Productivity and Output: Part I

Yi Xin
(Singapore Management University)

Macroeconomics 1 (Econ 112)
Term Two, 2023–2024, Week 2

Background

- So we have measured variables of macroeconomic interest. We now turn to the construction and analysis of a particular macroeconomic model.
- Recall the three elements of competitive equilibrium: optimization, competitiveness, and market clearing.
- Competitiveness is assumed. We will study optimization and market clearing in this lecture.
- Optimization by consumers (workers) and firms.
- Labor and goods market clear.
- One-period, static decisions. Two-period, dynamic decisions later.
- Loads of maths and models, but I will try my best to explain. Make appointment with me for consultations if you need more explanations.

Plan for this Class

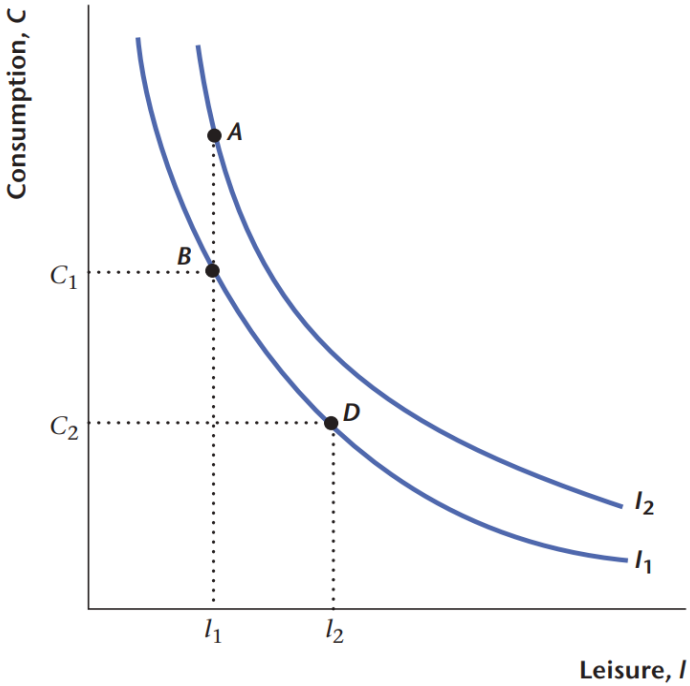
1. **Consumer Behavior**
2. Firm Behavior
3. Competitive Equilibrium and Market Clearing

Overview of Consumer's Problem

- With regard to consumer behavior, we focus on how a consumer makes choices concerning the trade-off between consuming and working (leisure).
- For the consumer, consuming more goods comes at a cost: the consumer must work harder and will enjoy less leisure time.
- Primarily, we are interested in how a consumer's work–leisure choice is affected by his or her preferences and by the constraints he or she faces.
- For example, how a change in the market wage rate and in the consumer's non-wage income affects his or her choices concerning
  - How much to work (how much leisure time to take)?
  - How much to consume?

The Representative Consumer

Building Block 1: Indifference Curves



Two goods that consumer desire

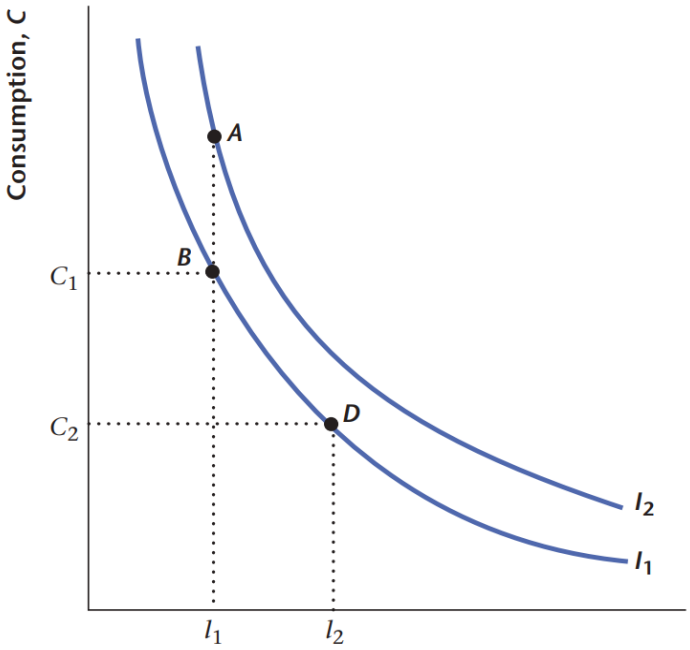
- Consumption good that measures aggregate consumption in the economy.
- Leisure which is any time spent not working.

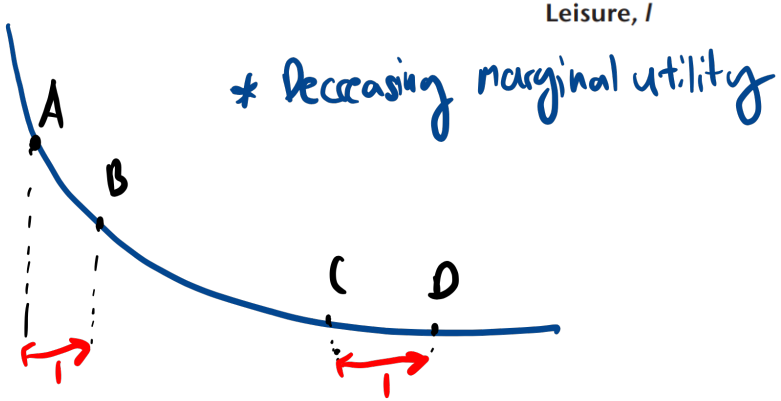
Reflect consumer preferences: Points on the same indifference curve deliver the same level of utility, $U(C_1, l_1) = U(C_2, l_2)$.

- Downward-sloping: More is preferred to less.
- Higher indifference curves: Higher utility levels

The Representative Consumer

Building Block 1: Indifference Curves





- Bowed in towards the origin (convex):

  As quantity of leisure increases, willing to give up ever decreasing amounts of consumption good to stay indifferent

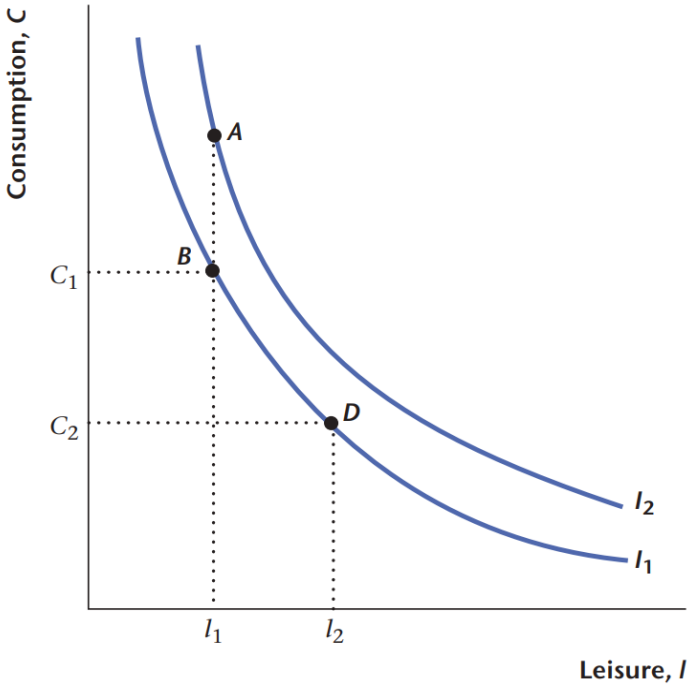
  (Preferences exhibit diminishing marginal utility)

- Rate at which consumer is willing to sacrifice consumption good for another unit of leisure:

  Marginal rate of substitution $= \frac{MU_l}{MU_C} =$ $-$(Slope of indifference curve)

The Representative Consumer

Building Block 1: Indifference Curves



One big assumption:

The preferences of consumers in the entire economy can be represented by a single set of indifference curves, ie their preferences can be aggregated.

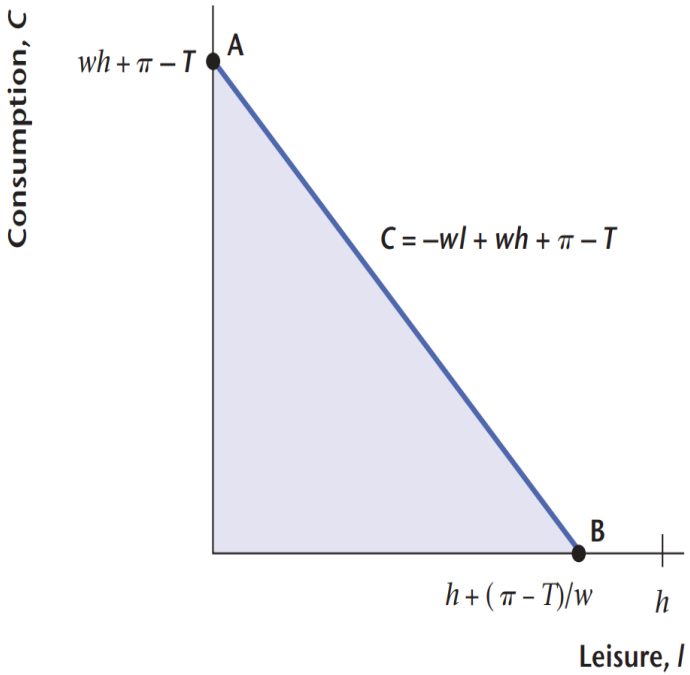
A sufficient condition: Often convenient to assume that preferences are identical and homothetic.

The homotheticity assumption: indifference curves are radial expansions with respect to the origin.

This means that if income, I, doubles, the utility-maximizing consumption of each good doubles. (Income elasticity of demand $= 1$)

The Representative Consumer (Cont'd)

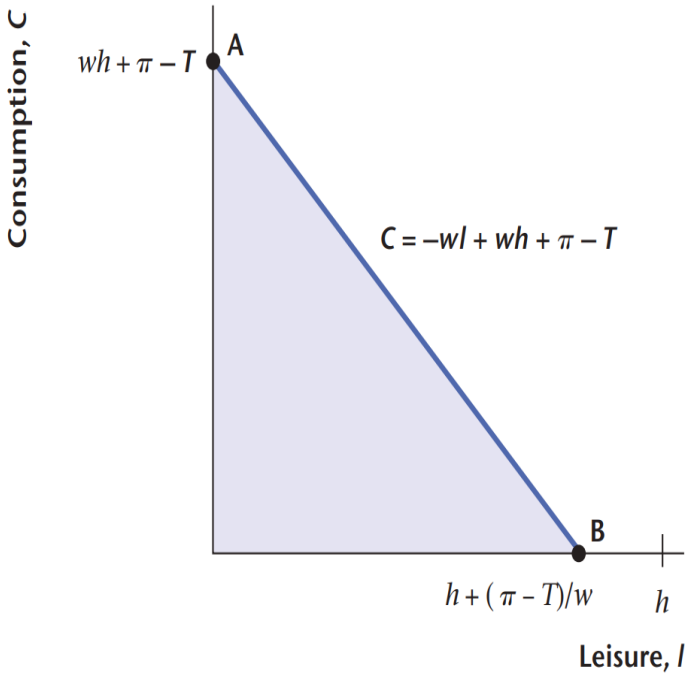
Building Block 2: Budget Line



Budget line AB shows all combinations of consumption goods and leisure that the consumer, who receives wage w, dividend income π, and pays lump-sum tax T, can purchase.

The Representative Consumer (Cont'd)

Building Block 2: Budget Line



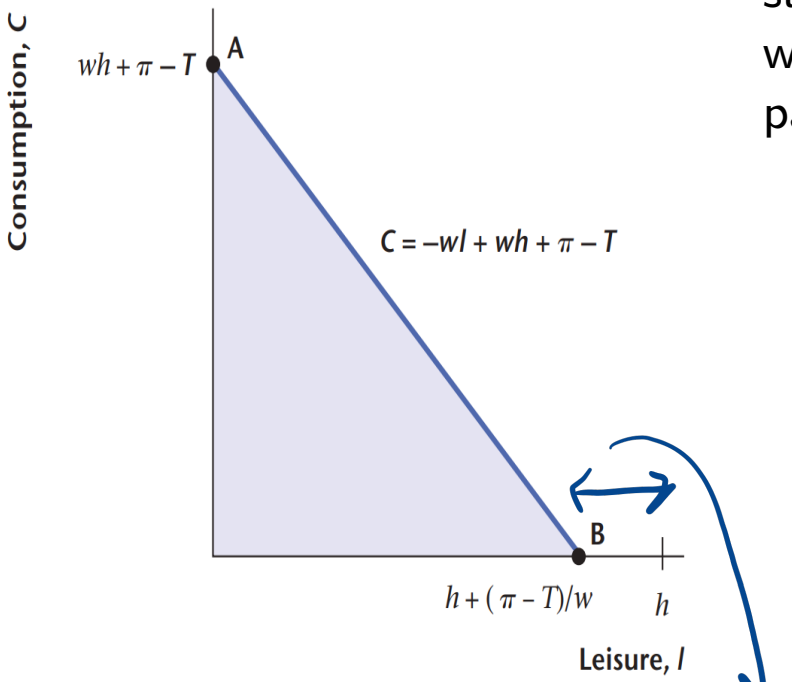
Real model: all in terms of quantities

Budget line AB shows all combinations of consumption goods and leisure that the consumer, who receives wage w, dividend income π, and pays lump-sum tax T, can purchase.

