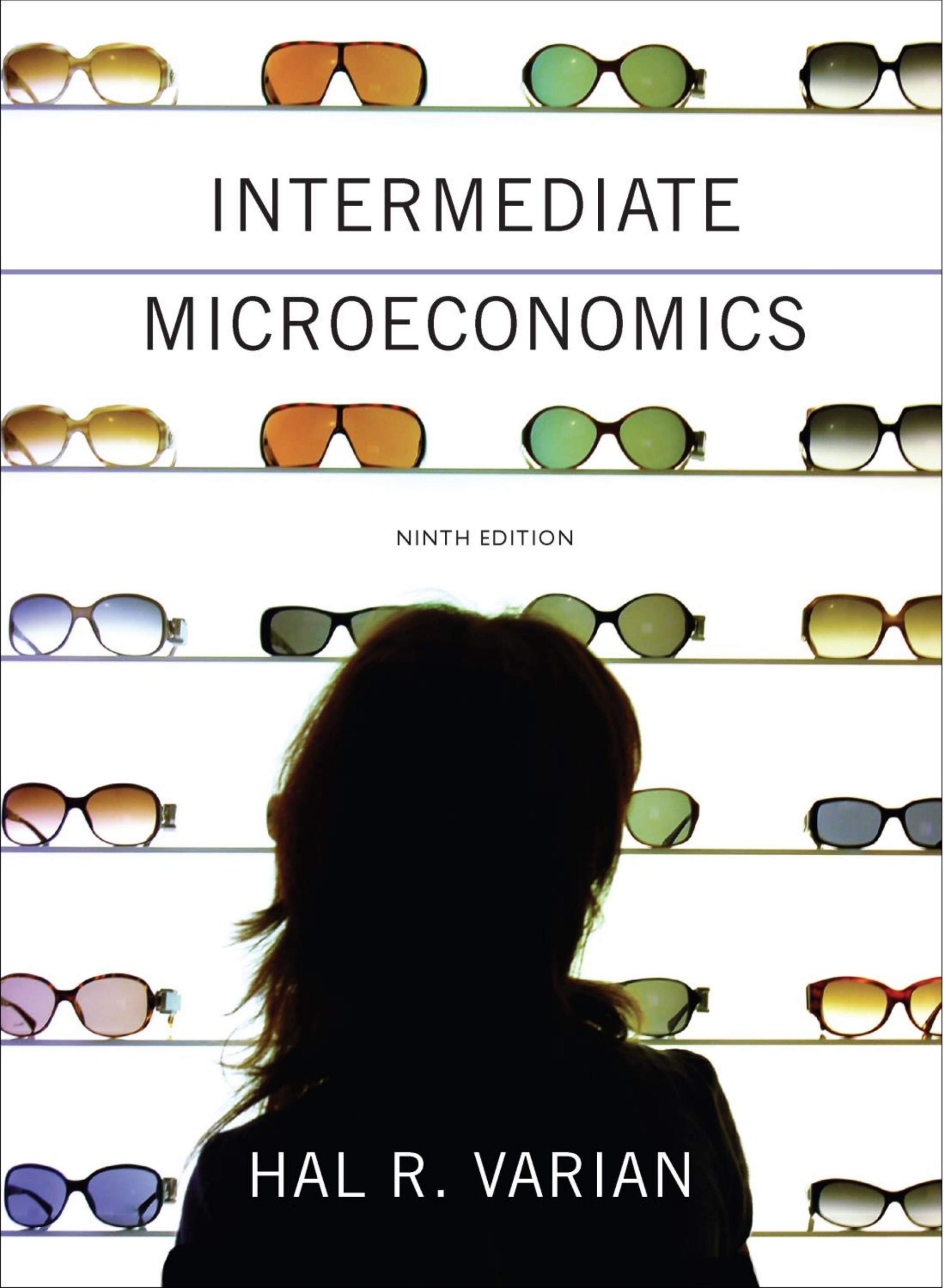


Production and the General Equilibrium

The presentation is based on the slides by Hal R. Varian, *Intermediate Microeconomics*.

Pure exchange model

- No production, only initial endowments, so no description of how resources are converted into consumables
- General equilibrium: All markets clear simultaneously
- 1st and 2nd Fundamental Theorems of Welfare Economics

Now add production …

- Add input markets, output markets, describe firms’ technologies, the distributions of firms’ outputs and profits …

