Labor Supply 1

Introduction

- We will start by looking at the supply side of the labor market.
- Main questions:
  - What affects the decision to work/not work? (extensive margin)
  - How many hours to work? (intensive margin)
- Applications and extensions
  - What explains the main changes in labor supply of different demographic groups?
  - What is the effect of policy interventions? Taxes, subsidies, welfare
  - Labor supply over the life cycle
  - Labor supply, home production and family decisions.

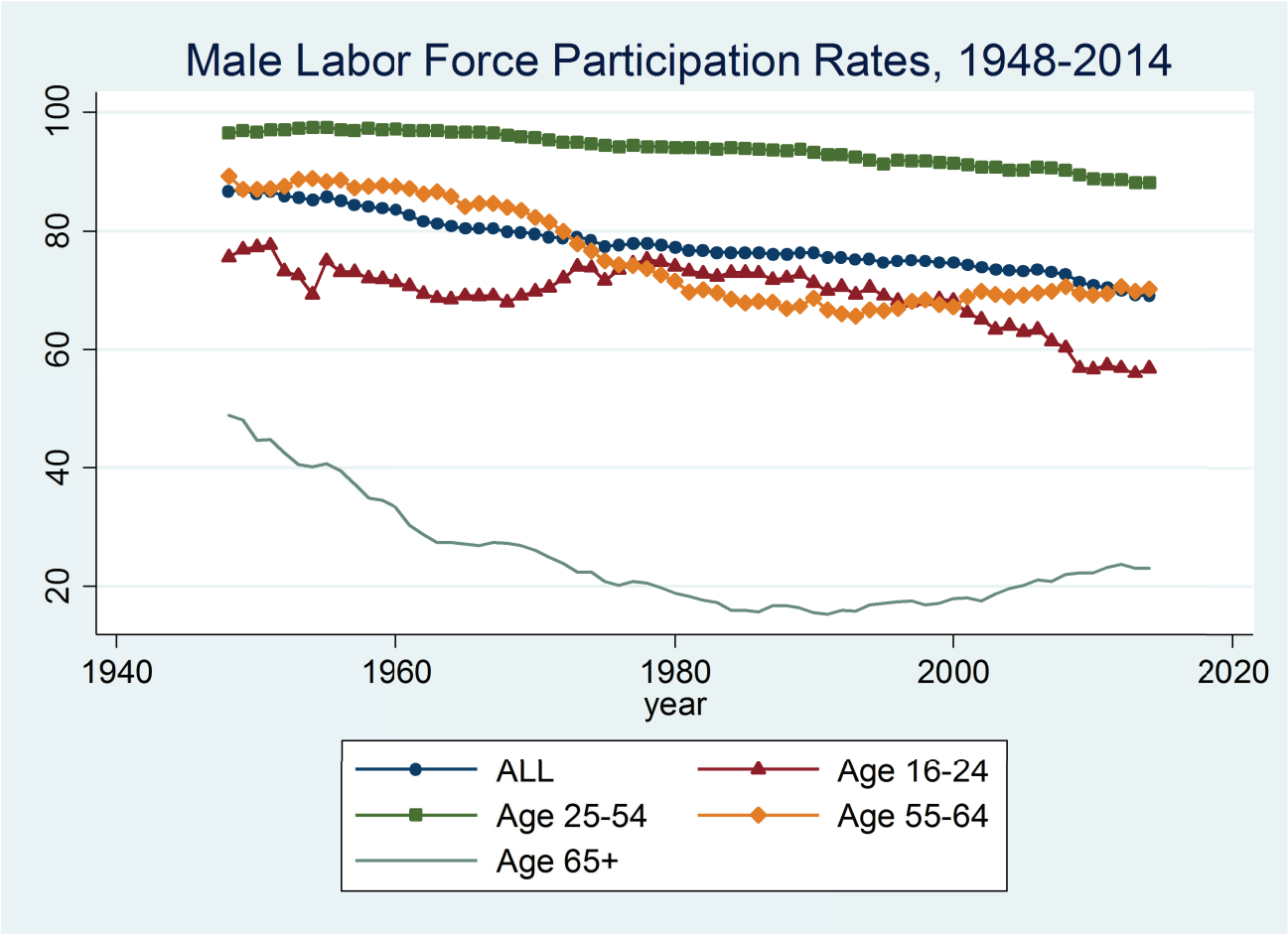
Basic Facts

- Male labor force participation rate [(E+U)/POP] has steadily declined over time:

TABLE 2-1 **Labor Force Participation Rates of Men, 1900–2000**

Sources: U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Years to 1970,* Washington, DC: Government Printing Office, 1975; U.S. Bureau of the Census, *Statistical Abstract of the United States,* Washington, DC: Government Printing Office, various issues.

Year	All Men	Men Aged 25–44	Men Aged 45–64	Men Aged over 65
1900	80.0	94.7	90.3	63.1
1920	78.2	95.6	90.7	55.6
1930	76.2	95.8	91.0	54.0
1940	79.0	94.9	88.7	41.8
1950	86.8	97.1	92.0	45.8
1960	84.0	97.7	92.0	33.1
1970	80.6	96.8	89.3	26.8
1980	77.4	93.0	80.8	19.0
1990	76.4	93.3	79.8	16.3
2000	74.7	87.9	78.3	17.5


Male Labor Force Participation Rates, 1948-2014
100
80
60
40
20
1940
1960
1980
2000
2020
year
ALL
Age 16-24
Age 25-54
Age 55-64
Age 65+