- h: Total hours of time that the consumer has.
- l: Hours of time allocated to leisure.
- C: Consumption good with price 1. It plays the role of numeraire, or the good in which all prices and quantities are denominated.
- w: Real wage, or the wage rate of the consumer in units of purchasing power.

The Representative Consumer (Cont'd)

Building Block 2: Budget Line



Budget line AB shows all combinations of consumption goods and leisure that the consumer, who receives wage w, dividend income π, and pays lump-sum tax T, can purchase.

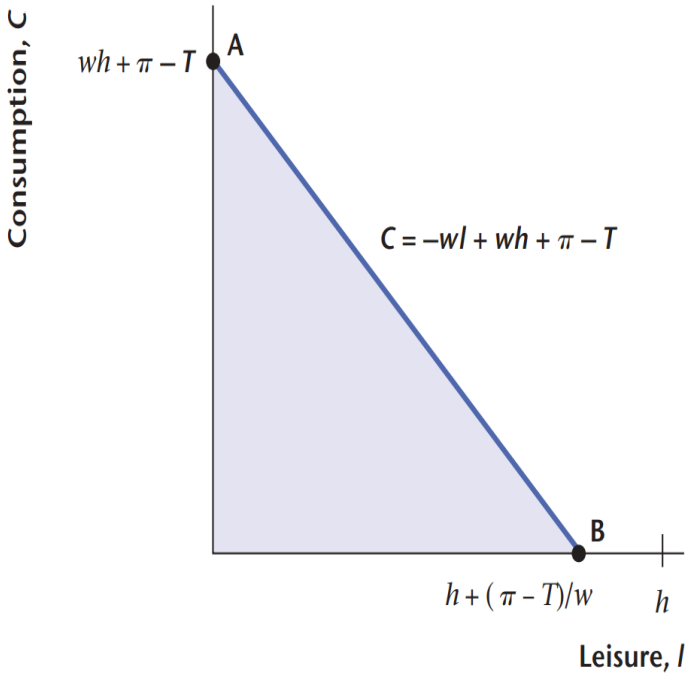
- π: Dividend income, the quantity of profits, in real terms, that the consumer receives.
- T: Lump-sum tax, the real quantity of taxes in a lump-sum amount.
- T is assumed to be greater than π in this figure, such that $T > \pi$.

because $T > \pi$

advance $\pi < T$

The Representative Consumer (Cont'd)

Building Block 2: Budget Line



Budget line AB shows all combinations of consumption goods and leisure that the consumer, who receives wage w, dividend income π, and pays lump-sum tax T, can purchase.

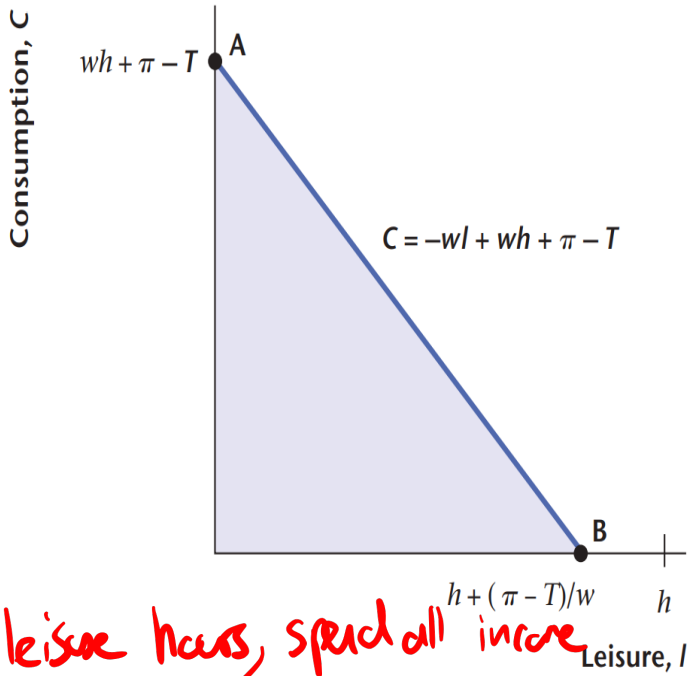
- The budget constraint can be written as

$$C + wl = wh + \pi - T.$$

- Interpretation of LHS: Expenditure on consumption goods and leisure.
- Interpretation of RHS: Total income/wealth of the consumer (market value of time endowment, dividend income, lump-sum taxes to be paid).

The Representative Consumer (Cont'd)

Building Block 2: Budget Line



A: No leisure hours, spend all income

B: No consumption, all leisure hours

Budget line AB shows all combinations of consumption goods and leisure that the consumer, who receives wage w, dividend income π, and pays lump-sum tax T, can purchase.

- Equivalently we can write budget constraint as

$$C = w(h - l) + \pi - T.$$

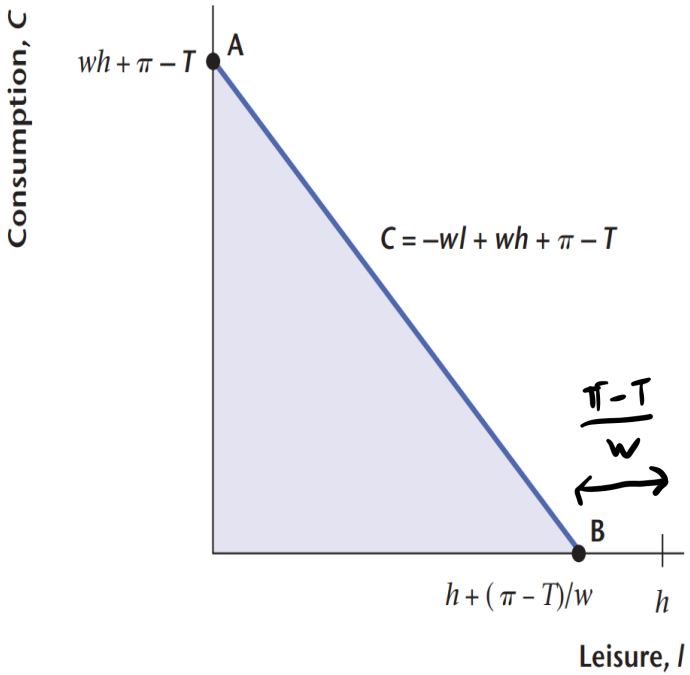
$C = -wl + wh + \pi - T$, $-w$ is slope

- This is obtained by moving wl from the LHS of the budget constraint on the previous slide to the RHS.
- Interpretation of $h - l$: Hours worked.
- Interpretation of RHS: Total disposable income of the consumer (market value of hours worked, dividend income, lump-sum taxes to be paid).

The Representative Consumer (Cont'd)

w is the tradeoff between leisure & expenditure (price ratio)

Building Block 2: Budget Line



Some assumptions:

- No savings: Expenditure = Income
- Money is implicit: All that matters is relative prices

  Get comfortable with relative prices!

How does the budget line shift when ...

- (1) the relative price of leisure (real wage) increases?
- (2) the total hours of time that the consumer has, h, increases?

π − T: amount of taxes paid through working

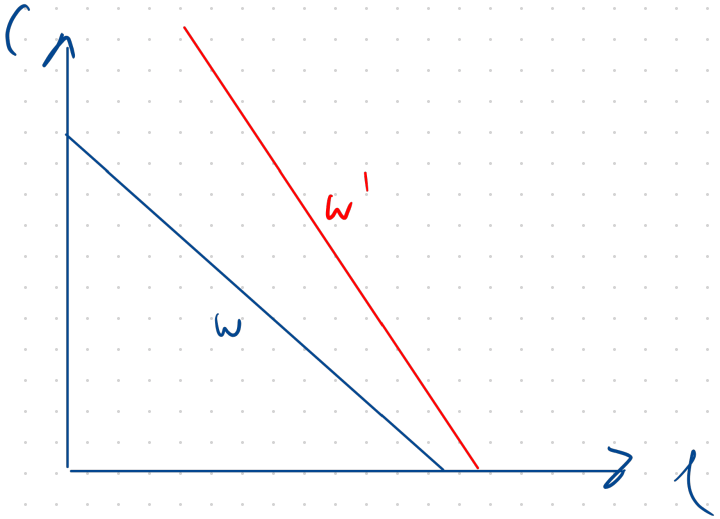
① B: $h + \frac{(\pi - T)}{w} \Rightarrow h + \frac{(\pi - T)}{w'}$, w increases to w'

① B moves to the left (increases)

A: $wh + \pi - T \Rightarrow w'h + \pi - T$, w increases to w'

② A moves up (increases)

slope: $-w \Rightarrow -w'$, w increases to w'

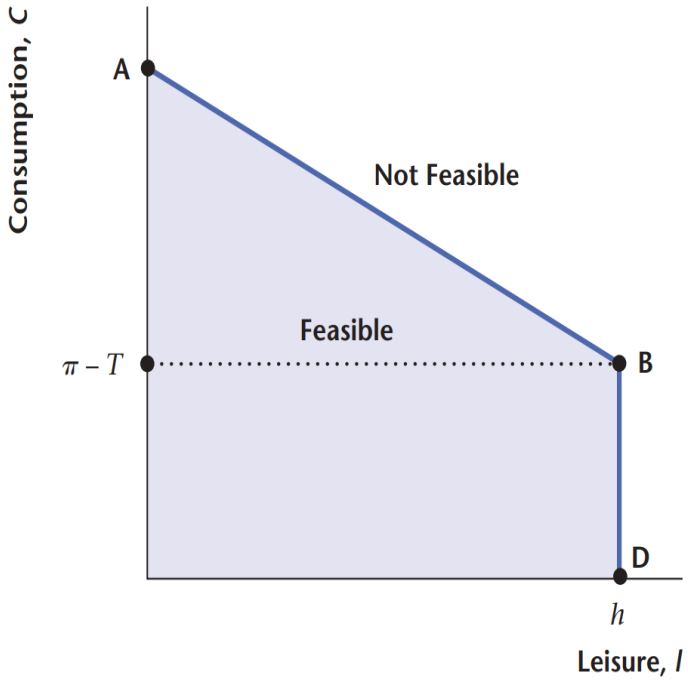


② h increases to h'

The Representative Consumer (Cont'd)

understand ① Math ② Economic interpretation ③ Graph

Building Block 2: Budget Line

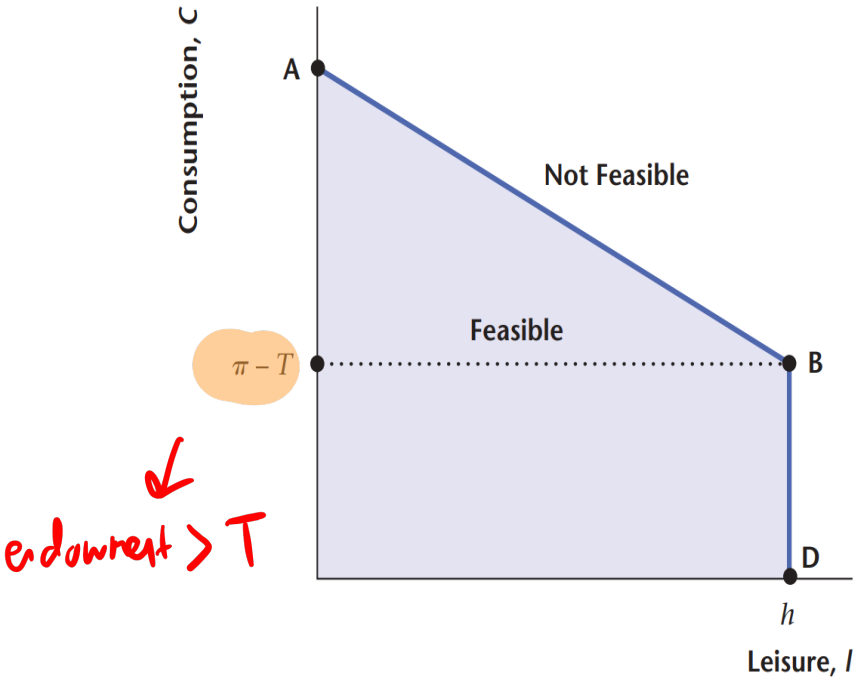


Budget line AB shows all combinations of consumption goods and leisure that the consumer, who receives wage w, dividend income π, and pays lump-sum tax T, can purchase.