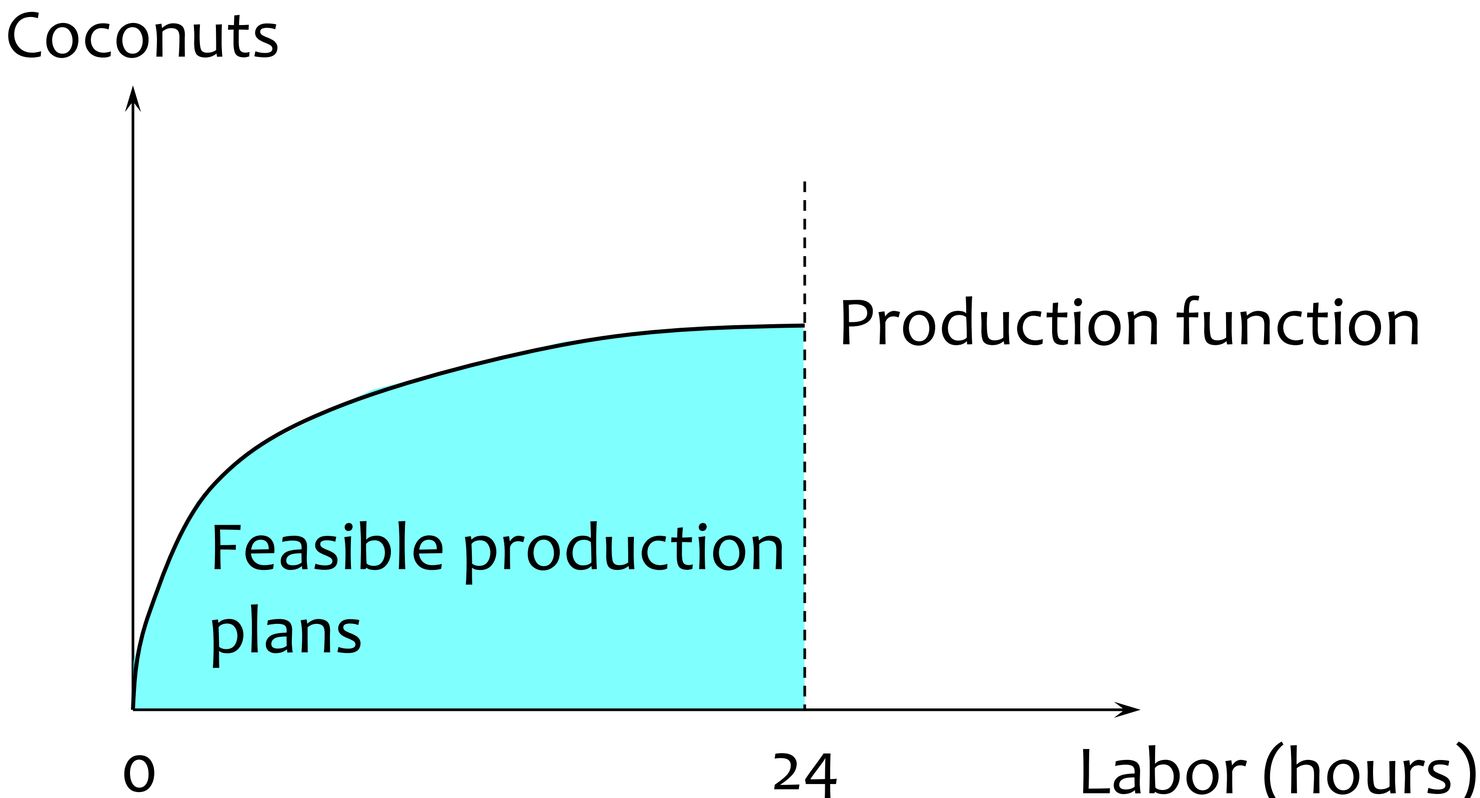
Now add production …

- Add input markets, output markets, describe firms' technologies, the distributions of firms' outputs and profits … That's not easy!

Robinson Crusoe's economy

- One agent – Robinson Crusoe (RC)
- Endowed with a fixed quantity of one resource (time in a day) – 24 hours
- Time used for labor (production) or leisure (consumption)
- Labor time = L; Leisure time = $24 - L$
- What will the agent (RC) choose?