- Decline has continued in the 00s: today: 70%

- Explanations:
  - social security, retirement
  - more investment in education

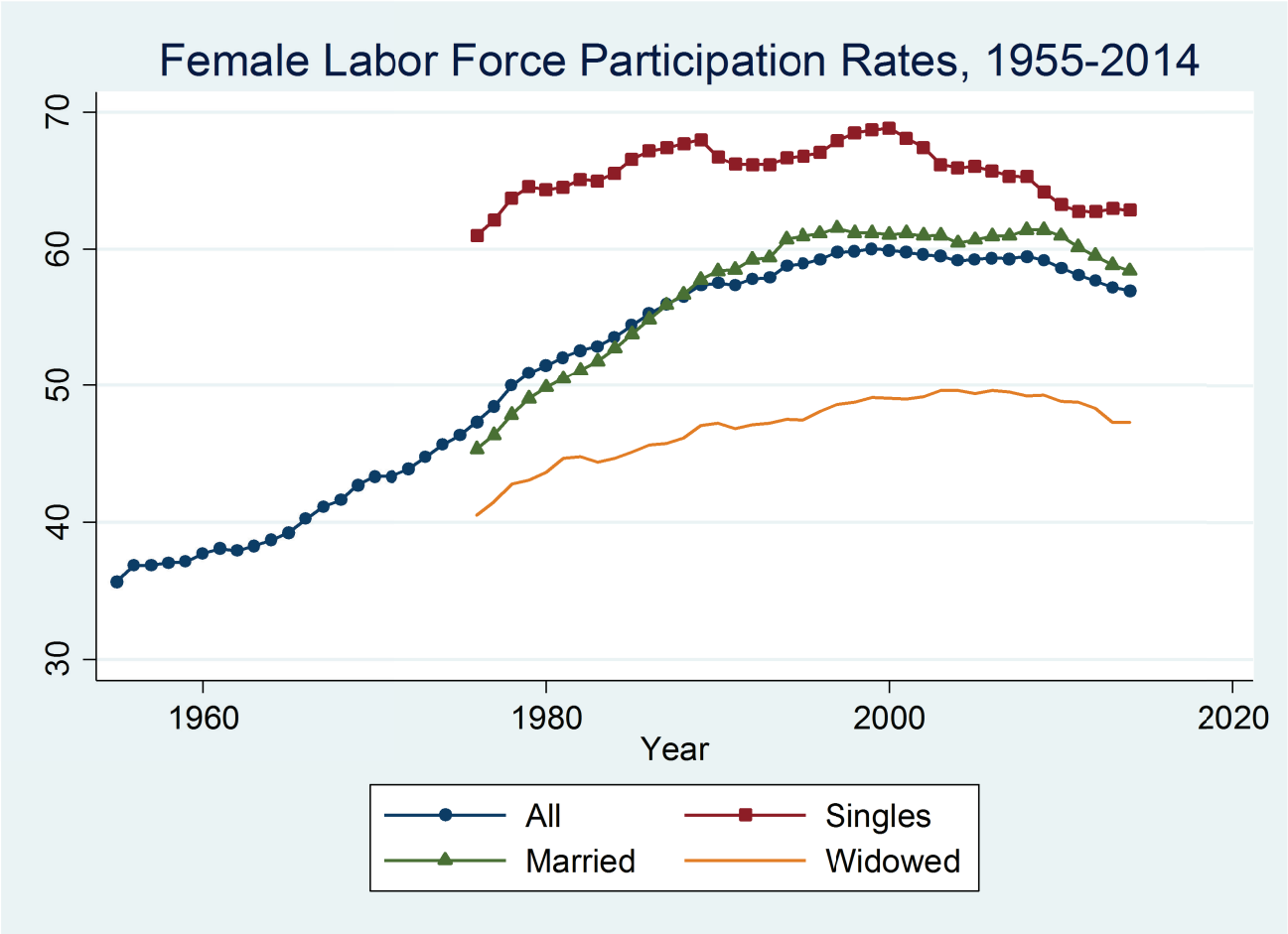
Female labor supply

- Steady increase in female LFP, massive increase among married women.

TABLE 2-2 **Labor Force Participation Rates of Women, 1900–2000**

Sources: U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Years to 1970,* Washington, DC: Government Printing Office, 1975, p. 133; and U.S. Department of Commerce, *Statistical Abstract of the United States, 2002,* Washington, DC: Government Printing Office, 2002, Table 569.

Year	All Women	Single Women	Married Women	Widowed, Divorced, or Separated
1900	20.6	43.5	5.6	32.5
1910	25.4	51.1	10.7	34.1
1930	24.8	50.5	11.7	34.4
1940	25.8	45.5	15.6	30.2
1950	29.0	46.3	23.0	32.7
1960	34.5	42.9	31.7	36.1
1970	41.6	50.9	40.2	36.8
1980	51.5	64.4	49.9	43.6
1990	57.5	66.7	58.4	47.2
2000	60.2	69.0	61.3	49.4


Female Labor Force Participation Rates, 1955-2014
70
60
50
40
30
1960
1980
2000
2020
Year
All
Singles
Married
Widowed

- Trend has somewhat stabilized, maybe even a small dip lately: today, 56.9% female LFP.

- Explanations:
  - changes in wages?
  - technological and medical advances (household appliances, the "pill", fertility treatment)
  - changes in tastes? (women's movement)

- Large differences by demographic groups:

TABLE 2-3 **Labor Supply in the United States, 2007 (persons aged 25–64)**

Source: U.S. Bureau of Labor Statistics, *Current Population Survey,* March 2007. The average number of hours worked is calculated in the subsample of workers. The percent of workers in part-time jobs refers to the proportion working fewer than 30 hours per week.