- Now let's examine the case that the lump-sum taxes T is less than dividend income π, such that $T < \pi$.
- We would obtain a kinked budget constraint instead.
- Slope of the budget constraint over its upper portion: $-w$.
- The constraint is vertical over its lower portion.

The Representative Consumer (Cont'd)

Building Block 2: Budget Line

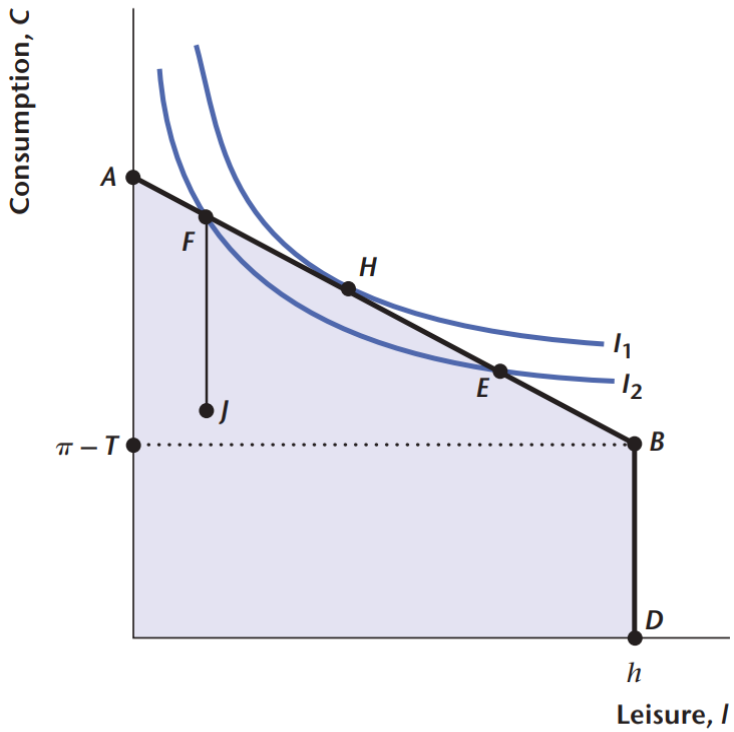


Budget line AB shows all combinations of consumption goods and leisure that the consumer, who receives wage w, dividend income π, and pays lump-sum tax T, can purchase.

- Point B: The number of hours worked by the consumer is zero, $l = h$.
- Points along BD all involve the consumer working zero hours and consuming some amount $C \leq \pi - T$, in which case the consumers are throwing away some of her or his dividend income.
- In what follows, we always consider the case where $\pi - T > 0$,

Consumer Optimization

Let's bring the two building blocks together in one diagram:

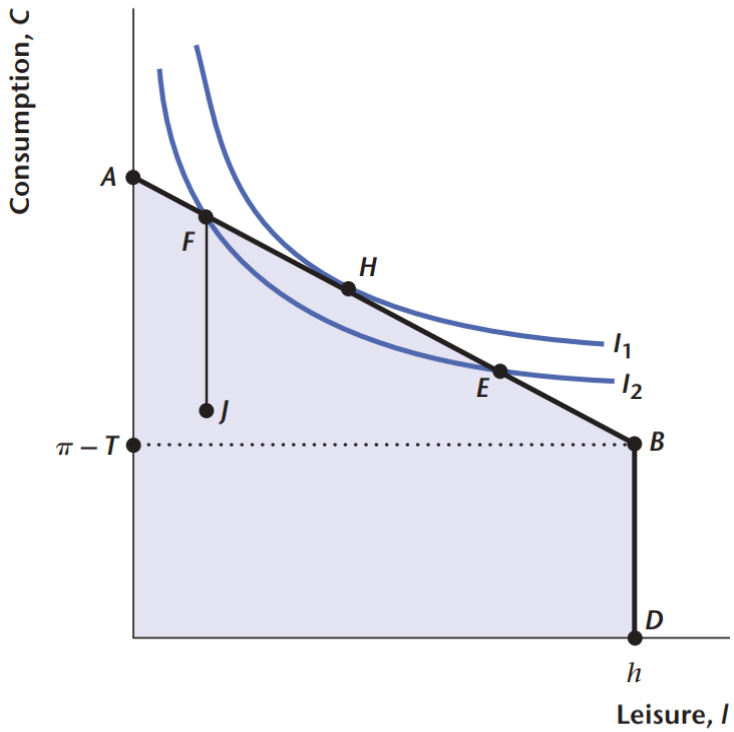


Point H is the optimal consumption bundle.

- First, the consumer would never choose a consumption bundle (point J) inside the budget constraint.
- Clearly, point F, which is on the budget constraint, is strictly preferred by the consumer to J. (more ≥ less)
- Because the consumer gets more consumption at point F than at J, while receiving the same quantity of leisure.
- Similarly, she/he would not choose any points along BD other than B.

Consumer Optimization

Let's bring the two building blocks together in one diagram:



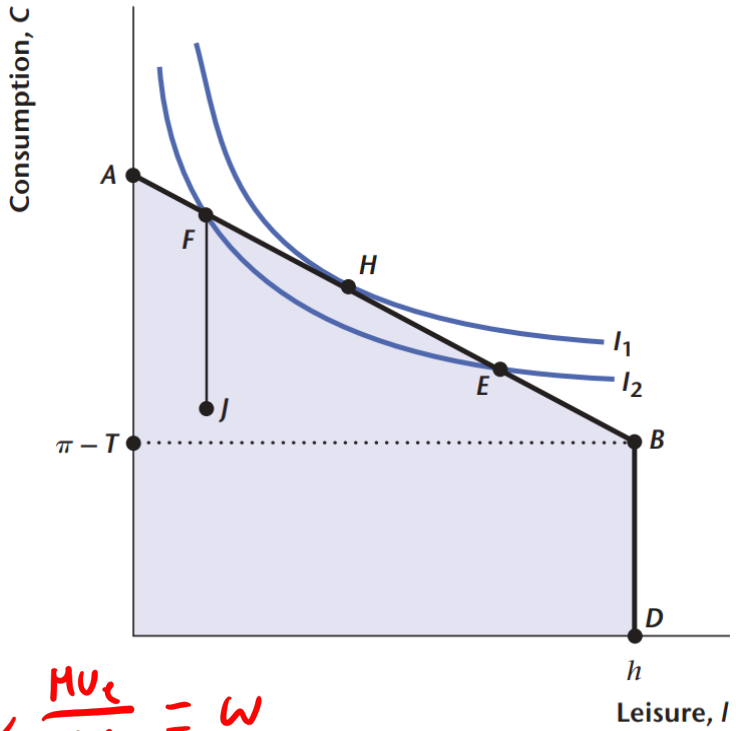
Point H is the optimal consumption bundle.

- Now, we can restrict attention solely to points on the line segment AB.
- Claim: Point H, the point at which an indifference curve is tangent to AB, is the optimal consumption bundle.
- Why? At a point like F other than H, she/her will be on a lower indifference curve and be willing to trade consumption for leisure in order to move to a higher indifference curve.
- At point H, the marginal rate of substitution will be equal to w, which is $-$(slope of budget line). * MRS = price ratio

$$MRS_{l,c} = MU_l / MU_C = w.$$

Consumer Optimization

Let's bring the two building blocks together in one diagram:



Point H is the optimal consumption bundle.

- At point H, the marginal rate of substitution will be equal to w, which is $-$(slope of budget line).

$$MRS_{l,c} = MU_l/MU_C = w.$$

- At any other point, the consumer could trade on the market and improve her/his utility.
- If she/he is at point F, where $MU_l/MU_C > w$, the consumer can trade consumption for leisure, and $U \uparrow$.
- If she/he is at point E, where $MU_l/MU_C < w$, the consumer can trade leisure for consumption, and $U \uparrow$.

At H, $\frac{MU_l}{MU_c} = w$

At F, $\frac{MU_l}{MU_c} > w$

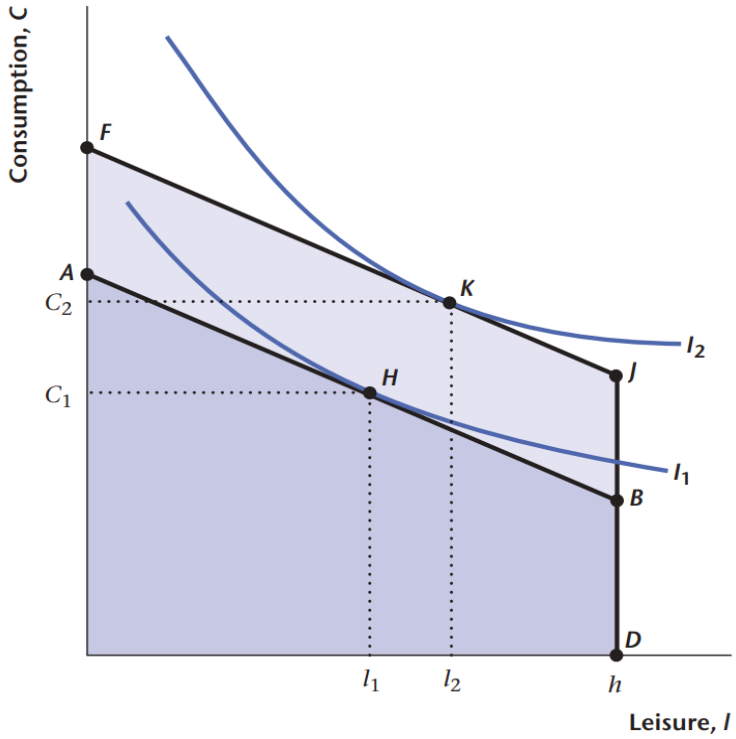
At E, $\frac{MU_l}{MU_c} < w$

* As l ↑, MU l ↓
* As l ↓, MU l ↑

save for C

Comparative Statics (Preference + Budget)

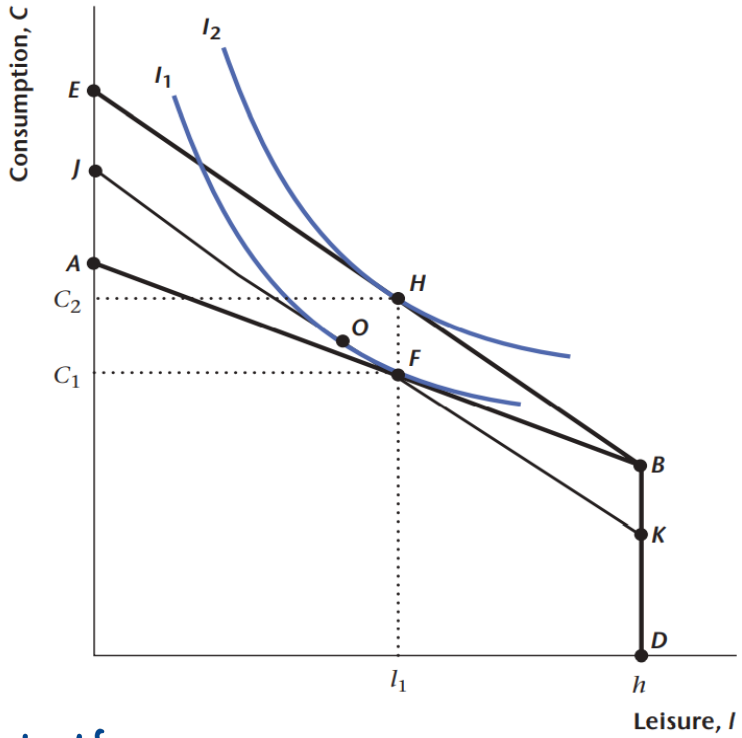
How does the consumer respond to an increase in $\pi - T$?



- Initially the consumer chooses H.
- When $\pi - T$ rises, this shifts the budget constraint out in a parallel fashion. (no change in w)
- Consumption and leisure both increase.
- An increase in $\pi - T$ could be caused either by an increase in π (firm productivity increases) or a decrease in T (tax cut), or both.
- Pure income effect. (no change in slope)

Comparative Statics (Cont'd)

How does the consumer respond to an increase in w?



