Kingdom	68	110	62
	Japan	62	127	49
	United States	100	100	100

*These data are for persons aged 15–64.

Source: Prescott (2004).

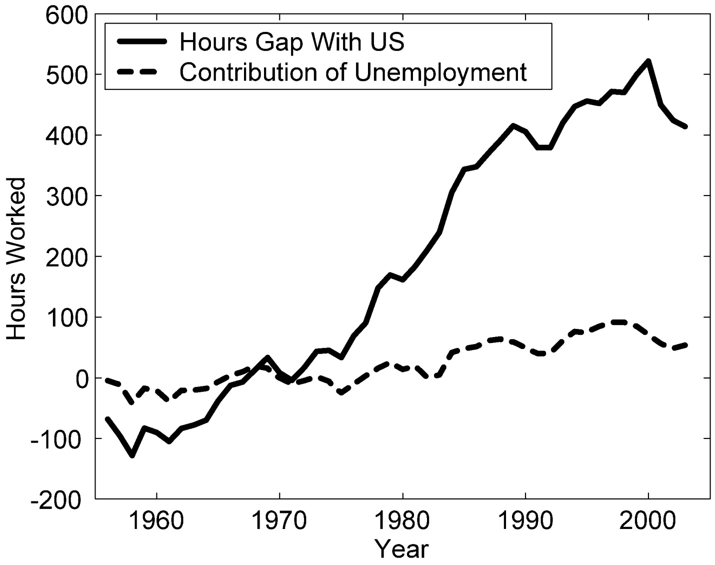

Fig. 13. Hours gap explained by unemployment: France.

Source: Rogerson (RED 2006).

Table 2

A Decomposition of the Change in Hours Worked Per Capita in France and the United States from 1970 to 2000

(*percentage*)

	Percentage change in:				
	HN/P	*H*	*N/L*	L/P_A	P_A/P
France	−21	−21	−7	3	4
United States	21	−4	1	10	14
Difference	−42	−17	−8	−7	−10

Source: OECD Economic Outlook database.

To address these questions, it is useful to decompose the change in hours worked per capita into its different components:

$$\Delta(HN/P) = \Delta\ln H + \Delta\ln (N/L) + \Delta \ln (L/P_A) + \Delta\ln (P_A/P).$$

The change in hours worked per capita, HN/P, can be written as the change in hours worked per worker, H, plus the change in the employment rate—the ratio of employment, N, to the labor force, L—plus the change in the participation rate—the ratio of the labor force L to the population of working age, P_A, plus the change in the ratio of the population of working age to total population, P. The decomposition of the change in hours worked into these components is given in Table 2 for France and the United States, for the period 1970 to 2000.

Source: Blanchard (JEP 2004).

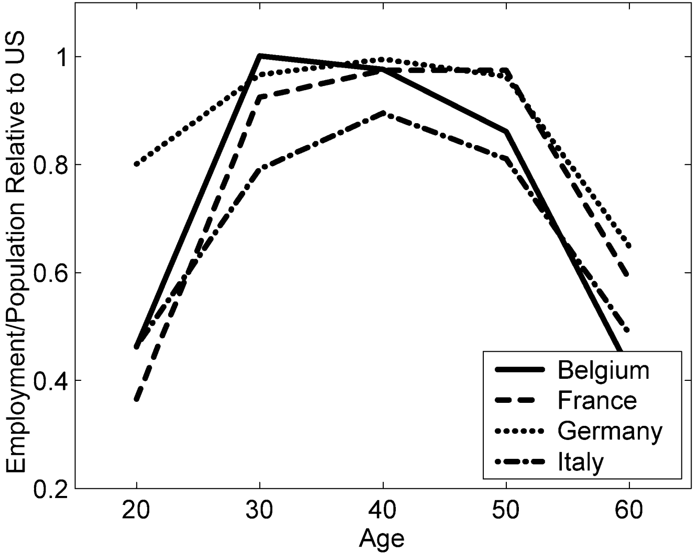

Fig. 37. Employment relative to the US by age.