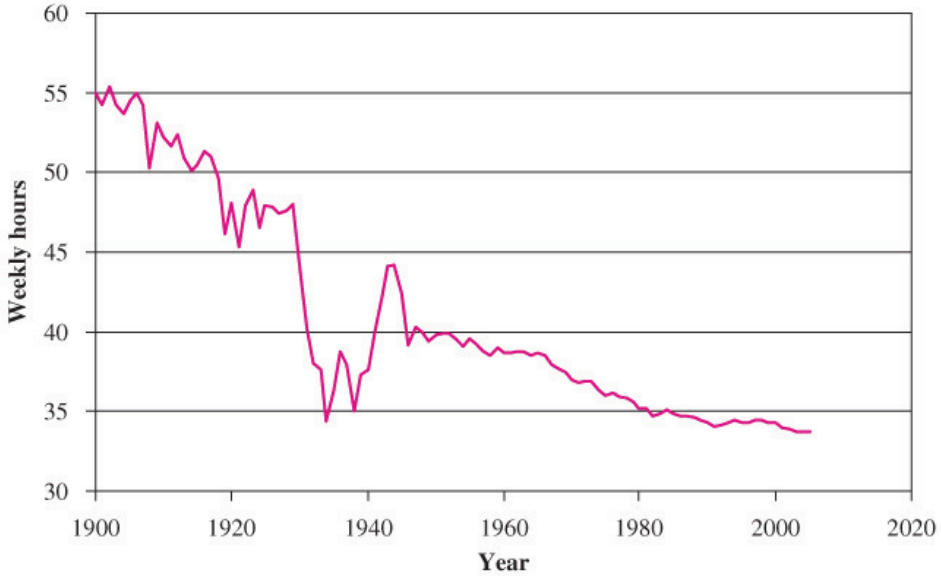
	Labor Force Participation Rate		Annual Hours of Work		Percent of Workers in Part-Time Jobs	
	Men	Women	Men	Women	Men	Women
All persons	87.1	72.7	2,153	1,810	3.6	14.8
Educational attainment:						
Less than 12 years	75.3	49.3	1,966	1,655	5.0	16.4
12 years	85.1	70.1	2,111	1,778	3.2	14.7
13–15 years	88.9	76.4	2,146	1,804	4.1	15.1
16 years or more	92.4	81.0	2,261	1,884	3.2	14.2
Age:						
25–34	92.2	75.6	2,090	1,768	3.9	13.6
35–44	91.9	77.5	2,203	1,814	2.4	15.6
45–54	88.3	76.6	2,209	1,879	2.6	12.5
55–64	68.9	55.0	2,058	1,747	7.8	19.7
Race:						
White	88.0	74.0	2,194	1,804	3.5	16.2
Black	79.6	74.3	2,015	1,864	4.7	8.6
Hispanic	88.1	65.3	2,040	1,766	3.2	12.6

- Higher LFP and more hours (conditional on working) for more educated workers.
- Conditional on working, men work more hours than women, fewer part-time jobs.
- Hours are inverse-U shaped function of age: rise over the life-cycle, then fall.

- Substantial decline in hours of work per week

FIGURE 2-1 **Average Weekly Hours of Work of Production Workers, 1947–2007**

Sources: The pre-1947 data are drawn from Ethel Jones, "New Estimates of Hours of Work per Week and Hourly Earnings, 1900–1957," *Review of Economics and Statistics* 45 (November 1963): 374–85. Beginning in 1947, the data are drawn from U.S. Department of Labor, Bureau of Labor Statistics, *Employment, Hours, and Earnings from the Current Employment Statistics Survey,* "Table B-2. Average Weekly Hours of Production or Nonsupervisory Workers on Private Nonfarm Payrolls by Industry Sector and Selected Industry Detail": www.bls.gov/ces/cesbtabs.htm.



The Labor-Leisure Choice

- Basic workhorse model of labor supply.
- Agent divides time between labor (H) and leisure (L)

$$L + H = T$$

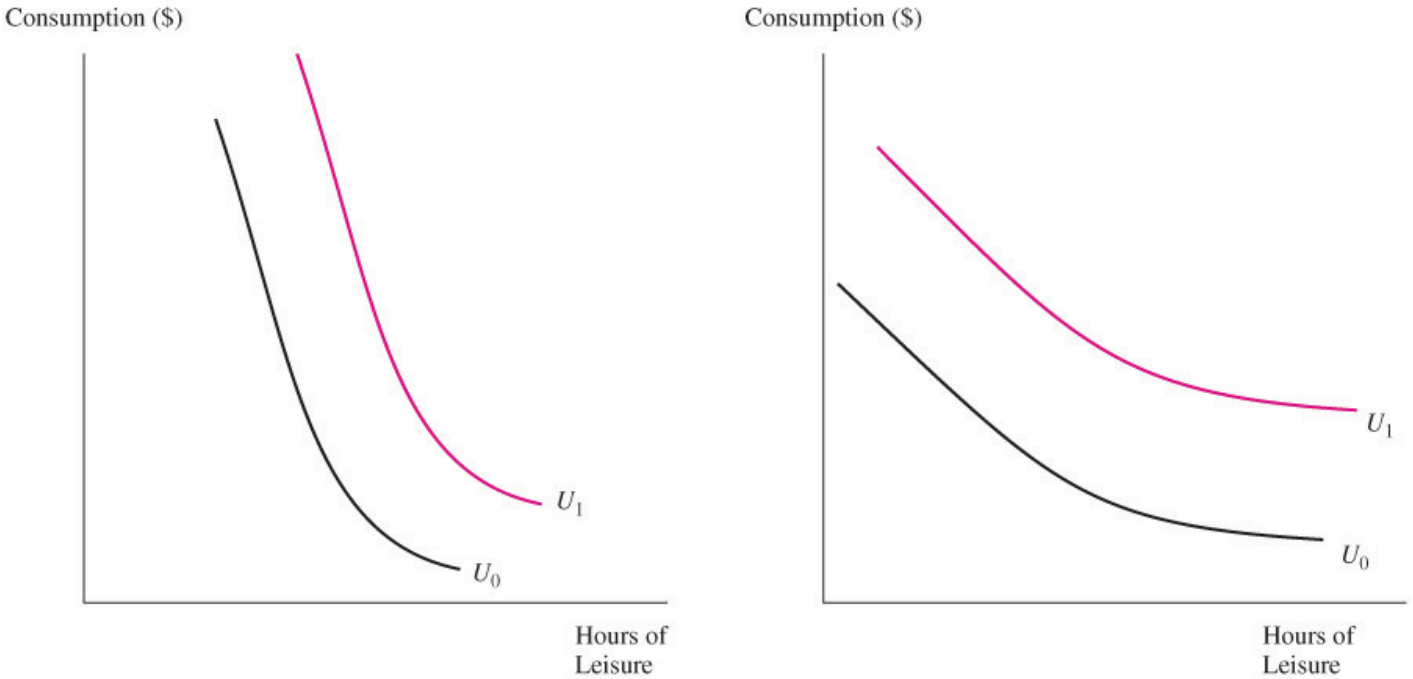
- Agent derives utility from consumption (C) and leisure.

$$U = U(C, L)$$

  - utility function has the usual properties (positive first derivatives, quasi-concavity) $\rightarrow$ indifference curves are downward sloping, smooth and convex.
  - additional assumption: both consumption and leisure are *normal* goods (i.e., consume more when income is higher).