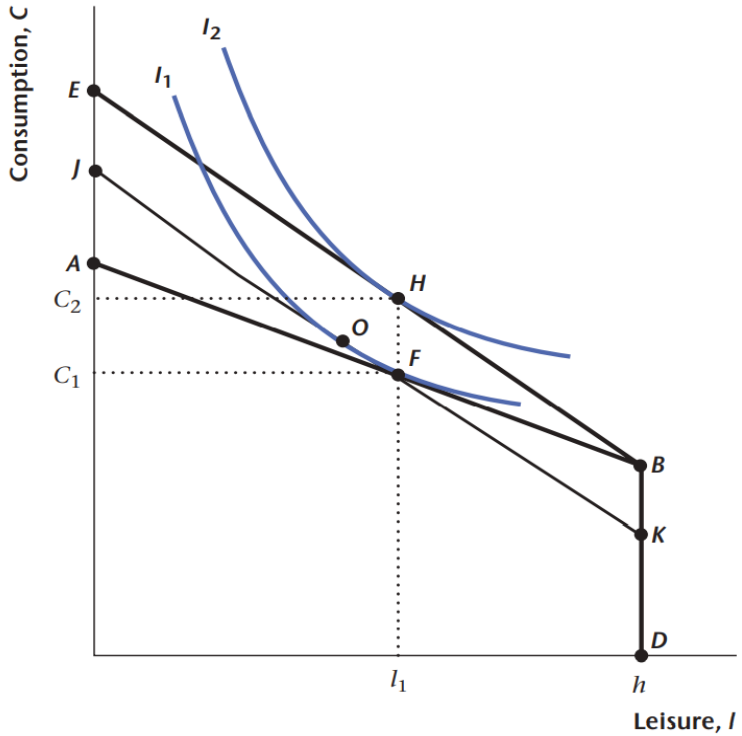
- An increase in the real wage shifts the budget constraint from ABD to EBD.
- Consumer's choice moves from F to H. (total effect)
- Consumption increases; leisure stays the same. (coincidental)
- Total effect can be broken into two steps:
  1. Substitution effect: $F \mapsto O$. (budget line pivots)
  2. Income effect: $O \mapsto H$. (budget line shifts, price ratio stays the same)

1. Substitution effect
- utility doesn't change
- budget line pivots

2. Income effect
- utility changes
- budget line shifts, price ratio no change

Comparative Statics (Cont'd)

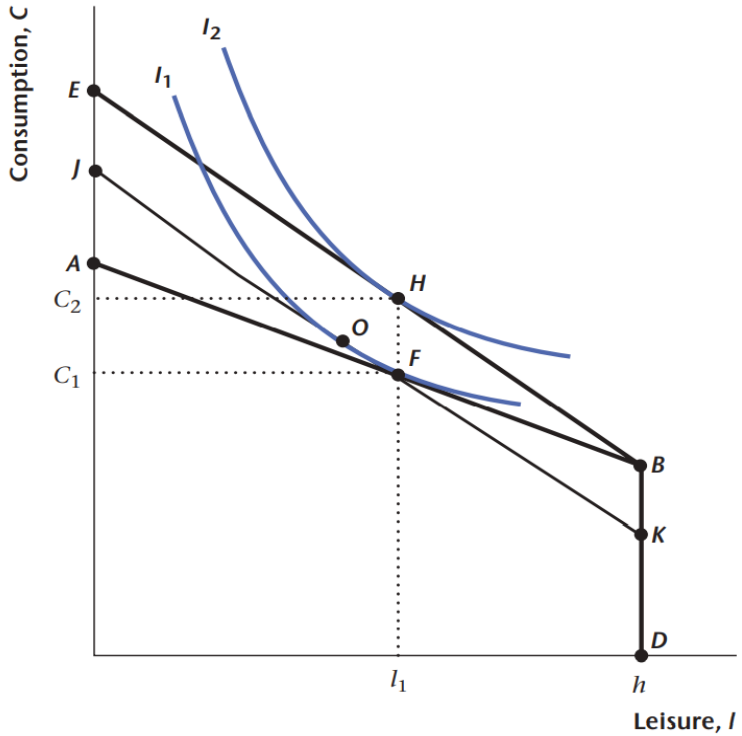
How does the consumer respond to an increase in w?



- Total effect can be broken into two steps:
  1. Substitution effect: $F \mapsto O$.
  2. Income effect: $O \mapsto H$.
- From F to O: as if only the relative price of leisure ($-$slope of budget line), w, is changing, and there are no income changes so that the consumer stays on the same indifference curve.
- The real wage increases, so that leisure has become more expensive relative to consumption goods, and the consumer substitutes away from the good that has become more expensive (leisure) to the one that has become relatively cheaper (consumption).

Comparative Statics (Cont'd)

How does the consumer respond to an increase in w?



- Total effect can be broken into two steps:
  1. Substitution effect: $F \mapsto O$.
  2. Income effect: $O \mapsto H$.
- From O to H: as if only income increases so that the budget line shifts out. But the relative price of leisure ($-$slope of budget line), w, stays the same.
- The consumer consume more consumption goods and more leisure.
- Both the substitution and income effects increase consumption.
- Opposing substitution and income effects on leisure.

Plan for this Class

1. Consumer Behavior
2. **Firm Behavior**
3. Competitive Equilibrium and Market Clearing

Overview of Firm's Problem

- While the representative consumer supplies labor and demands consumption goods, we turn now to the behavior of firms, which demand labor and supply consumption goods.
- The choices of the firms are determined by the available technology and by profit maximization.
- The firms in this economy own productive capital (plant and equipment), and they hire labor to produce consumption goods.
- We can describe the production technology available to each firm by a production function, which describes the technological possibilities for converting factor inputs into outputs

$$Y = zF(K, N^d)$$

The Representative Firm

- We can describe the production technology available to each firm by a production function, which describes the technological possibilities for converting factor inputs into outputs

$$Y = zF(K, N^d)$$

- z is total factor productivity.
- Y is output of consumption goods.
- K is the quantity of capital input in the production process.
- N^d is the quantity of labor input. measured as total hours worked by employees of the firm. (labor demand)

- We treat K as being a fixed input to production, and N^d as a variable factor of production. * big assumption

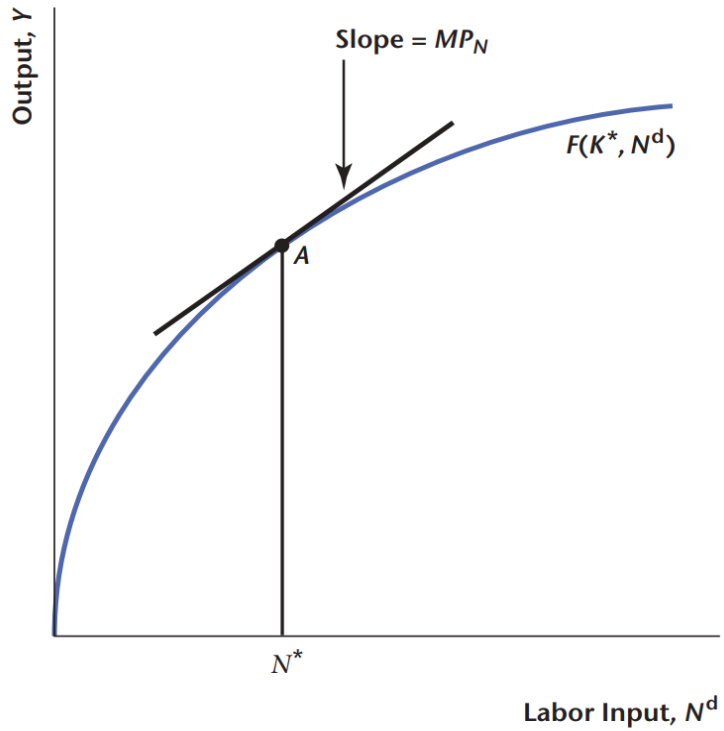
Assumptions for the Production Function

We further assume that the production function satisfies the following assumptions:

assumption from perfect competition

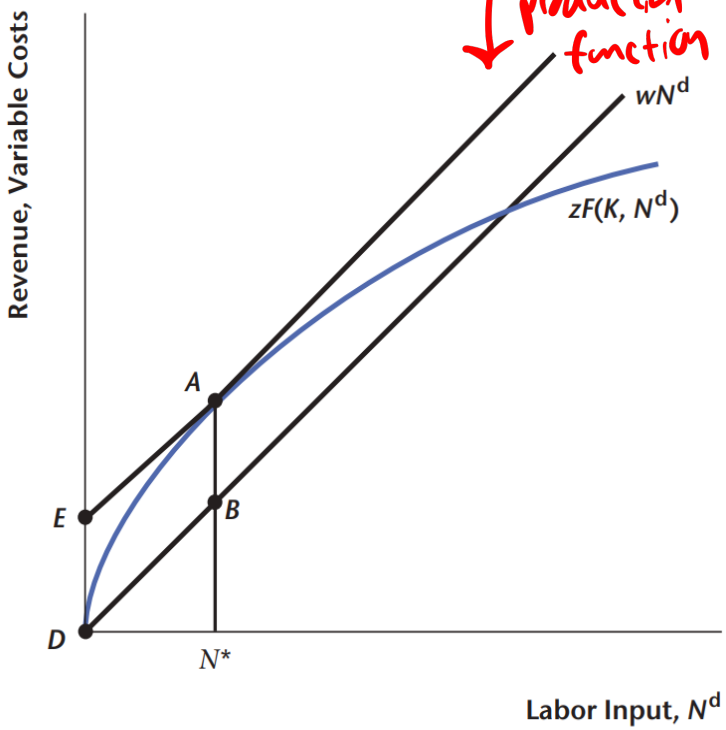
- The production function exhibits constant returns to scale. Constant returns to scale means that, given any constant $\alpha > 0$, the following relationship holds:
$$zF(\alpha K, \alpha N^d) = \alpha z F(K, N^d)$$
- The production function has the property that output increases when either the capital input or the labor input increases. In other words, the marginal products of labor and capital are both positive: $MP_N > 0$ and $MP_K > 0$.
- The marginal product of labor (capital) decreases as the quantity of labor (capital) increases.
- The marginal product of labor (capital) increases as the quantity of the capital (labor) input increases.

Production Function



- We can plot the production function by fixing the quantity of capital, and varying the quantity of labor.
- The marginal product of labor is the slope of the production function at a given point. Why? $\frac{\partial Y}{\partial N^d}$
- Note that the marginal product of labor declines with the quantity of labor.

Firm Optimization



- $Y = zF(K, N^d)$ is the firm's revenue.
- wN^d is the firm's variable cost.
- Profits are the difference between the revenue and the variable cost.
- Contribution to firm's profits of having employees work an extra hour is $MP_N - w$.
- The firm maximizes profits at the point where marginal revenue equals marginal cost, or

$$MP_N = w.$$

- Maximized profits are the distance AB, or the distance ED.

Government

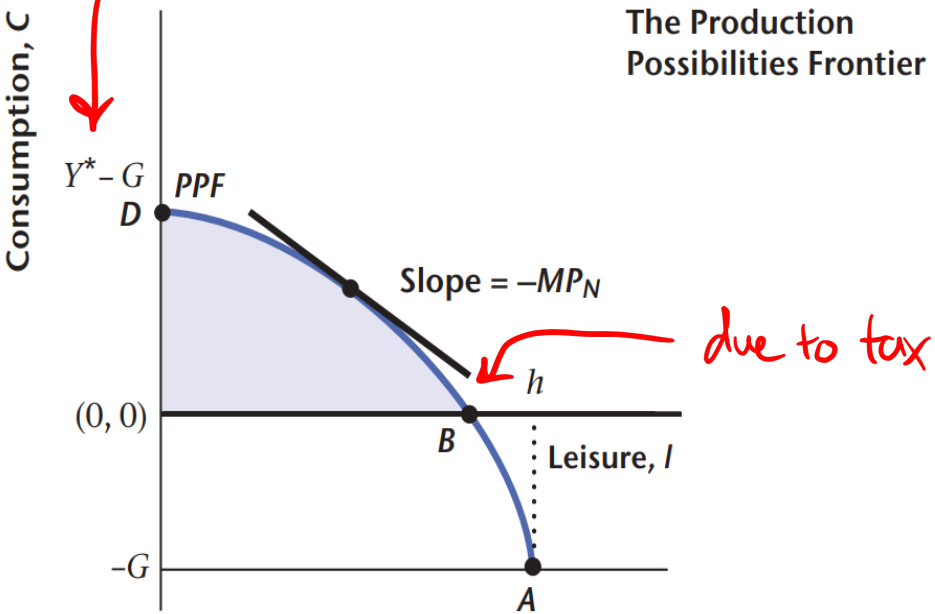
- We are missing one final economic agent, the government.
- We simply assume that the government abide the government budget constraint to use all taxes and provide public goods G such as national defense,

$$G = T.$$

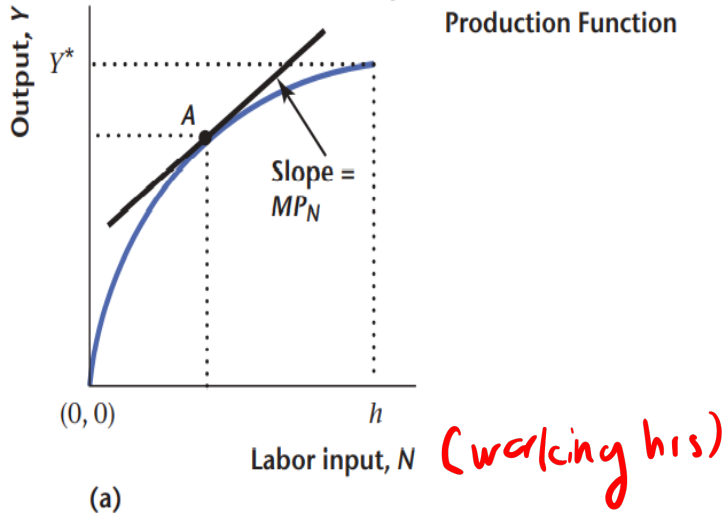
- At this point, it is also useful to define exogenous variables (assumed, given) and endogenous variables (determined by the model).
- Examples of exogenous variables: T, G, z, K, h.
- Examples of endogenous variables: Prices, quantities, revenues, profits, w, I, N^d, Y, π. "One price to rule them all".