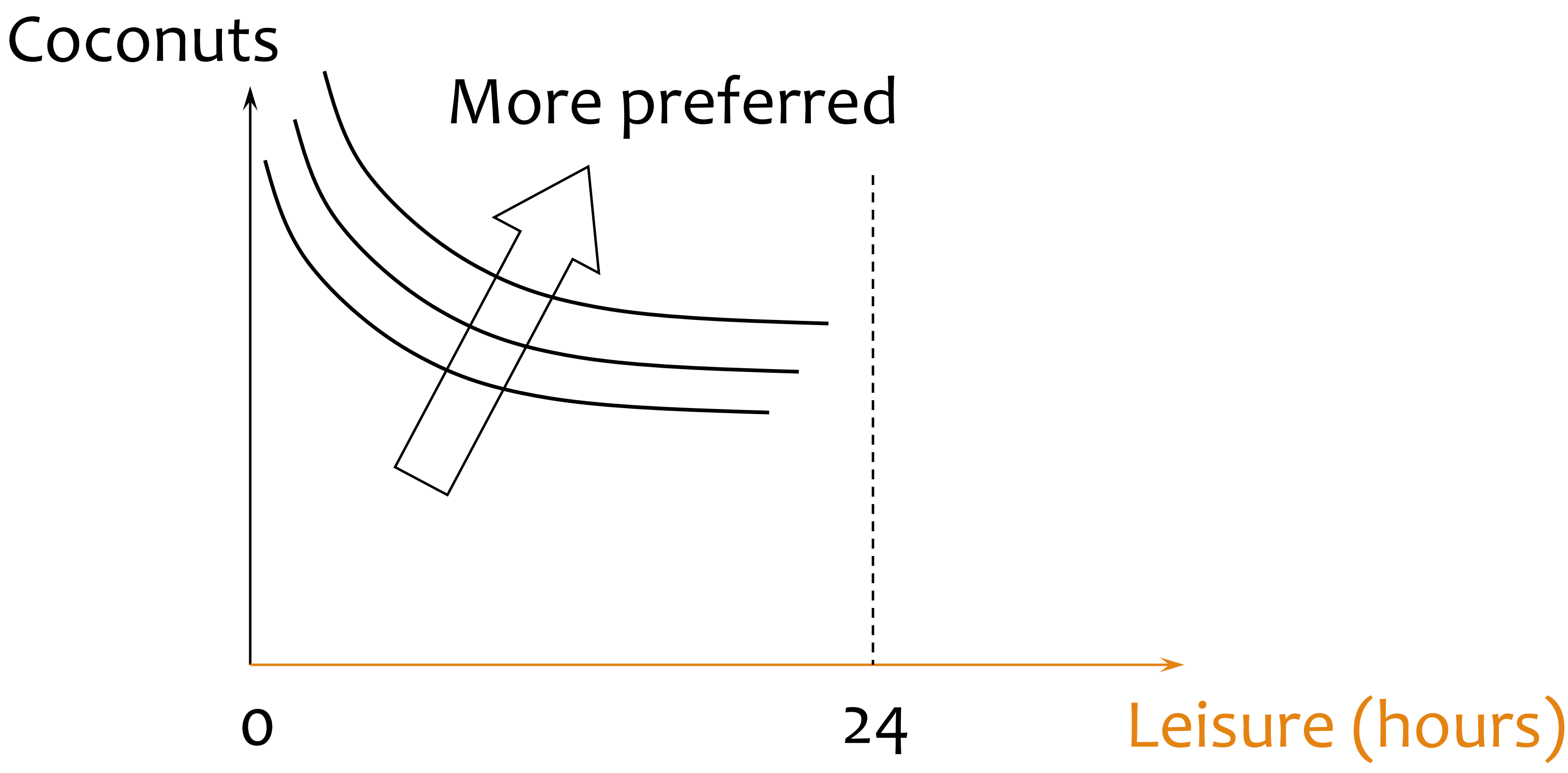
Robinson Crusoe's technology



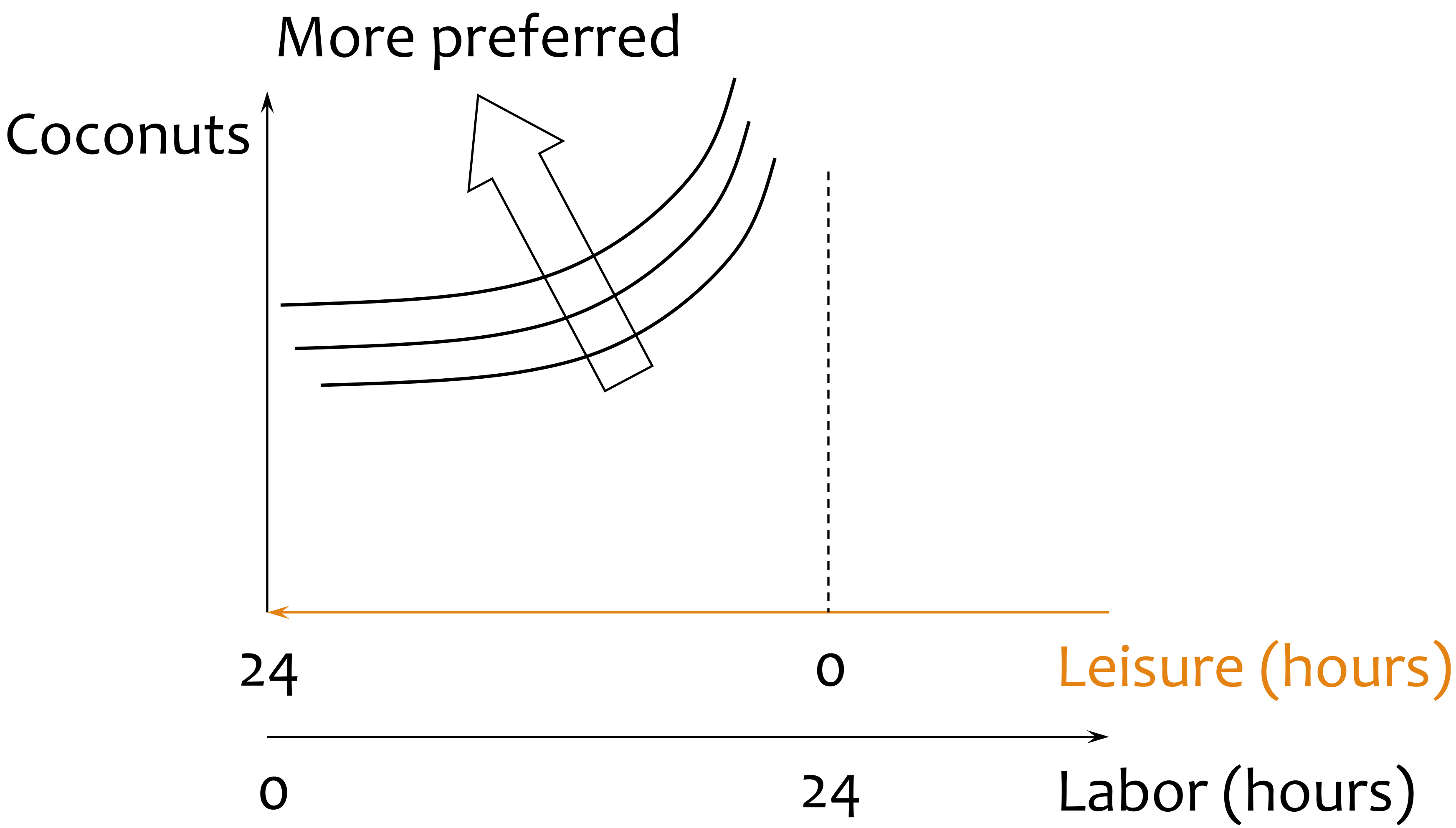
Technology: Labor produces output (coconuts) according to a concave production function.