FIGURE 2-4 **Differences in Preferences across Workers**

(*a*) Cindy's indifference curves are relatively steep, indicating that she requires a substantial bribe to give up an additional hour of leisure. (*b*) Mindy's indifference curves are relatively flat, indicating that she attaches a much lower value to her leisure time.



(*a*) Cindy's Indifference Curves

(*b*) Mindy's Indifference Curves

Budget constraint

- Agent can work any amount of hours at wage w. Price of one unit of consumption is 1.
- Agent has unearned income (rents, inheritances, government subsidies, alimony payments, lottery winnings, etc.) equal to V.
- Budget constraint:

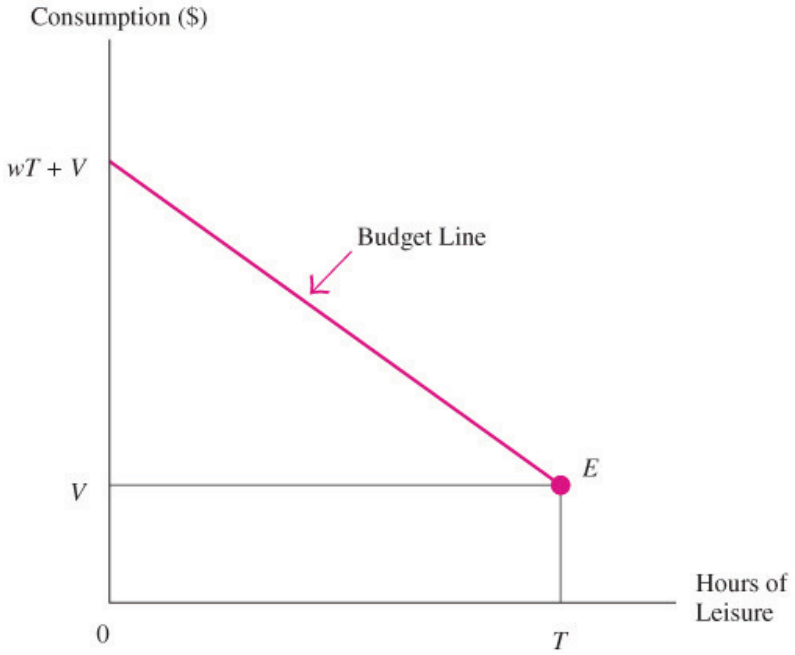
$$C = wH + V$$

- Alternatively:

$$\begin{aligned} C &= w(T - L) + V \\ wL + C &= wT + V \end{aligned}$$

FIGURE 2-5 **The Budget Line Is the Boundary of the Worker's Opportunity Set**

Point E is the endowment point, telling the person how much she can consume if she does not enter the labor market. The worker moves up the budget line as she trades off an hour of leisure for additional consumption. The absolute value of the slope of the budget line is the wage rate.



Utility maximization

- Agent's problem:

$$\begin{aligned} & \max_{C,L} U(C, L) \\ s.t. \quad : \quad & wL + C \leq wT + V \end{aligned}$$

- Lagrangian:

$$\mathcal{L} = U(C, L) + \lambda (wT + V - wL - C)$$

- First order conditions:

$$\begin{aligned} \partial U/\partial L - \lambda w &= 0 \\ \partial U/\partial C - \lambda &= 0 \\ wT + V - wL - C &= 0 \end{aligned}$$

- Divide first equation by second, simplify, obtain condition for an interior solution:

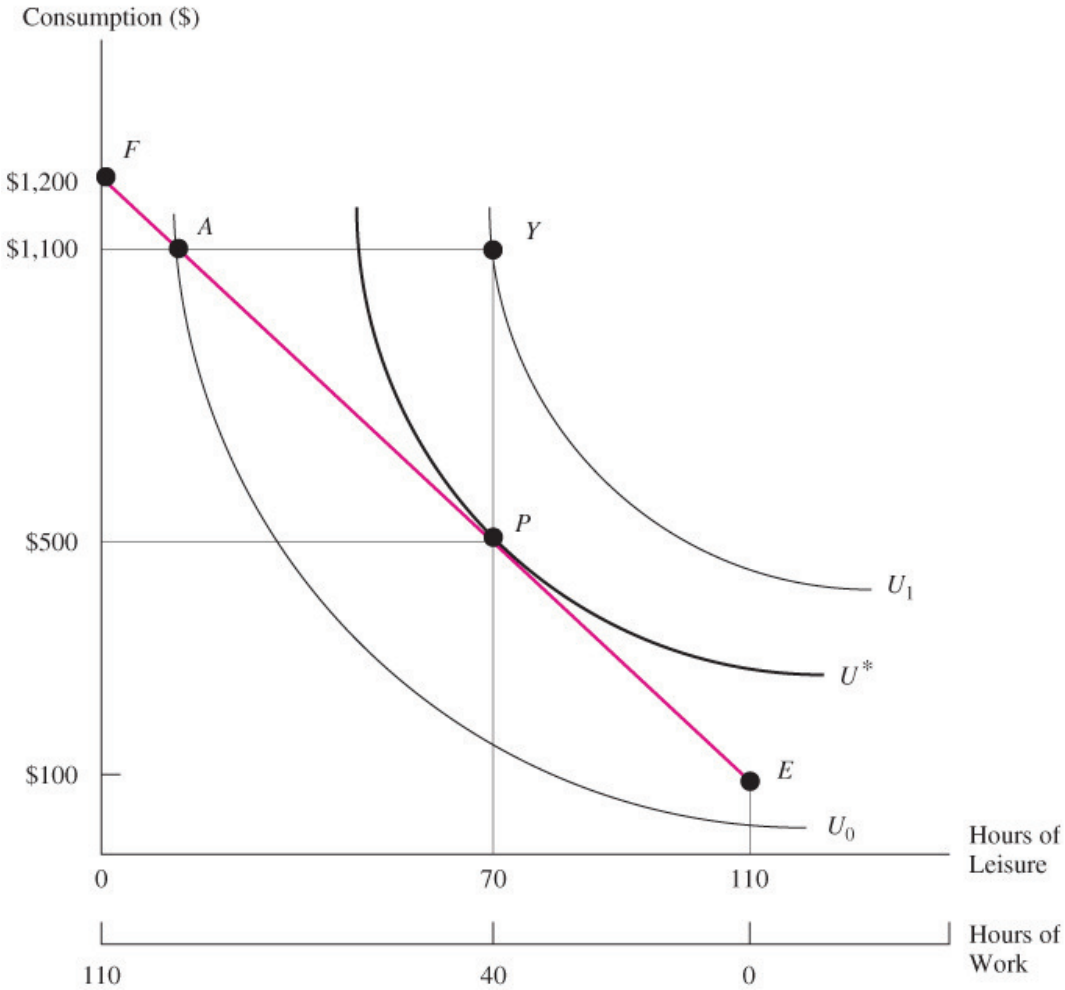
$$\frac{\partial U/\partial L}{\partial U/\partial C} \equiv MRS = w$$