Building Block 3: Production Possibility Frontier (*summarises tradeoff in terms of

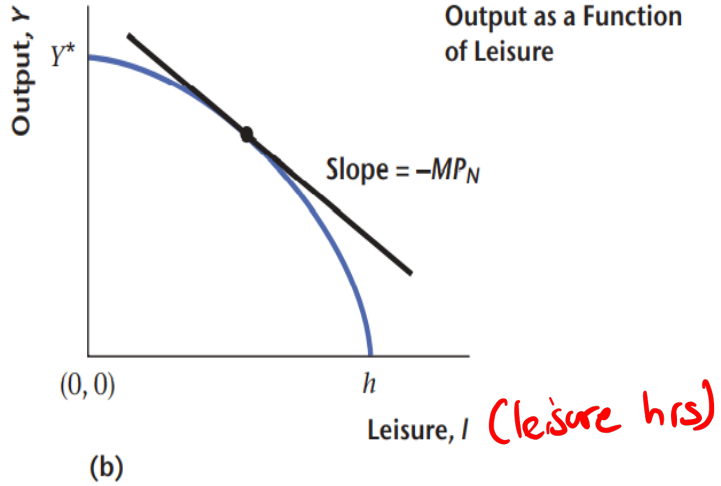
due to tax T, G=T



To pay G=T, must give up (h - B) leisure

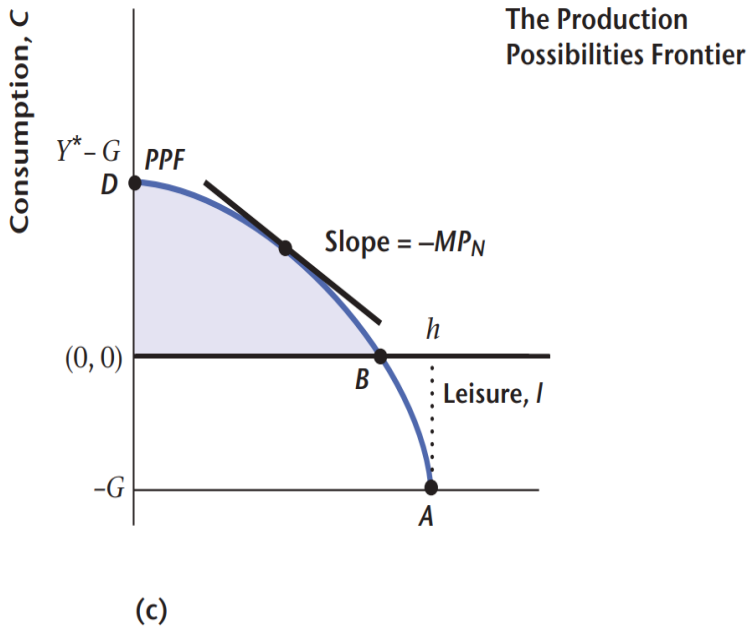


(working hrs)



(leisure hrs)

Building Block 3: Production Possibility Frontier



- Production possibilities frontier (PPF) describes what the technological possibilities are for the economy as a whole, in terms of the production of consumption goods and leisure.
- Negative of the slope of the PPF is the marginal rate of transformation

$$MRT_{l,C} = MP_N = -(\text{the slope}),$$

which is the rate that leisure can be converted in the economy into consumption goods through work.

- Firm optimization dictates that $MRT = MP_N = w$.

Plan for this Class

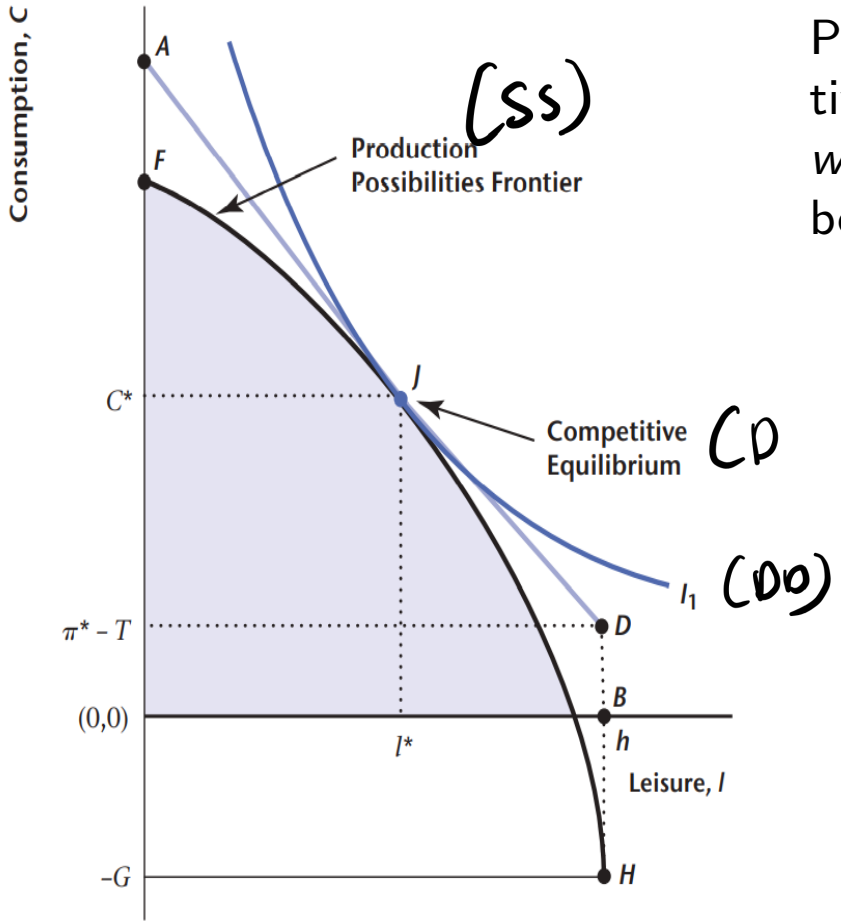
1. Consumer Behavior
2. Firm Behavior
3. **Competitive Equilibrium and Market Clearing**

Overview of Competitive Equilibrium

- Recall the definition of competitive equilibrium: optimization (done), competitiveness (assumed), and market clearing.
- Two markets to clear: factor market (labor) and goods market (consumption goods). But only one price, w.
- But ... wait, we assumed that the consumption good is the numeraire, and its price is implicitly 1. So we have two prices to clear two markets.
- Walras's Law: in a competitive equilibrium with N markets, if all the other $N-1$ markets clear, then the Nth market will automatically clear.
- As if the good sold in the Nth market is the numeraire, and every other price is the [relative] price in relative to the price of this numeraire (1).
- Hence, we only need to find one price w that clears the labor market. The consumption goods market would clear by Walras's Law with price 1.
- The quantity of labor the consumer wishes to supply is equal to the quantity of labor the firm wishes to hire.

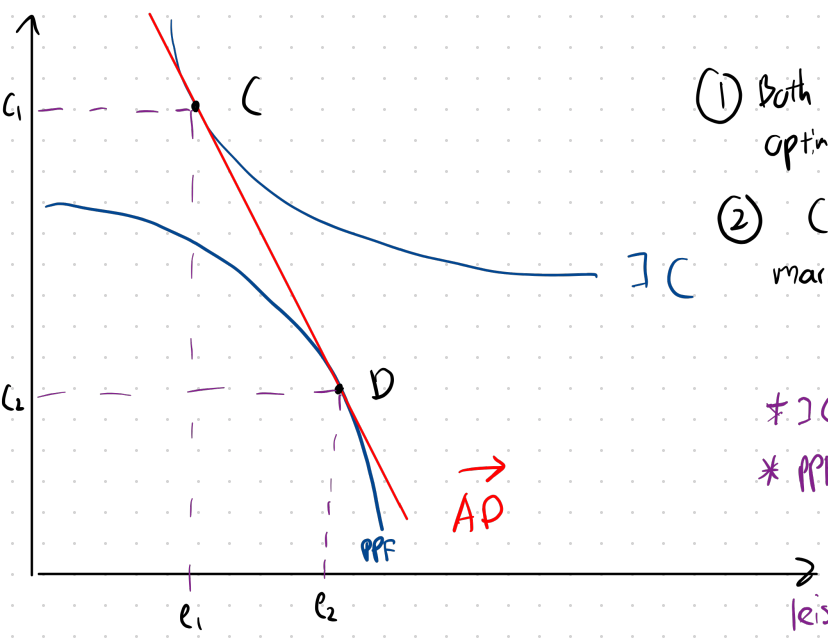
Competitive Equilibrium

Let's bring all three building blocks together in one diagram:



AD is the line that is tangent to both the PPF and the indifference curve. The negative of its slope will be the equilibrium wage w^* that clears the labor market. Point J will be the competitive equilibrium.

- If firm optimizes, the marginal rate of transformation must be equal to wage. Hence, the PPF must be tangent to a line with slope $= -w$ at firm optimization.
- If consumer optimizes, the marginal rate of substitution must be equal to wage. Hence, the indifference curve must be tangent to a line with slope $= -w$ at consumer optimization.
- The two tangent points must coincide at J. Otherwise, markets will not clear.



① Both firm & consumers are optimising

② C & D are different, market does not clear

* IC represents consumers
* PPF represents firms

$C_1 > C_2 \Rightarrow$ Dd > SS

$h - l_1$ = labor SS

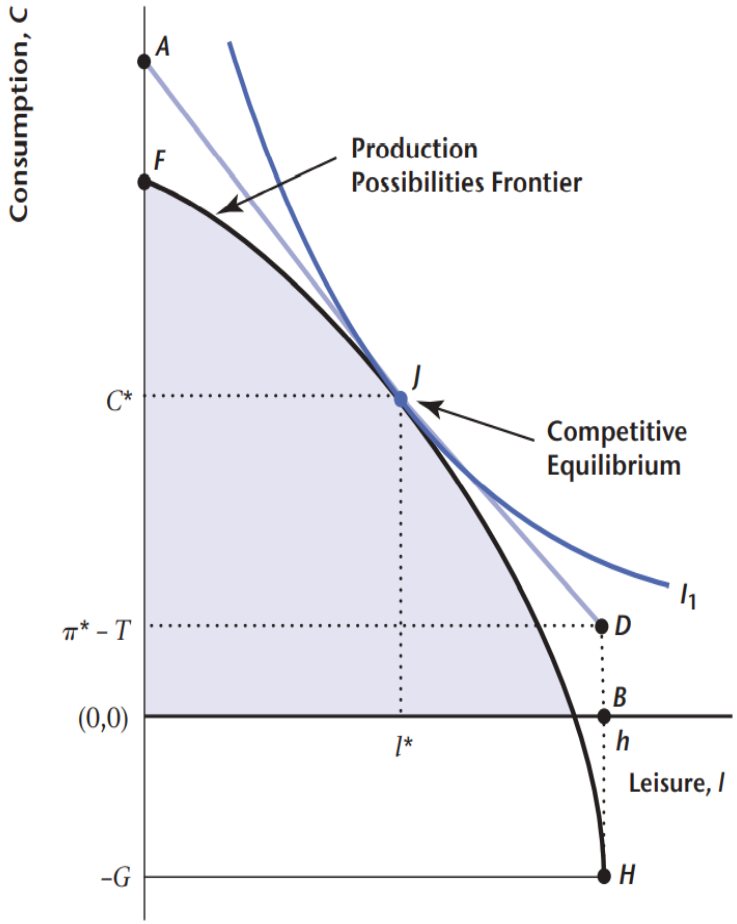
$h - l_2$ = labor Dd

Since $l_2 > l_1$, labor SS > labor Dd, w must ↓

∴ Slope of AD will ↓

Competitive Equilibrium

Let's bring all three building blocks together in one diagram:



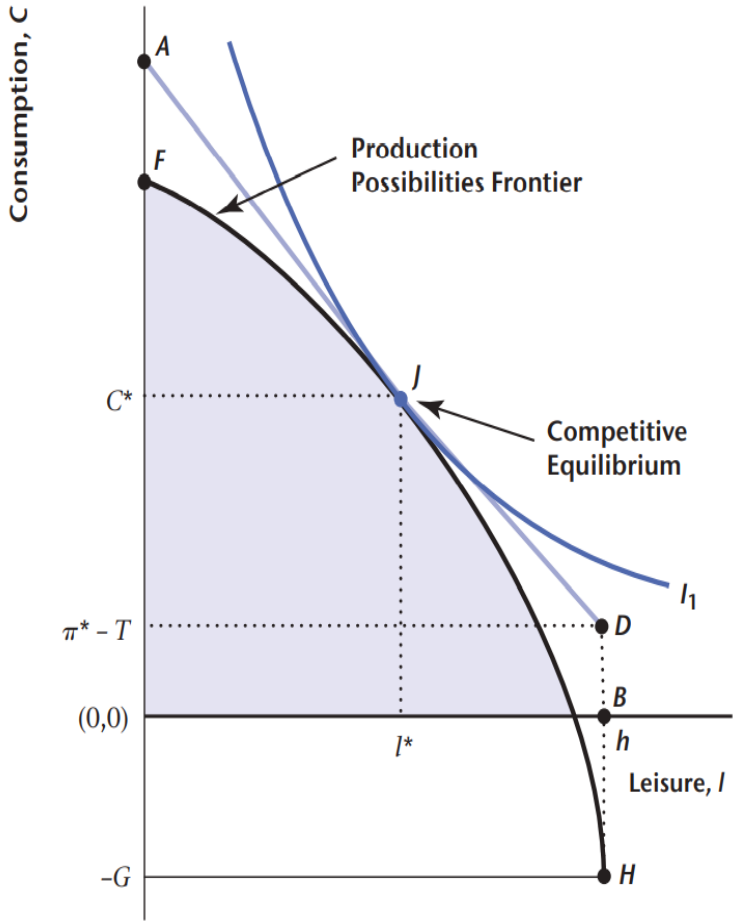
AD is the line that is tangent to both the PPF and the indifference curve. The negative of its slope will be the equilibrium wage w^* that clears the labor market. Point J will be the competitive equilibrium.

- Firm chooses labor demand equal to $h - l^*$ and produces $Y^* = zF(K, h - l^*)$.
- Maximized profits for the firm are $\pi^* = zF(K, h - l^*) - w(h - l^*)$.
- Explicitly, labor demand is

$$N^d = h - l^*.$$

Competitive Equilibrium

Let's bring all three building blocks together in one diagram:



AD is the line that is tangent to both the PPF and the indifference curve. The negative of its slope will be the equilibrium wage w^* that clears the labor market. Point J will be the competitive equilibrium.

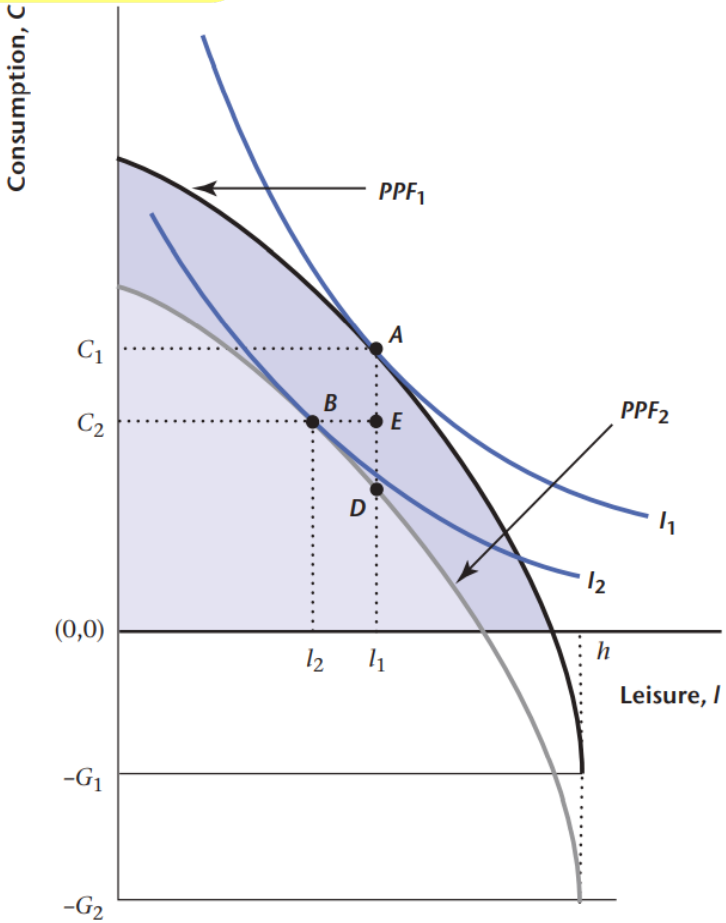
- ADB is the budget constraint that the consumer faces in equilibrium.
- DB is equal to $\pi^* - T = \pi^* - G$.
- Consumer will consume C^* and enjoy leisure l^*.
- She/he provides labor of $h - l^*$.
- Explicitly, labor supply is

$$N^s = h - l^* = N^d$$

- Labor market clears!

Comparative Statics → describe the static environment

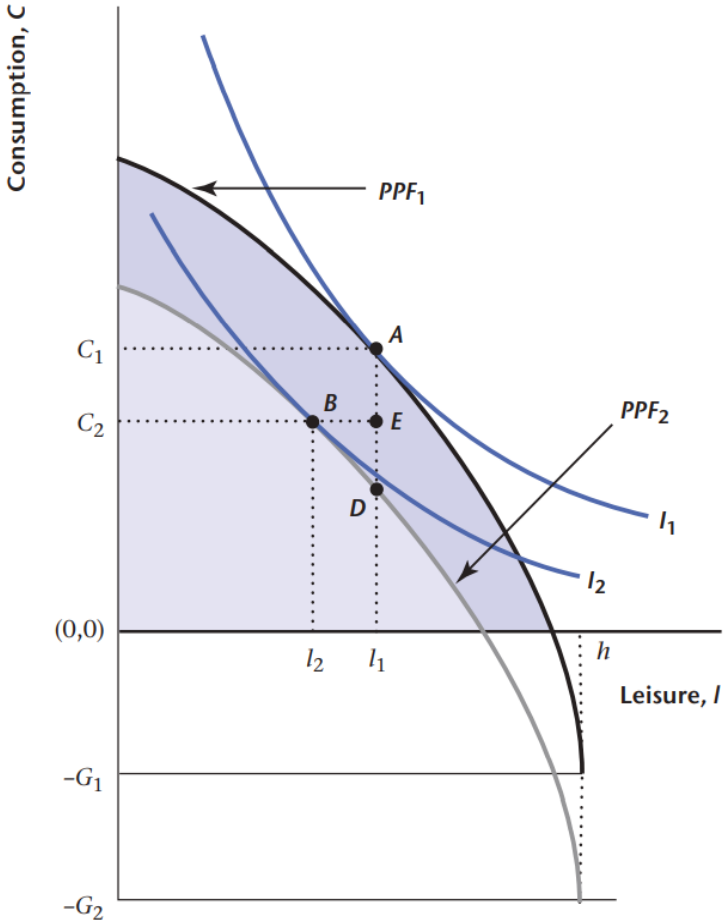
What's the effect of expansionary fiscal policy such that government spending G increases?



- An increase in government spending shifts the PPF down from PPF_1 to PPF_2 by the amount of the increase in $G = G_2 - G_1$.
- Both consumption and leisure decrease. (no borrowing)
- Indeed, because $G = T$, an increase in government spending must necessarily increase taxes by the same amount, which reduces the consumer's disposable income. (C ↓ due to income effect)
- Because leisure falls, employment, which is $N_2 = h - l_2$, must rise in comparison with $N_1 = h - l_1$.
- Further, because employment ↑, the quantity of output ↑. (Y, not C)

Comparative Statics

What's the effect of expansionary fiscal policy such that government spending G increases?



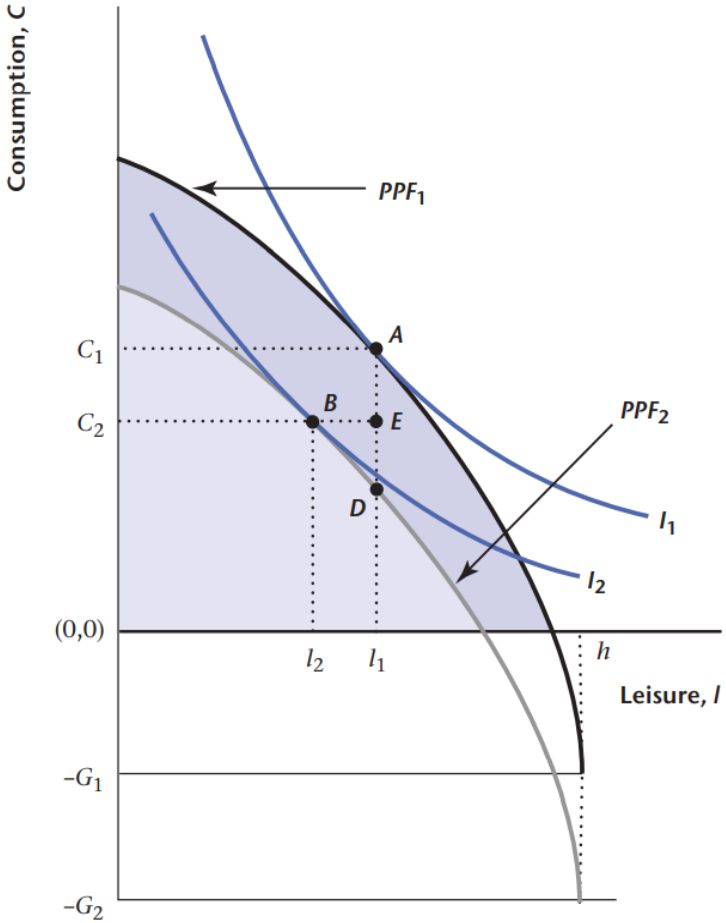
- The income–expenditure identity tells us that $Y = C + G$; therefore, $C = Y - G$, and so

$$\Delta C = \Delta Y - \Delta G.$$

- Thus, because $\Delta Y > 0$, we have $\Delta C > -\Delta G$.
- Private consumption is crowded out by government purchases, but it is not completely crowded out as a result of the increase in output.

Comparative Statics

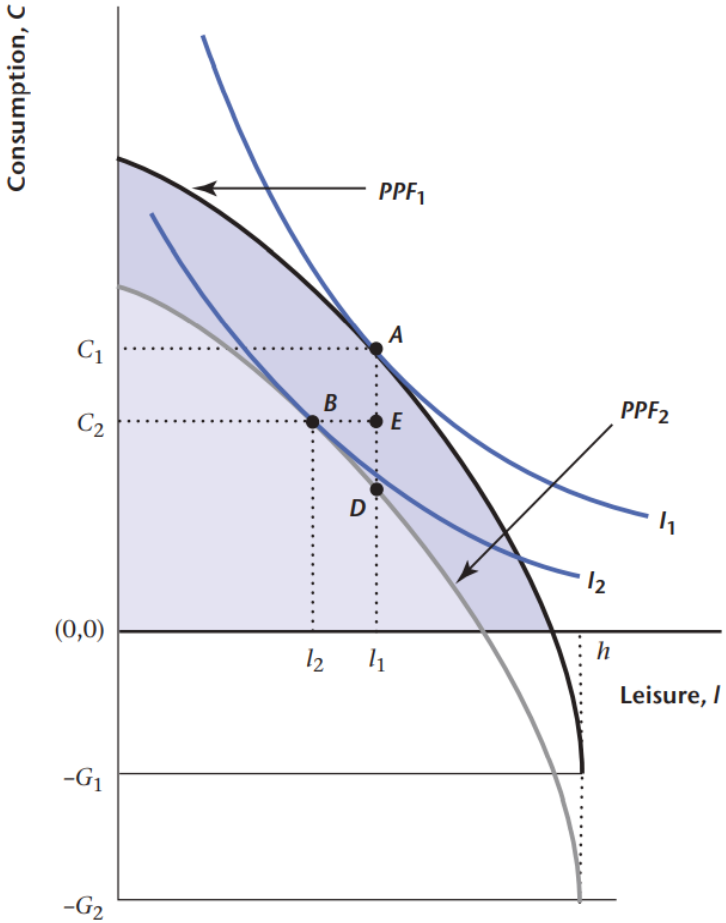
What's the effect of expansionary fiscal policy such that government spending G increases?