Robinson Crusoe's preferences

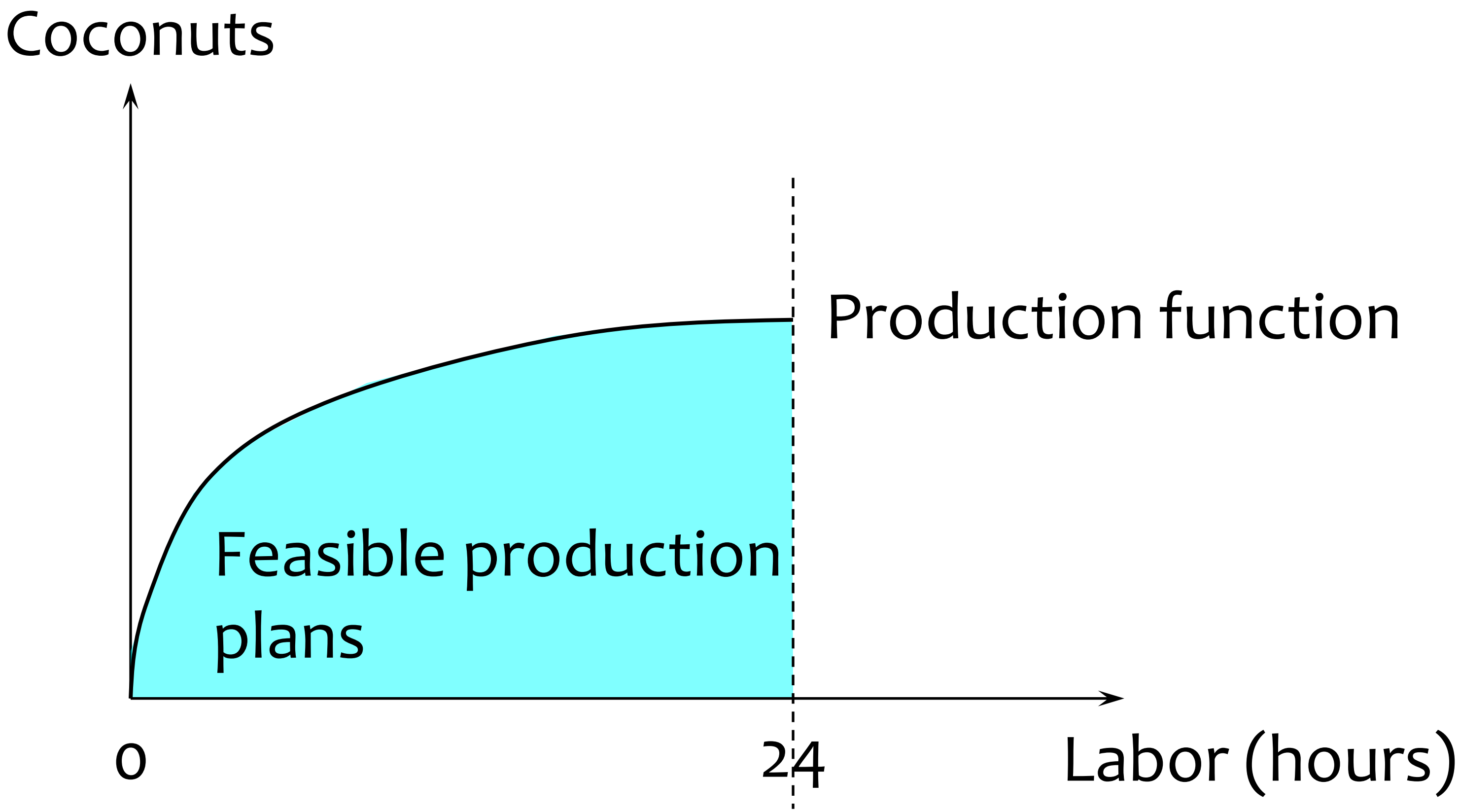
Coconut is a good. & Leisure is a good.