- At the optimum, the individual's subjective willingness to trade off between consumption and leisure must equal the market price of leisure.

- If not, the consumer could change his/her consumption plan, and achieve more utility.

FIGURE 2-6 **An Interior Solution to the Labor-Leisure Decision**

A utility-maximizing worker chooses the consumption-leisure bundle given by point *P*, where the indifference curve is tangent to the budget line.

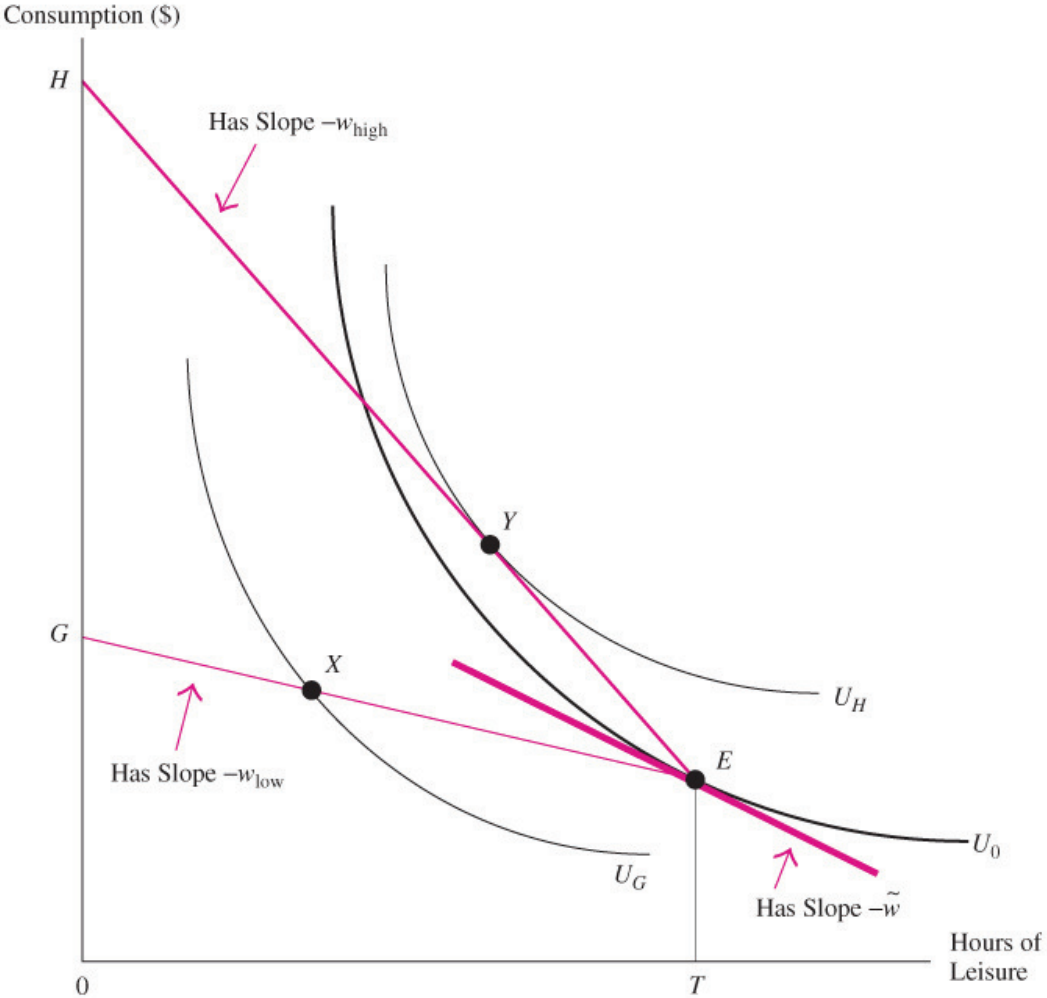


Corner solution

- If the indifference curves are sufficiently steep, there may not be an interior solution (formally, the first order condition is $MRS \geq w$).
- Specifically, if $MRS\left(T, V\right) \geq w$, then the agent chooses the corner solution $\left(T, V\right)$.
- To move away from corner solution, the wage must increase above $MRS\left(T, V\right)$.
- Therefore $MRS\left(T, V\right)$ is the *reservation wage*: the minimum level of wage required to induce the agent to work a positive amount of hours.

FIGURE 2-10 The Reservation Wage

If the person chooses not to work, she can remain at the endowment point E and get U_0 units of utility. At a low wage (w_{low}), the person is better off not working. At a high wage (w_{high}), she is better off working. The reservation wage is given by the slope of the indifference curve at the endowment point.