- ΔG is the distance AD and ΔC is the minus the distance AE.
- A larger government, reflected in increased government spending, results in more output being produced, because there is a negative income effect on leisure and, therefore, a positive effect on labor supply.
- However, a larger government reduces private consumption, through a negative income effect produced by the higher taxes required to finance higher government spending.
- The consumer spends less on consumption goods, and works harder to support a larger government.

Comparative Statics

What's the effect of expansionary fiscal policy such that government spending G increases?



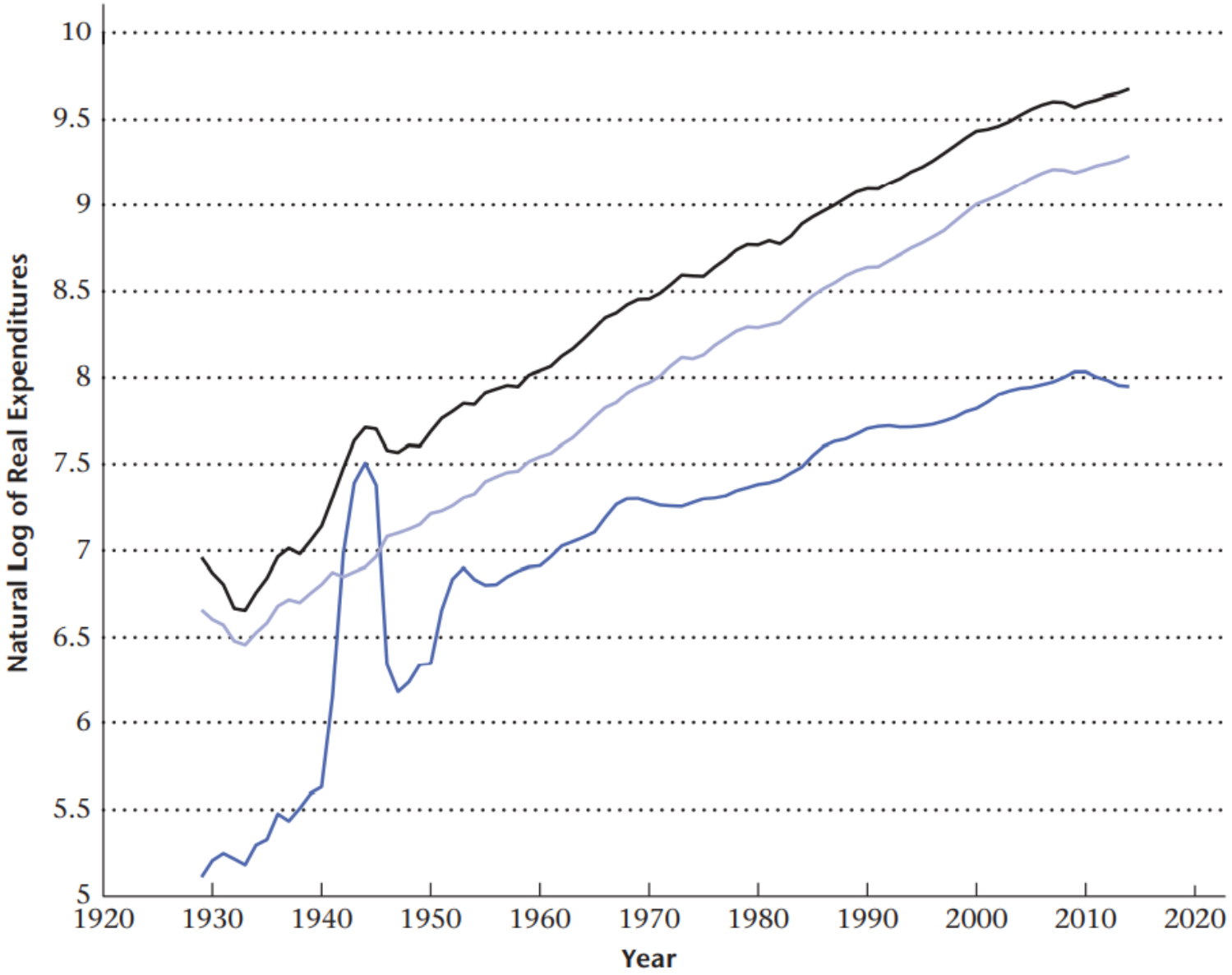
- What happens to the real wage?
- Observe that the slope of PPF_2 is identical to the slope of PPF_1 for each quantity of leisure, l, because we are shifting it down in parallel.
- Because the PPF becomes less steep as l decreases, PPF_2 at point B is less steep than is PPF_1 at point A.
- The real wage must fall.
- As equilibrium employment rises, and the representative firm would hire more labor only in response to a reduction in the market real wage.

(movement along the labor Dd curve)

Back to Our Key Macroeconomic Questions

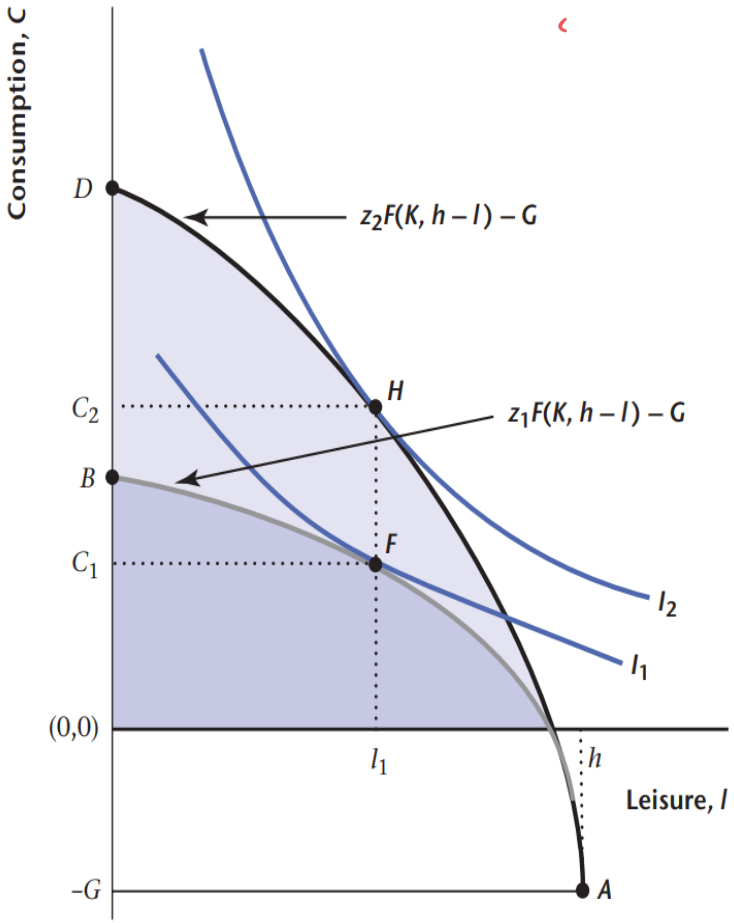
- Now, a question we might like to ask is whether or not fluctuations in government spending are a likely cause of business cycles.
- One of our key business cycle facts is that employment is procyclical.
- This fact is consistent with government spending shocks causing business cycles, because employment always moves in the same direction as aggregate output in response to a change in G.
- Additional business cycle facts are that consumption and the real wage are also procyclical.
- But the model predicts that consumption and the real wage are countercyclical in response to government spending shocks.
- Not a good candidate to explain business cycle.
- Exception: WW2. Aggregate output was channeled from private consumption to military uses, and there was a sharp increase in total real GDP. But consumption dipped.

Figure: GDP, Consumption, and Government Expenditure.



Comparative Statics

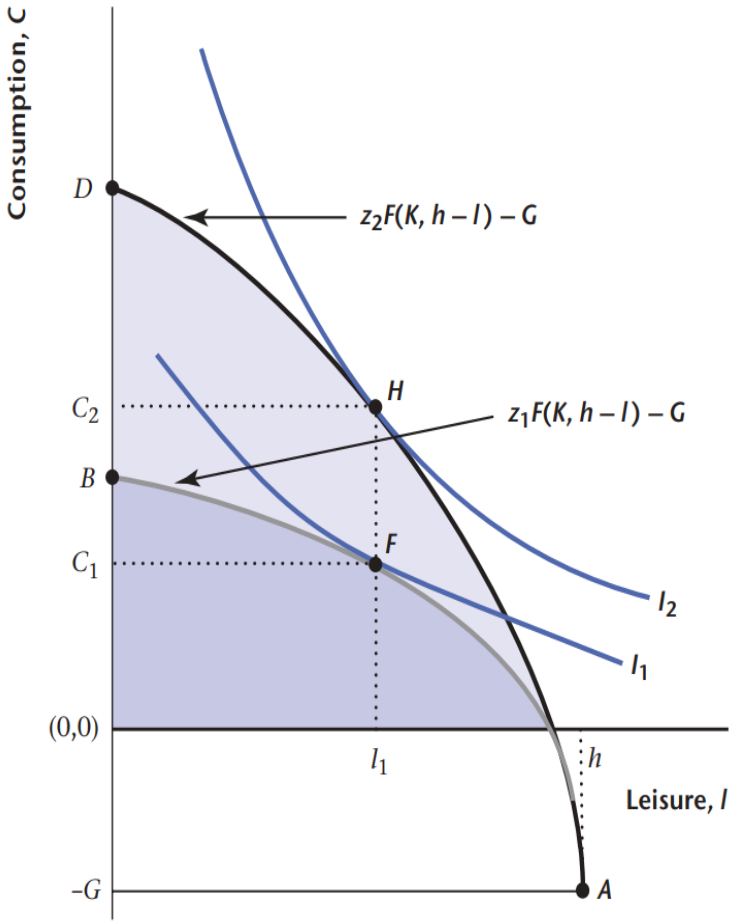
What's the effect of an increase in total factor productivity?



- The effect of an increase in z is to shift the PPF outward from AB to AD.
- More consumption is attainable given the better technology, for any quantity of leisure consumed.
- The trade-off between consumption and leisure has improved, in that the new PPF is steeper for any given quantity of leisure.
- That is, because MP_N increases and the slope of the PPF is $-MP_N$, the PPF is steeper when z increases.
- Hence equilibrium wage $w = MP_N$ increases.

Comparative Statics

What's the effect of an increase in total factor productivity?

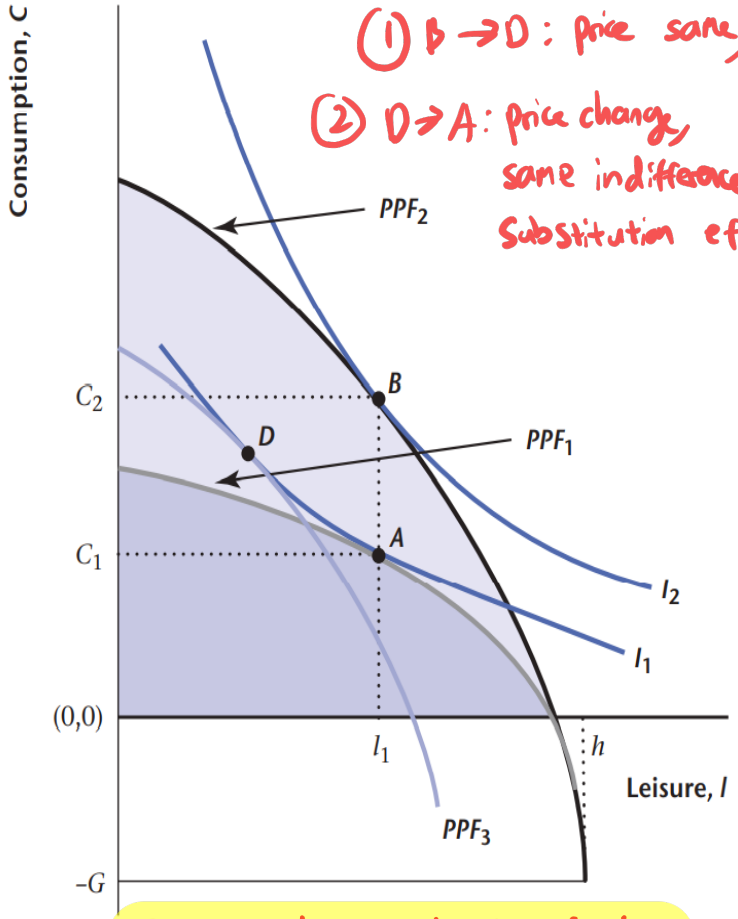


- Consumption increases from C_1 to C_2.
- Leisure, however, may increase or decrease, and here we have assumed the case where it remains the same at l_1 and so does employment.
- Because $Y = C + G$ in equilibrium and because G remains constant and C increases, there is an increase in aggregate output.