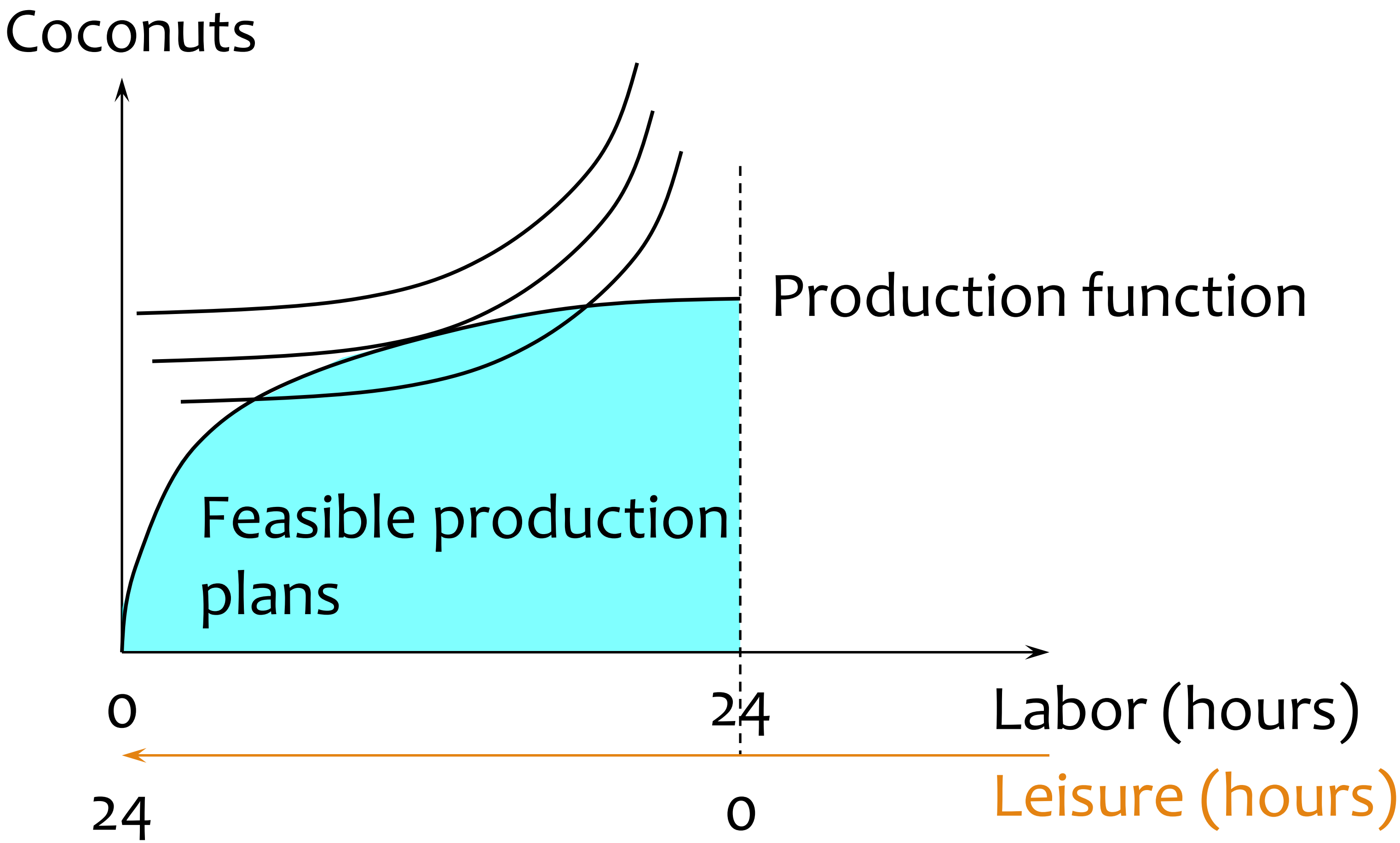
Robinson Crusoe's preferences



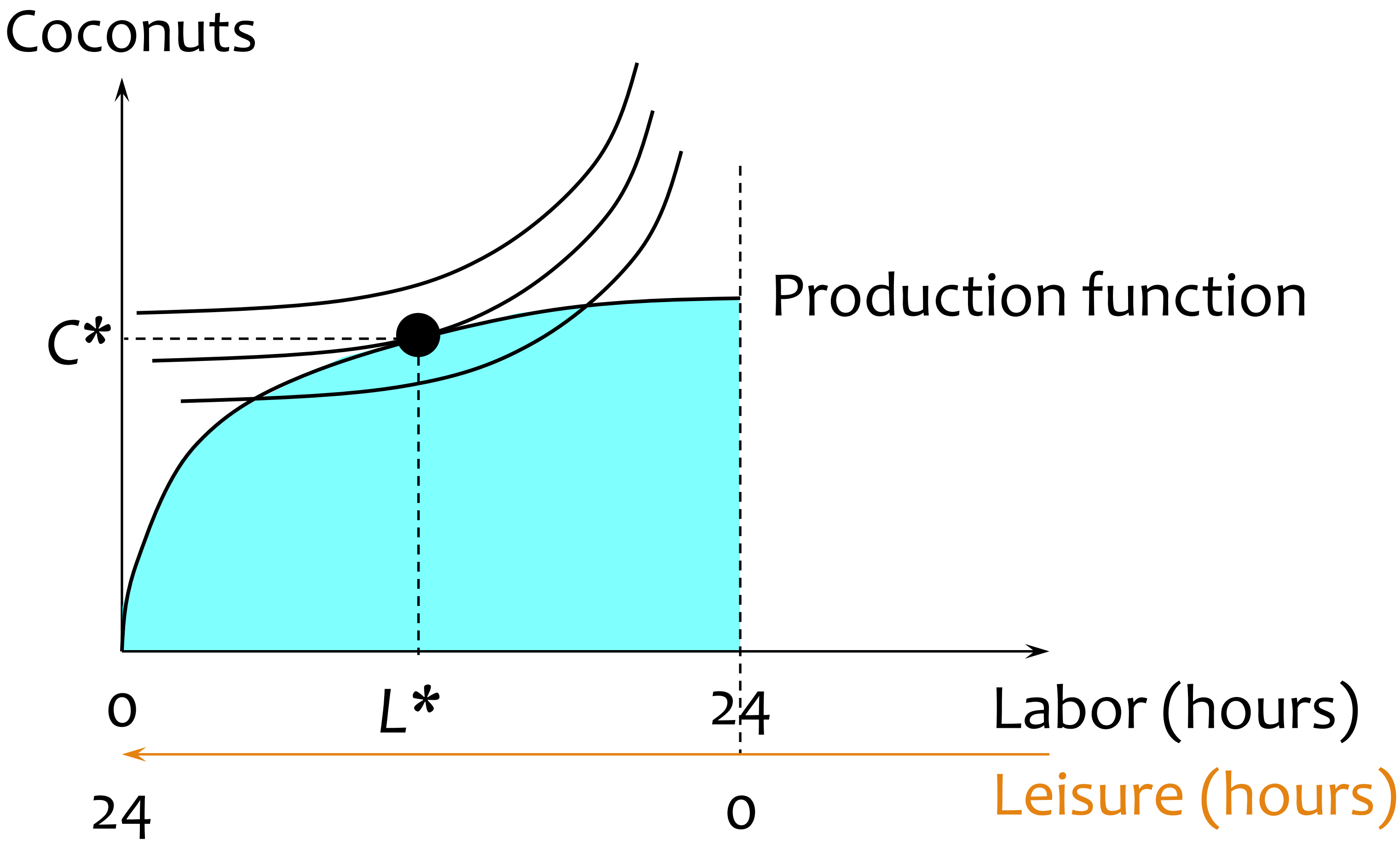
Robinson Crusoe's choice



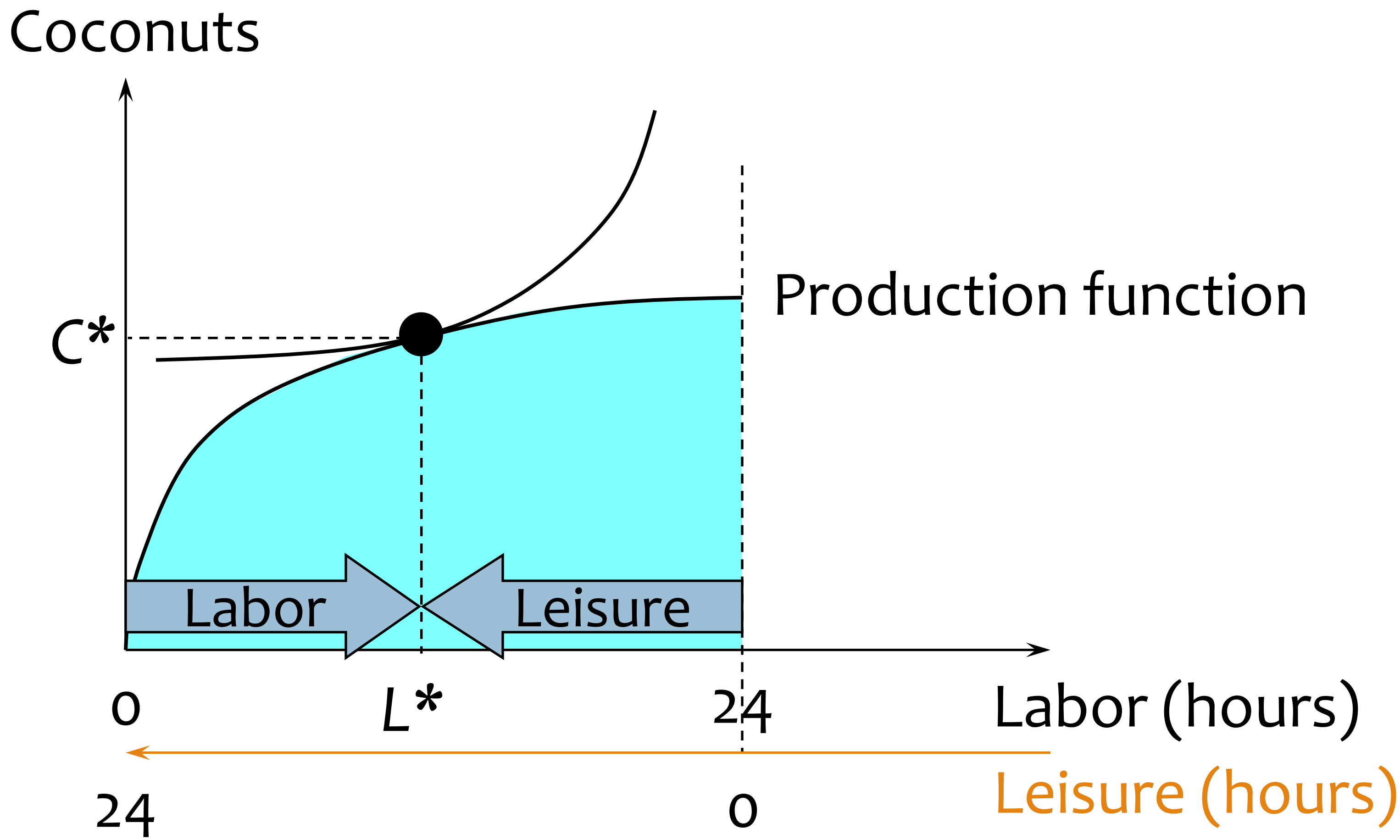
Robinson Crusoe's choice



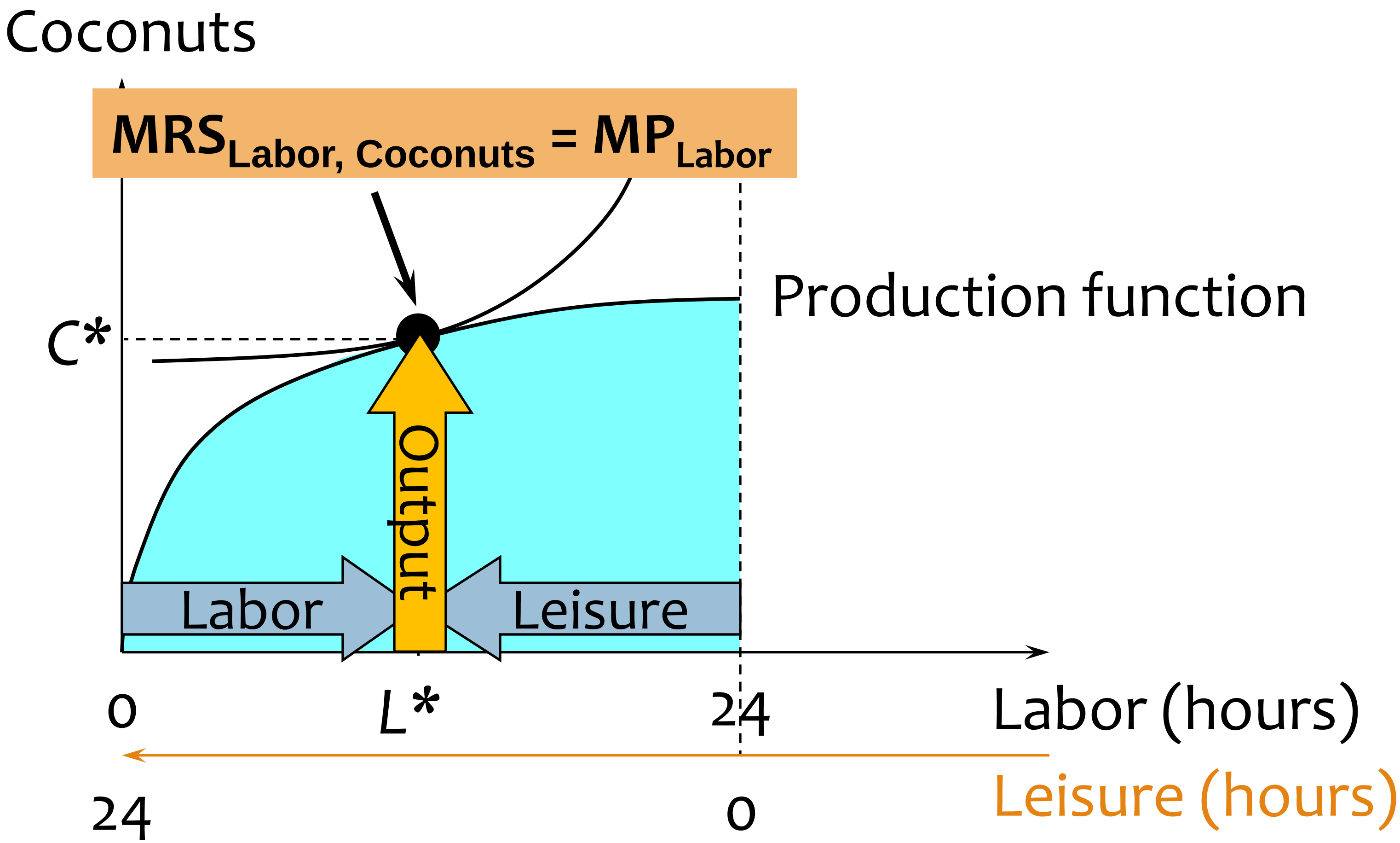
Robinson Crusoe's choice