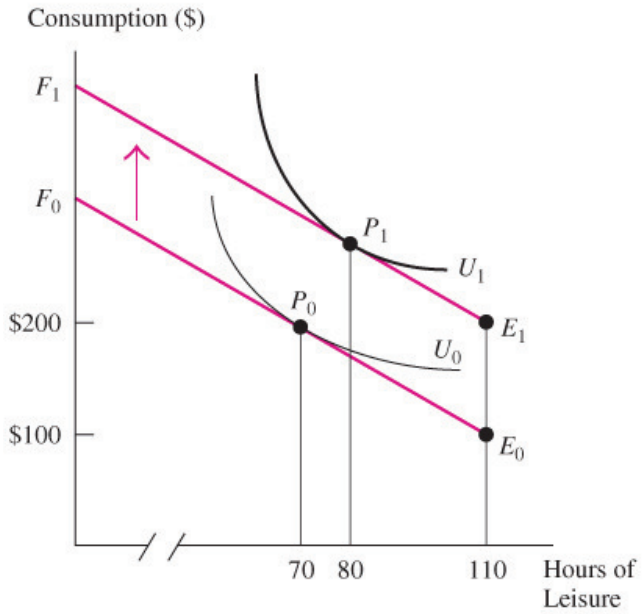


Comparative statics 1: Increase in non-labor income V

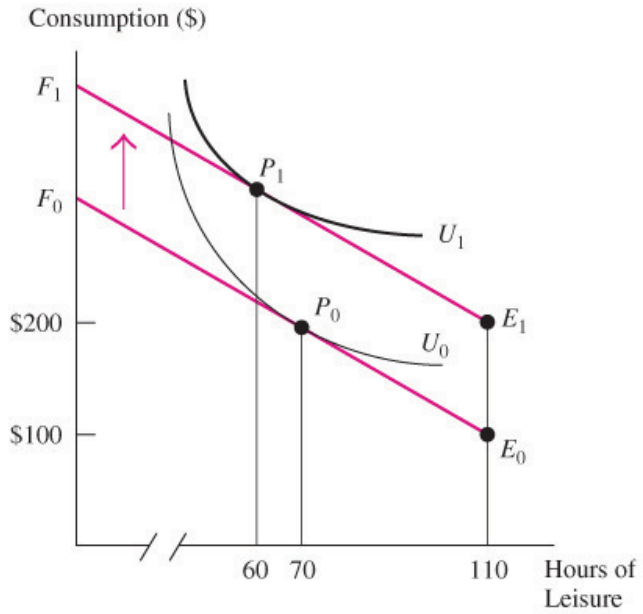
- Increase in non-labor income V shifts the budget constraint outwards.
- Consumption and leisure are normal goods, therefore demand for both will increase: optimal consumption moves to the "north-east".
- Unambiguously, labor supply falls.
- Potentially, can even induce exit from the labor force.

FIGURE 2-7 **The Effect of a Change in Nonlabor Income on Hours of Work**

An increase in nonlabor income leads to a parallel, upward shift in the budget line, moving the worker from point P_0 to point P_1. (*a*) If leisure is a normal good, hours of work fall. (*b*) If leisure is an inferior good, hours of work increase.



(*a*) Leisure Is a Normal Good



(*b*) Leisure Is an Inferior Good

Comparative statics 2 - Increase in the wage w

- Two contrasting effects on labor supply.

  1. The relative price of leisure has gone up. Agent will want to substitute away from leisure (relatively expensive) and into consumption (relatively cheap). This is the **substitution effect.**

  2. But agent also has an endowment of leisure, he/she "sells" his own leisure in the labor market. The price of the good that he/she sells has gone up, agent has more income, this increases the demand for both leisure and consumption. This is the **income effect.**

- Substitution effect: less leisure, **more** labor supply.
- Income effect: more leisure, **less** labor supply.

- The overall effect of an increase in w on labor supply is ambiguous.

FIGURE 2-8 **The Effect of a Change in the Wage Rate on Hours of Work**

A change in the wage rate rotates the budget line around the endowment point E. A wage increase moves the worker from point P to point R, and can either decrease or increase hours of work.