Source: Rogerson (RED 2006).

Possible Explanations

Possible Explanations

- Differences in preferences/culture
- Differences in social norms (coordination problem/unions)
- More generous social safety net
- Higher minimum wage
- Hiring and firing costs
- Higher taxes

Prescott (2004)

- Representative household maximizes:

$$E\left\{\sum_{t=0}^{\infty}\beta^t(\log c_t + \alpha \log(1-h_t))\right\}$$

- Household owns capital and rents to firms
- Law of motion for capital:

$$k_{t+1} = (1-\delta)k_t + x_t$$

- Representative firm produces using Cobb-Douglas technology:

$$y_t = c_t + x_t + g_t \leq A_t k_t^{\theta} h_t^{1-\theta}$$

- Household budget constraint:

$$(1+\tau_c)c_t + (1+\tau_x)x_t = (1-\tau_h)w_t h_t + (1-\tau_k)(r_t - \delta)k_t + \delta k_t + T_t$$

Prescott (2004)

- Labor supply:

$$\frac{\alpha/(1-h)}{1/c} = (1-\tau)w$$

where

$$(1-\tau) = \left(1 - \frac{\tau_h + \tau_c}{1+\tau_c}\right) = \frac{1-\tau_h}{1+\tau_c}$$

- Labor demand:

$$(1-\theta)\frac{y}{h} = w$$

Prescott (2004)

- Combining labor supply and labor demand yields:

$$h_{it} = \frac{1-\theta}{1-\theta+\frac{c_{it}}{y_{it}}\frac{\alpha}{1-\tau_{it}}}$$

- Hours worked governed by:
  - consumption-output ratio (c_{it}/y_{it})
  - taxes (τ_{it})
- Tax revenue rebated lump sum to households (no income effect)
  - Without this, effect of taxes on hours would be zero
    since Prescott uses KPR preferences

Prescott (2004)

- Calibrates:
  - $\theta = 0.3224$ to match capital cost share
  - $\alpha = 1.54$ to roughly match hours worked
- Estimates tax rates based on national accounts data (I didn't understand all the details of this part)

Table 2

Actual and Predicted Labor Supply

In Selected Countries in 1993–96 and 1970–74

Period	Country	Labor Supply*		Differences (Predicted Less Actual)	Prediction Factors	
		Actual	Predicted		Tax Rate τ	Consumption/ Output (c/y)
1993–96	Germany	19.3	19.5	.2	.59	.74
	France	17.5	19.5	2.0	.59	.74
	Italy	16.5	18.8	2.3	.64	.69
	Canada	22.9	21.3	–1.6	.52	.77
	United Kingdom	22.8	22.8	0	.44	.83
	Japan	27.0	29.0	2.0	.37	.68
	United States	25.9	24.6	–1.3	.40	.81
1970–74	Germany	24.6	24.6	0	.52	.66
	France	24.4	25.4	1.0	.49	.66
	Italy	19.2	28.3	9.1	.41	.66
	Canada	22.2	25.6	3.4	.44	.72
	United Kingdom	25.9	24.0	–1.9	.45	.77
	Japan	29.8	35.8	6.0	.25	.60
	United States	23.5	26.4	2.9	.40	.74

*Labor supply is measured in hours worked per person aged 15–64 per week.

Source: Prescott (2004).

Table 4—Current Intratemporal Tax Wedge for France, the United Kingdom, and the United States

	France	United Kingdom	United States
τ_c	0.33	0.26	0.13
τ_h	0.49	0.31	0.32
Social-security tax	0.33	0.10	0.12
Marginal income tax	0.15	0.21	0.20
Intratemporal tax wedge	2.60	1.82	1.66
Hours, *h*	0.183	0.235	0.268
Predicted *h*	0.189	0.250	0.268

Source: United Nations (2000).