* income effects & substitution effects cancel out

Comparative Statics: Income and Substitution Effects

What's the effect of an increase in total factor productivity? ↑ w will always increase



① B → D: price same, income change (Income effect)

② D → A: price change, same indifference curve, substitution effect

- So far, we have assumed that leisure will remain constant.
- But why must the equilibrium wage w increase in moving from A to B, even if the quantities of leisure and employment may rise or fall?
- Let's look at income and substitution effects.
- First, the substitution effect involves an increase in MRS (the indifference curve gets steeper) in moving along the indifference curve from A to D.

D is always left of A

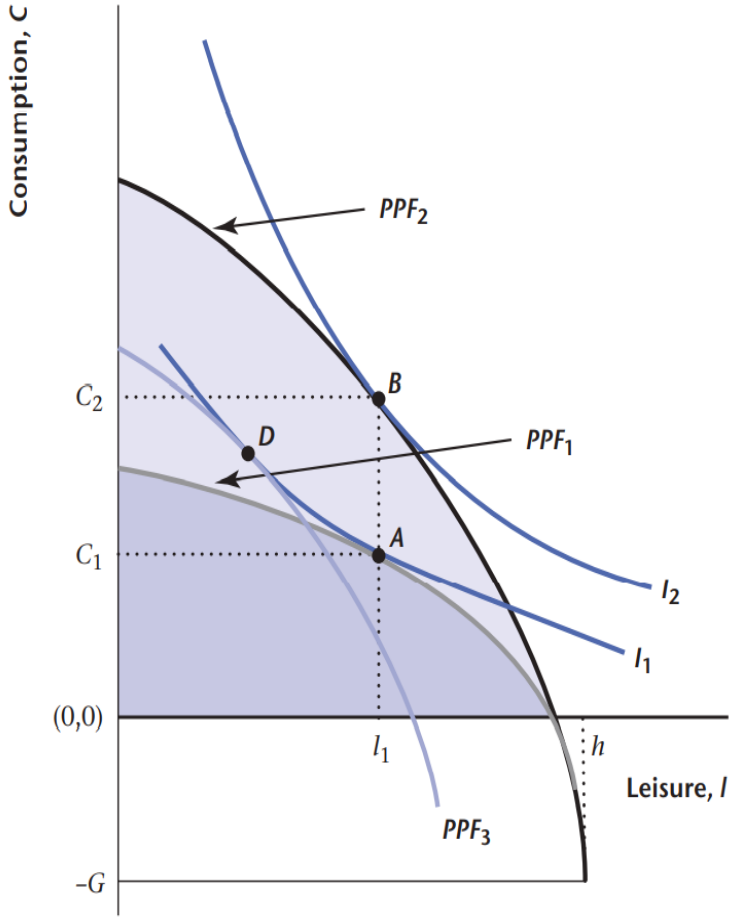
Since C must ↑, leisure must ↓ due to substitution effect

slope at // = slope at D

pure income effect, price is the same

Comparative Statics: Income and Substitution Effects

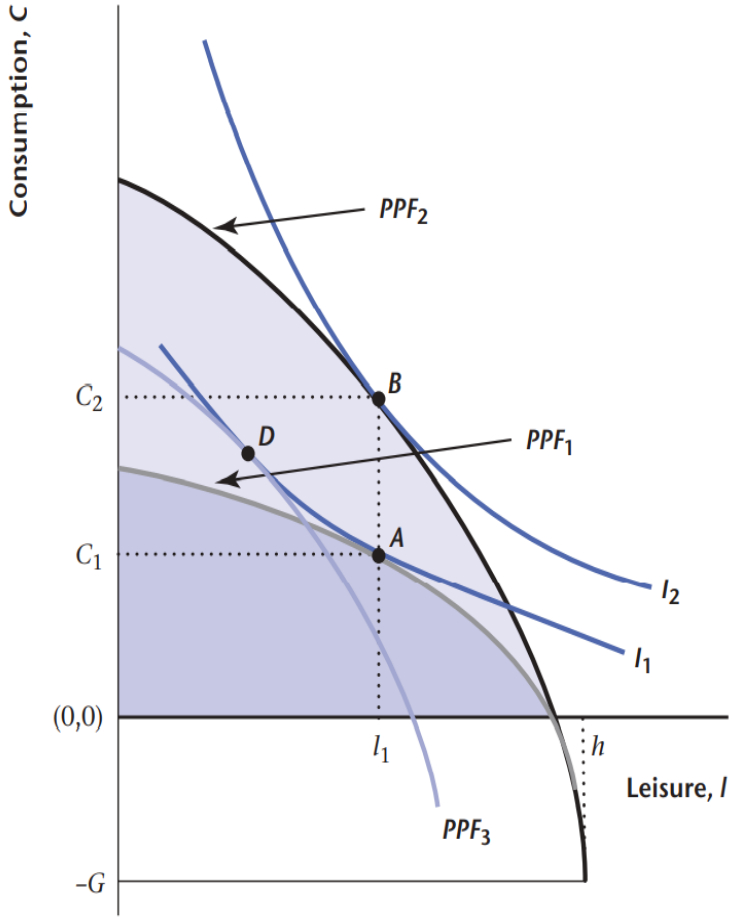
What's the effect of an increase in total factor productivity?



- Second, because PPF_2 is just PPF_3 shifted up by a fixed amount, the slope of PPF_2 is the same as the slope of PPF_3 for each quantity of leisure.
- As the quantity of leisure is higher at B than at D, the PPF is steeper at B than at D, and so MRS also increases in moving from D to B.
- Thus, the equilibrium wage, which is equal to the marginal rate of substitution in equilibrium, must be higher in equilibrium when z is higher.

Comparative Statics: Income and Substitution Effects

What's the effect of an increase in total factor productivity?



- The increase in total factor productivity causes an increase in the marginal productivity of labor, which increases the demand for labor by firms, driving up the equilibrium wage.
- Workers now have more income given the number of hours worked, and they spend the increased income on consumption goods.
- Because there are offsetting income and substitution effects on the quantity of labor supplied, however, hours worked may increase or decrease.
- Consumers are on a higher indifference curve. Unambiguously increase the aggregate standard of living.

The Solow Residual : measure of productivity

- A very common production function used in theory and empirical work is the Cobb–Douglas production function.
- This function takes the form

$$Y = zK^a(Nd)^{1-a},$$

Solow residual

where $0 < a < 1$ is the share that of income that capital receives, and $1 - a$ is the share of income that labor receives.

- From the data, a is about 30%.
- We can calculate the Solow residual to measure z as

$$z = \frac{Y}{K^a(Nd)^{1-a}} = \frac{Y}{K^{0}.3(Nd)^{0.7}}$$

Back to Our Key Macroeconomic Questions

- First, does technological innovations increase aggregate output in the data?
- Could fluctuations in total factor productivity be an important cause of business cycles?
- Our model predicts that, in response to an increase in z, aggregate output increases, consumption increases, and the real wage increases. $\rightarrow$ Consistent with procyclical data on consumption and real wages.
- Employment, however, may be procyclical or countercyclical, depending on the strength of opposing income and substitution effects.
- It is certainly possible that total factor productivity shocks could be a primary cause of business cycles, but to be consistent with the data requires that workers increase and decrease labor supply in response to increases and decreases in total factor productivity over the business cycle.

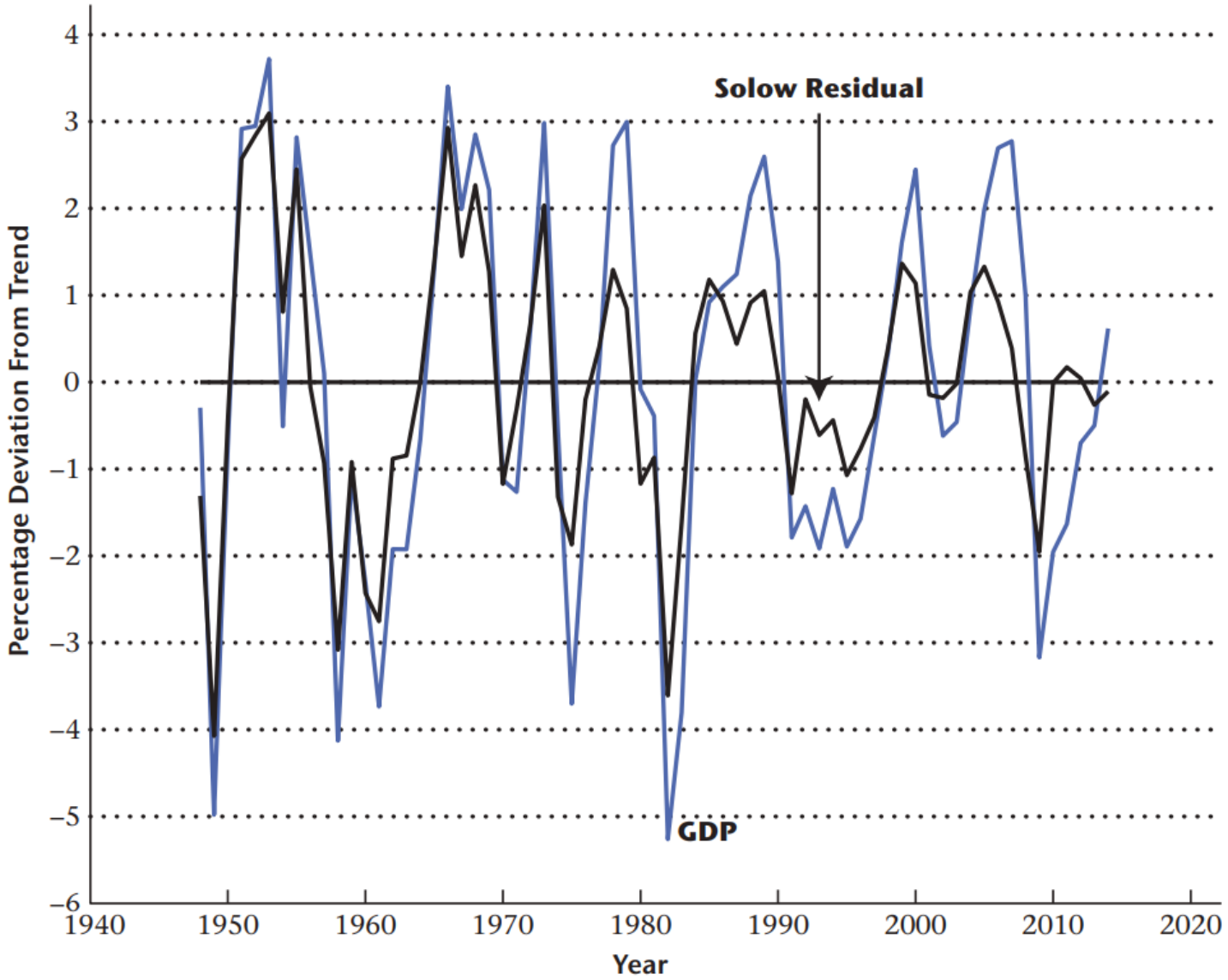
Back to Our Key Macroeconomic Questions (Cont'd)

- Some macroeconomists, the advocates of real business cycle theory, view total factor productivity shocks as the most important cause of business cycles.

productivity growth drives business cycle

- This view may seem to be contradicted by the long-run evidence that the income and substitution effects on labor supply of real wage increases appear to roughly cancel in the post–WW2 period.
- Real business cycle theorists, however, argue that much of the short-run variation in labor supply is the result of intertemporal substitution of labor.
- For example, a worker may choose to work harder in the present if he or she views his or her wage as being temporarily high, while planning to take more vacation in the future. "Makes hay while the sun shines."
- In this way, even though income and substitution effects may cancel in the long run, in the short run the substitution effect of an increase in the real wage could outweigh the income effect.

Figure: Deviations from Trend in GDP and the Solow Residual



Summary

By the end of this class, you should be able to understand the following:

- The building blocks of the consumer and firm optimizations.
- How do the consumer and firm optimize?
- How do the equilibrium wage clear the market?
- What are the effects of government spending and total factor productivity shocks?
- How to connect model predictions to the data on real business cycle?

Disclaimer

The slides for this course have been made available to students for the sole purpose of self study. They should not be disseminated without prior permission, nor should they be re-used for commercial purposes. The material draws on, among others:

- S. D. Williamson, Macroeconomics, Pearson Education, 5th edition.