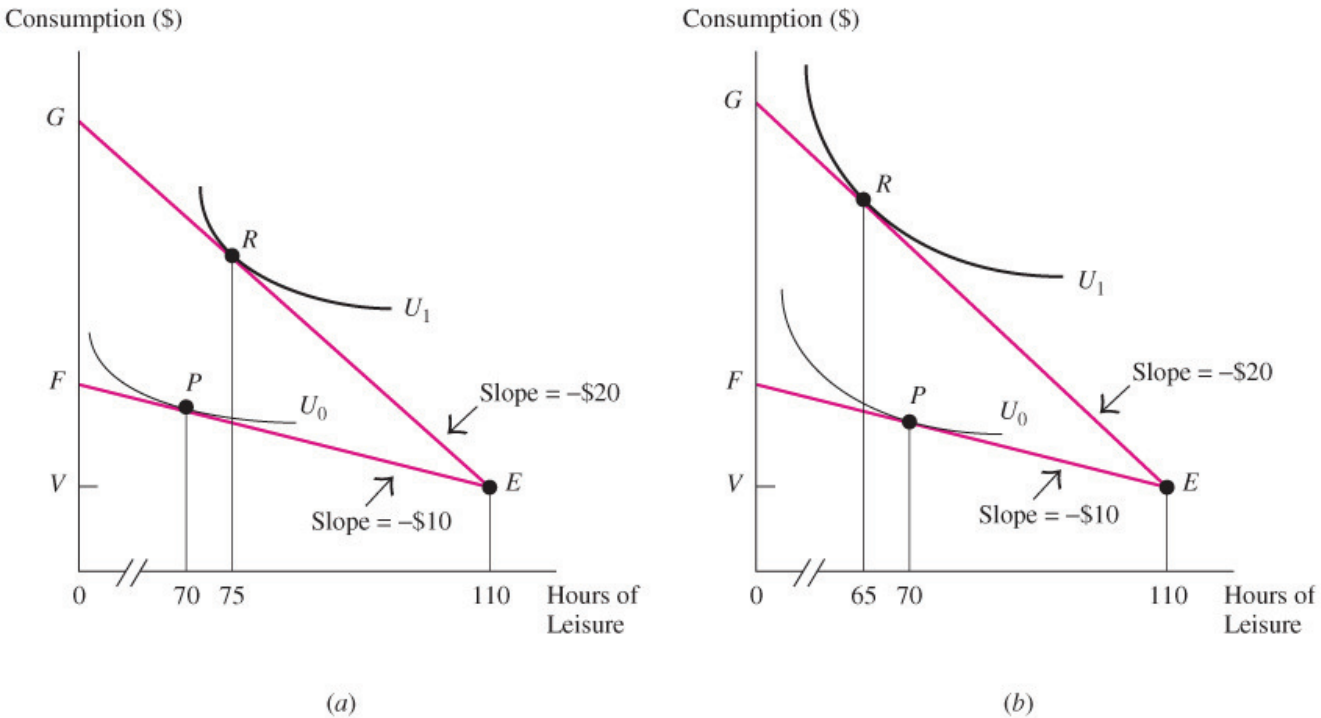
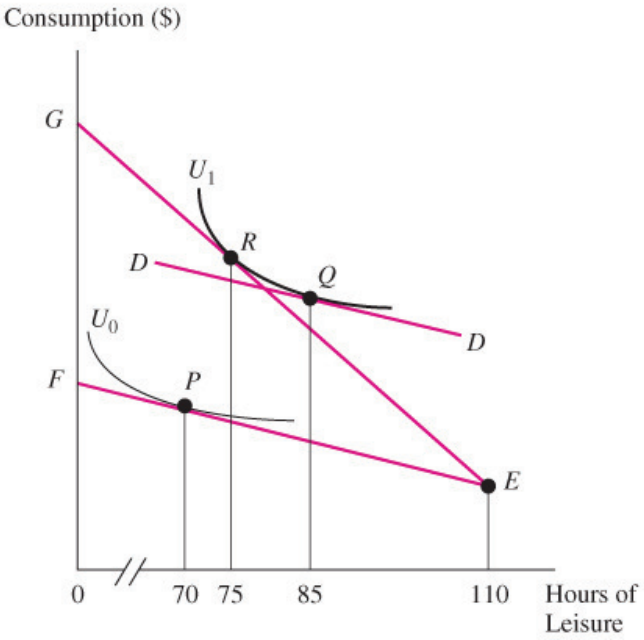
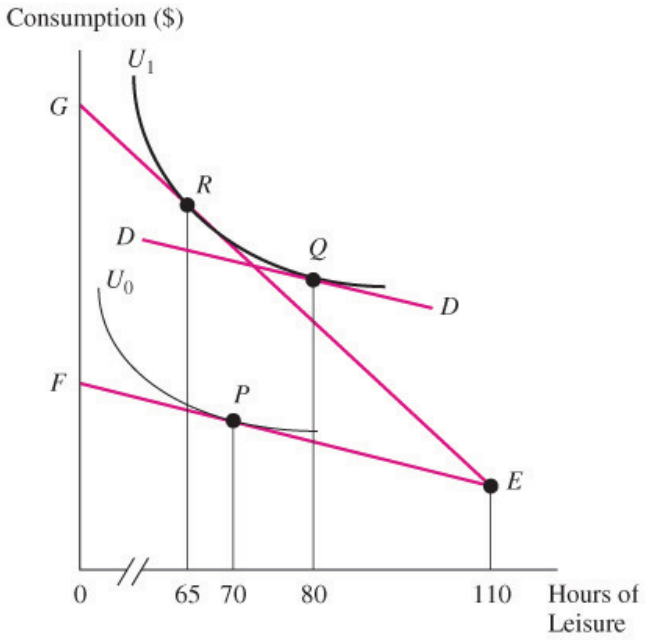


FIGURE 2-9 **Decomposing the Impact of a Wage Change into Income and Substitution Effects**

An increase in the wage rate generates both income and substitution effects. The income effect (the move from point P to point Q) reduces hours of work; the substitution effect (the move from Q to R) increases hours of work.



(*a*) Income Effect Dominates



(*b*) Substitution Effect Dominates

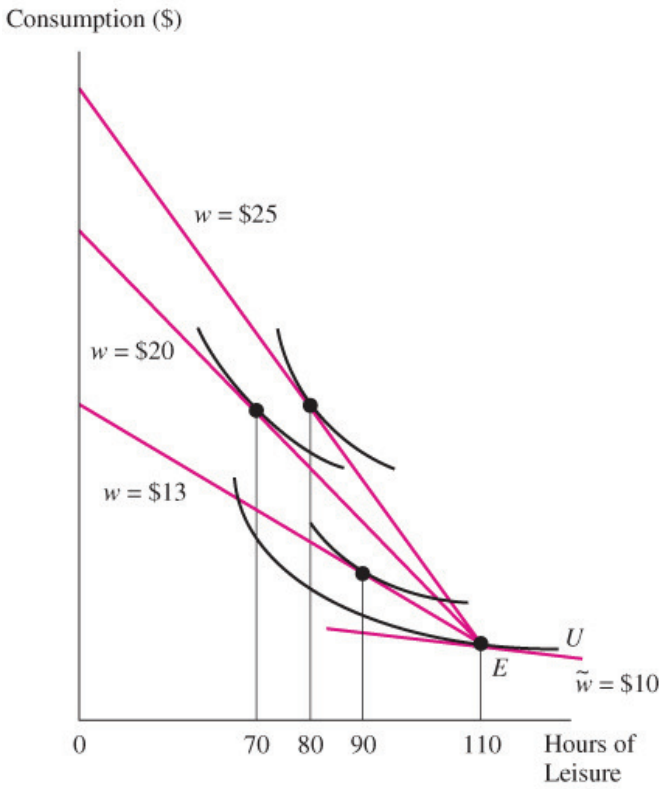
- Putting everything together, we can now derive the individual labor supply function.