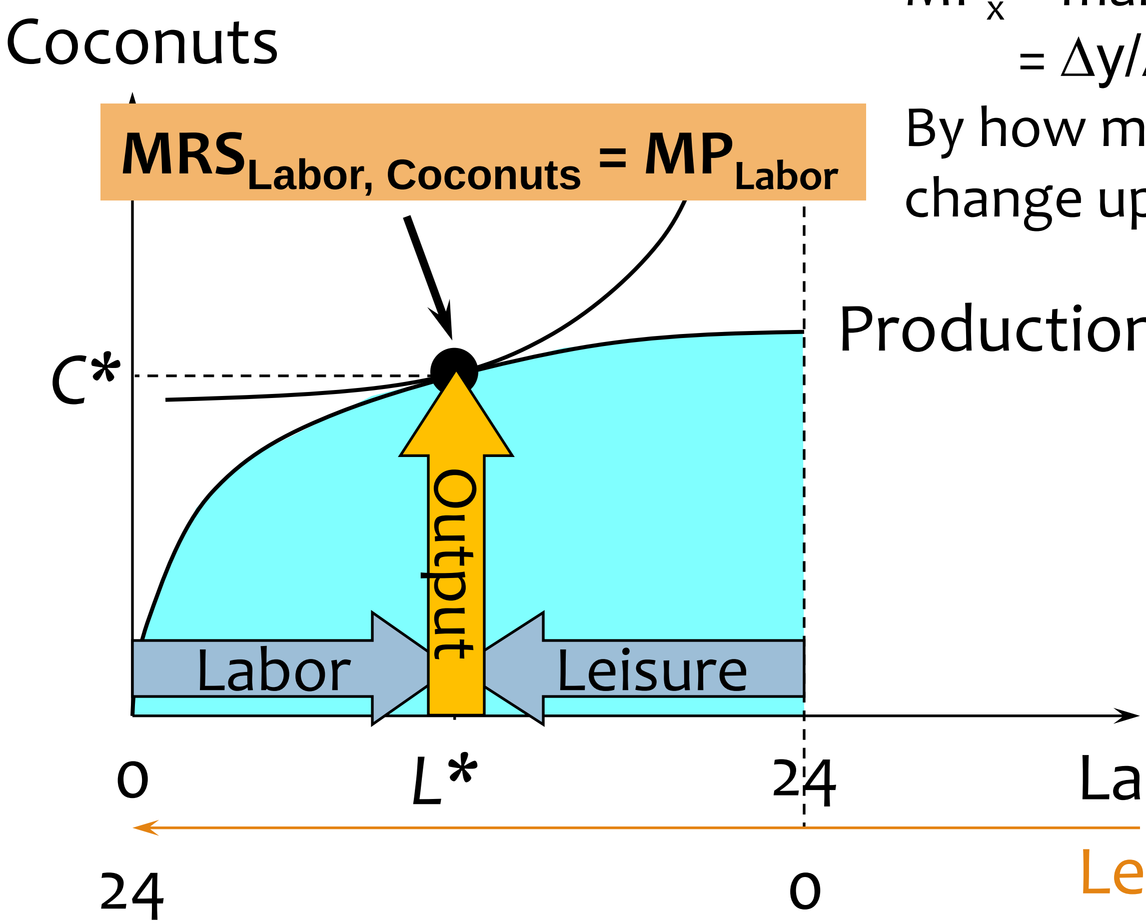
Robinson Crusoe's choice



Robinson Crusoe's choice



Robinson Crusoe's choice



MP_x = marginal product of x
$= \Delta y/\Delta x$

By how much will output (y) change upon a small change of x?

Production function y(x)