Source: Prescott (2002). Intratemporal tax wedge: $(1+\tau_c)/(1-\tau_h)$

Prescott (2004)

Main Conclusion:

"The important observation is that the low labor supplies in Germany, France, and Italy are due to high tax rates."

Simpler Model

- Household preferences:

$$\frac{C_t^{1-\sigma}-1}{1-\sigma}-\psi\frac{L_t^{1+1/\nu}}{1+1/\nu}$$

- No capital
- Production function:

$$Y_t = A_t L_t$$

- Resource constraint:

$$Y_t = C_t$$

- Household budget constraint:

$$(1+\tau_c)C_t = (1-\tau_L)W_t L_t + T_t$$

Simpler Model

- Labor Supply:

$$\psi L_t^{1/\nu} C_t^{\sigma} = \frac{1-\tau_L}{1+\tau_C} W_t$$

- Labor Demand:

$$W_t = A_t = \frac{Y_t}{L_t}$$

- Combining these yields:

$$\psi L_t^{\sigma+1/\nu} = (1-\tau) A^{1-\sigma}$$

Simpler Model

- Taking logs and differences yields:

$$\log L_{it} - \log L_{jt} = \frac{\nu}{1+\sigma\nu}(\log(1-\tau_{it}) - \log(1-\tau_{jt}))$$

- With balanced growth preferences $\sigma = 1$:

$$\log L_{it} - \log L_{jt} = \frac{\nu}{1+\nu}(\log(1-\tau_{it}) - \log(1-\tau_{jt}))$$

- Two key assumptions regarding effect of taxes on labor supply:
  1. Parameter ν
  2. Absence of income effects

The Parameter ν

- Labor supply in logs:

$$\log L_t = \nu \log W_t + \nu \log(1-\tau) - \nu \log C_t - \log \psi$$

- From this we see that ν is the "Frisch" elasticity of labor supply
- Frisch elasticity: elasticity of labor supply with respect to the wage holding marginal utility (i.e., consumption) constant

Prescott and the Labor Supply Elasticity

- Prescott assumed:

$$\log c_t + \alpha \log(1 - h_t)$$

- What does this imply about Frisch elasticity?

Prescott and the Labor Supply Elasticity

- If $V(L_t) = \alpha \log(1 - L_t)$ then Frisch elasticity is

$$\frac{1}{\nu} = \frac{V''(L)L}{V'(L)}$$

$$\nu = \frac{1 - L}{L}$$

- If we assume that steady state labor is 1/4 of available time (this is ballpark what Prescott assumed)

$$\nu = \frac{3/4}{1/4} = 3$$

Taxes and Labor Supply

$$\log L_{it} - \log L_{jt} = \frac{\nu}{\nu+1}(\log(1-\tau_{it}) - \log(1-\tau_{jt}))$$

- With $\nu = 3$, we have that $\nu/(\nu+1) = 3/4$ and

$$\frac{\nu}{\nu+1}(\log(1-\tau_{FR})-\log(1-\tau_{US})) = \frac{3}{4}(\log(1-0.59)-\log(1-0.4)) = -0.29$$

- With $\nu = 0.5$, we have that $\nu/(\nu+1) = 1/3$ and

$$\frac{\nu}{\nu+1}(\log(1-\tau_{FR})-\log(1-\tau_{US})) = \frac{1}{3}(\log(1-0.59)-\log(1-0.4)) = -0.13$$

- With $\nu = 0.1$, we have that $\nu/(\nu+1) = 1/11$ and

$$\frac{\nu}{\nu+1}(\log(1-\tau_{FR})-\log(1-\tau_{US})) = \frac{1}{11}(\log(1-0.59)-\log(1-0.4)) = -0.03$$

The Many Elasticities of Labor Supply

Labor Supply Elasticities

- Marshallian:
  - Total or “uncompensated” elasticity
  - Holds non-labor income constant
  - Includes both income and substitutions effects
- Hicksian:
  - “Compensated”
  - Holds utility constant
  - No income effect
- Frisch:
  - Holds marginal utility of consumption constant
    (i.e., holds consumption constant)
  - Also no income effect (but slightly different from Hicksian)
  - Intertemporal elasticity of labor supply