- If the wage is below the reservation wage, labor supply is zero.

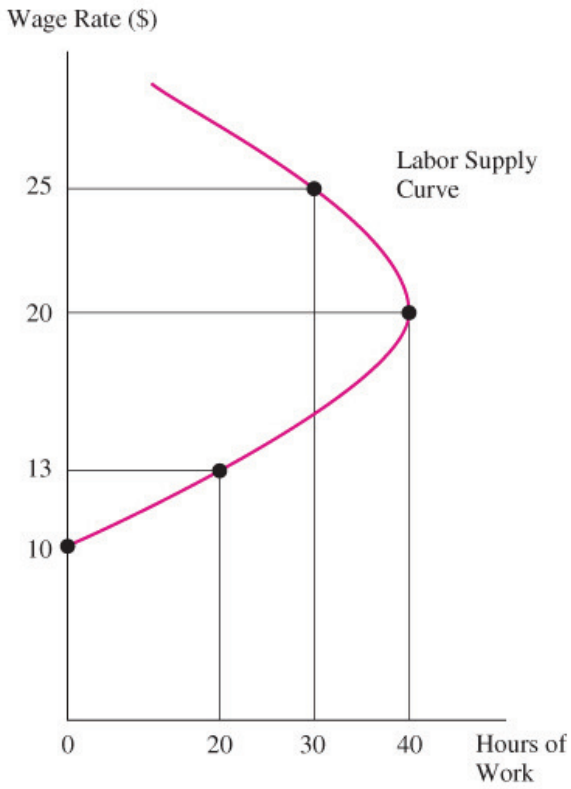
- At the reservation wage, the labor supply curve is unambiguously upward sloping: the income effect is zero (as labor supply is zero), so there is only the substitution effect.
- Beyond that point, the labor supply curve can be:
  - upward sloping, if the substitution effect dominates.
  - backward bending, if the income effect dominates.

FIGURE 2-11 **Deriving a Labor Supply Curve for a Worker**

The labor supply curve traces out the relationship between the wage rate and hours of work. At wages below the reservation wage ($10), the person does not work. At wages higher than $10, the person enters the labor market. The upward-sloping segment of the labor supply curve implies that substitution effects are stronger initially; the backward-bending segment implies that income effects may dominate eventually.



(*a*) Optimal Consumption Bundles



(*b*) Relation between Optimal Hours of Work and the Wage Rate

The Slutsky Equation for Labor Supply

- Decomposition of the wage effect into income and substitution effects:

$$\frac{\partial H^*}{\partial w} = \frac{\partial H^h}{\partial w} + \frac{\partial H^*}{\partial R} H^*.$$

- where $R = wT + V$, and H^h is the (compensated) Hicksian demand for leisure/work.
- The first term is the substitution effect: positive.
- The second term is the income effect: negative. More negative, the larger is H^* (i.e., the lower is leisure).

- Multiply by w/H^* to get total elasticity:

$$\begin{aligned} \frac{\partial H^*}{\partial w}\frac{w}{H^*} &= \frac{\partial H^h}{\partial w}\frac{w}{H^*} + \frac{\partial H^*}{\partial R}\frac{R}{H^*}\frac{H*}{R}H^*\frac{w}{H^*} \\ \eta_w &= \eta_w^h + \eta_R \frac{wH}{R} \end{aligned}$$

The Slutsky Equation for Labor Supply - Proof

- Let's derive a formal decomposition of the wage effect into income and substitution effects.
- Consider the *dual* optimization problem: minimize expenditures subject to a utility constraint.
- Agent's problem:

$$\begin{aligned} & \min_{L,C} wL + C \\ s.t. \quad : \quad & U(C, L) \geq \bar{U} \end{aligned}$$

- Same first order conditions as in the direct utility maximization problem:

$$MRS = w$$

- Define $R = wT + V$: "total income."
- The direct utility maximization problem yields the Marshallian demand functions:

$$L^* (w, R)$$
$$C^* (w, R)$$

and the indirect utility function:

$$V (w, R) = U (C^* (w, R), L^* (w, R)).$$

- The dual maximization problem yields the Hicksian demand functions:

$$L^h (w, \bar{U})$$
$$C^h (w, \bar{U})$$

and the expenditure function

$$E (w, \bar{U}) = wL^h (w, \bar{U}) + C^h (w, \bar{U}).$$

- Because the first order conditions are the same (and there are no savings, i.e., $R = E(w, \bar{U})$, the following holds:

$$L^h(w, \bar{U}) = L^*(w, E(w, \bar{U}))$$

- That is, if we give the agent exactly the level of resources that enables him to consume the bundle $\left(C^h, L^h\right)$, he will choose L^*.

- Differentiating both sides:

$$\frac{\partial L^h}{\partial w} = \frac{\partial L^*}{\partial w}|_R + \frac{\partial L^*}{\partial R}\frac{\partial E}{\partial w} = \frac{\partial L^*}{\partial w}|_R + \frac{\partial L^*}{\partial R}L^h(w, \bar{U}) = \frac{\partial L^*}{\partial w}|_R + \frac{\partial L^*}{\partial R}L^*.$$

- Rearranging:

$$\frac{\partial L^*}{\partial w}|_R = \frac{\partial L^h}{\partial w} - \frac{\partial L^*}{\partial R}L^*.$$

- Now:

$$\frac{\partial L^*}{\partial w} = \frac{\partial L^*}{\partial w}|_R + \frac{\partial L^*}{\partial R}\frac{\partial R}{\partial w} = \frac{\partial L^*}{\partial w}|_R + \frac{\partial L^*}{\partial R}T.$$

- Putting everything together:

$$\begin{aligned}\frac{\partial L^*}{\partial w} &= \frac{\partial L^h}{\partial w} - \frac{\partial L^*}{\partial R}L^* + \frac{\partial L^*}{\partial R}T \\ &= \frac{\partial L^h}{\partial w} + \frac{\partial L^*}{\partial R}\left(T - L^*\right).\end{aligned}$$