Labor Supply Elasticities

- Marshallian:
$$\nu_M = \frac{1 - \sigma S}{1/\nu + \sigma S}$$
- Hicksian:
$$\nu_H = \frac{1}{1/v + \sigma S}$$
- Frisch:
$$\nu$$

Where S is the labor income as a fraction of total income

See Keane (JEL 2011) for derivations

Labor Supply Elasticities

$$\frac{1-\sigma S}{1/\nu+\sigma S} \leq \frac{1}{1/v+\sigma S} \leq \nu$$

$$\nu_M \leq \nu_H \leq \nu$$

- With quasi-linear preference (i.e., linear in consumption ($\sigma = 0$):

$$\nu_M = \nu_H = \nu$$

- Common assumption in applied micro
- For long-run general equilibrium analysis, this assumption is suspect
- For $\sigma = 1$ and $S = 1$, $\nu_M = 0$. For $\sigma > 1$ and $S = 1$, $\nu_M < 0$.

Change in a Flat Tax with Revenue Rebated

- Consider change in a flat tax with revenue rebated back lump sum
- We calculated this before:

$$\begin{aligned} \log L_{it} - \log L_{jt} &= \frac{\nu}{1+\sigma\nu}(\log(1-\tau_{it}) - \log(1-\tau_{jt})) \\ &= \frac{1}{1/\nu+\sigma}(\log(1-\tau_{it}) - \log(1-\tau_{jt})) \end{aligned}$$

- Relevant elasticity is the Hicksian elasticity (with $S = 1$)
- The fact that revenue is rebated kills the income effect

Change in Flat Tax, No Rebate

- Change in a flat tax with revenue used for G_t that enter utility separately (e.g., military spending, infrastructure, or wasteful spending)
- Labor Supply:

$$\psi L_t^{1/\nu} C_t^{\sigma} = (1-\tau) W_t$$

- Labor Demand:

$$W_t = A_t$$

- Consumption:

$$C_t = Y_t - \tau Y_t = (1-\tau) A_t L_t$$

- Combining these yields:

$$\psi L_t^{\sigma+1/\nu} = (1-\tau)^{1-\sigma} A^{1-\sigma}$$

Change in Flat Tax, No Rebate

$$\psi L_t^{\sigma+1/\nu} = (1-\tau)^{1-\sigma} A^{1-\sigma}$$

- Taking log yields:

$$\log \psi + \left(\sigma + \frac{1}{\nu}\right) \log L = (1-\sigma)\log(1-\tau) + (1-\sigma)\log A$$

- Taking differences yields:

$$\log L_t - \log L_s = \left(\frac{1-\sigma}{1/\nu + \sigma}\right)(\log(1-\tau_t) - \log(1-\tau_s))$$

- Marshallian elasticity (with $S = 1$) governs effects of this tax change
- Potentially much smaller than with rebate due to income effect
- With balanced growth preferences ($\sigma = 1$) effect is zero
- Arguably the relevant result for fighting a war

Temporary Tax Change

- Consider a temporary tax change in a dynamic setting
- Take log of labor supply

$$\log \psi + \frac{1}{\nu} \log L_t + \sigma \log C_t = \log(1-\tau) + \log W_t$$

- Take differences:

$$\Delta \log L_t = \nu \Delta \log(1-\tau) + \nu \Delta \log W_t - \nu \Delta \sigma \log C_t$$

- If tax change has no effect on wages and consumption, Frisch elasticity governs effect
- In general equilibrium, wages and consumption may change

General Equilibrium vs. Partial Equilibrium

- All our derivations have been done in general equilibrium
- Most empirical analysis makes use of diff-in-diff strategies which difference out general equilibrium
- Empirical analysis therefore estimates partial equilibrium effects
- Important to keep in mind when going from empirical estimates to policy advice