or here: C(L)

Robinson Crusoe as a firm

- Suppose RC is both a utility-maximizing consumer and a profit-maximizing firm
- We take coconuts as the numeraire good; that is, a price of a coconut, p_C = \$1
- w – RC's wage; L – hours of labor; C – coconut output level

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- Profit of RC's firm: $\pi = p_C C - wL = C - wL$
- $C = \pi + wL$, the equation of an isoprofit line
- Slope of the line = w

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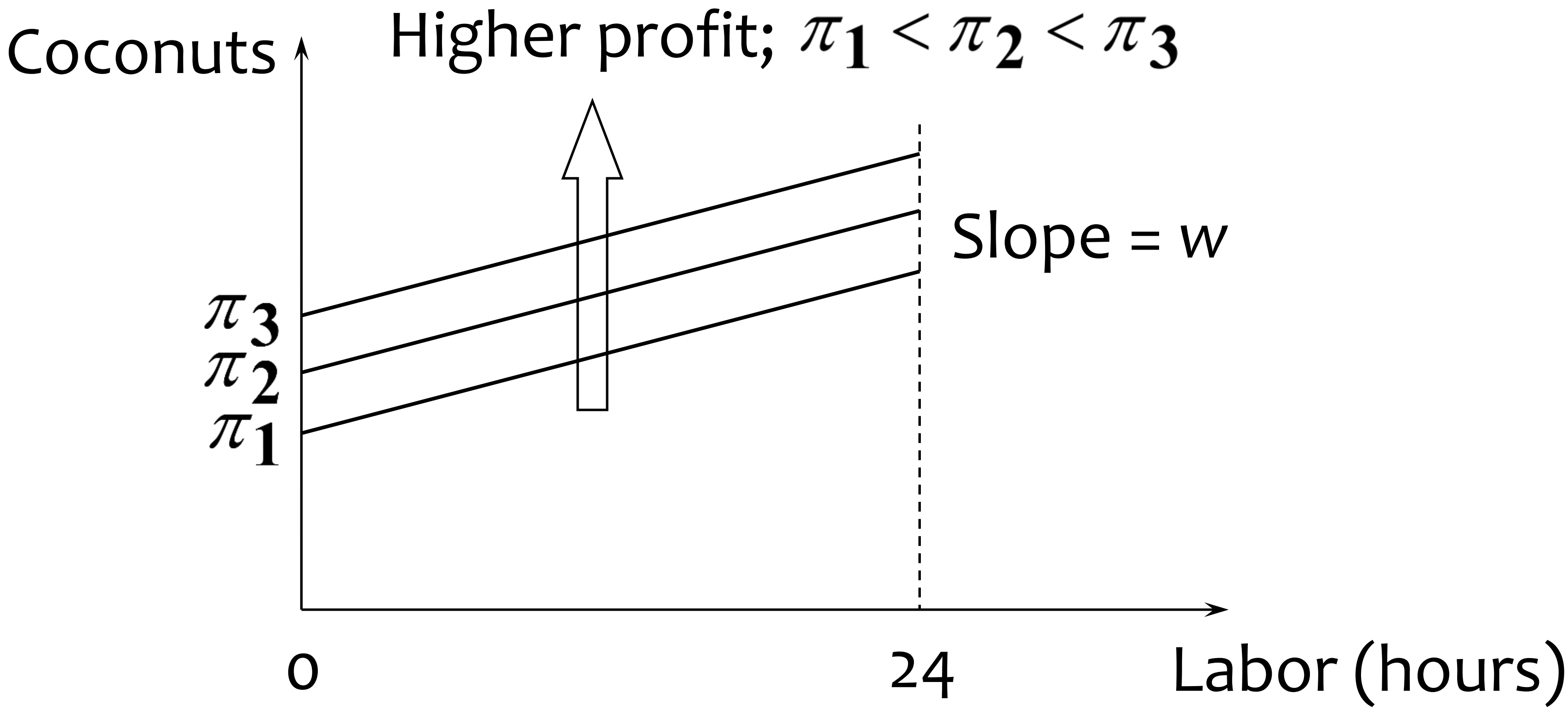
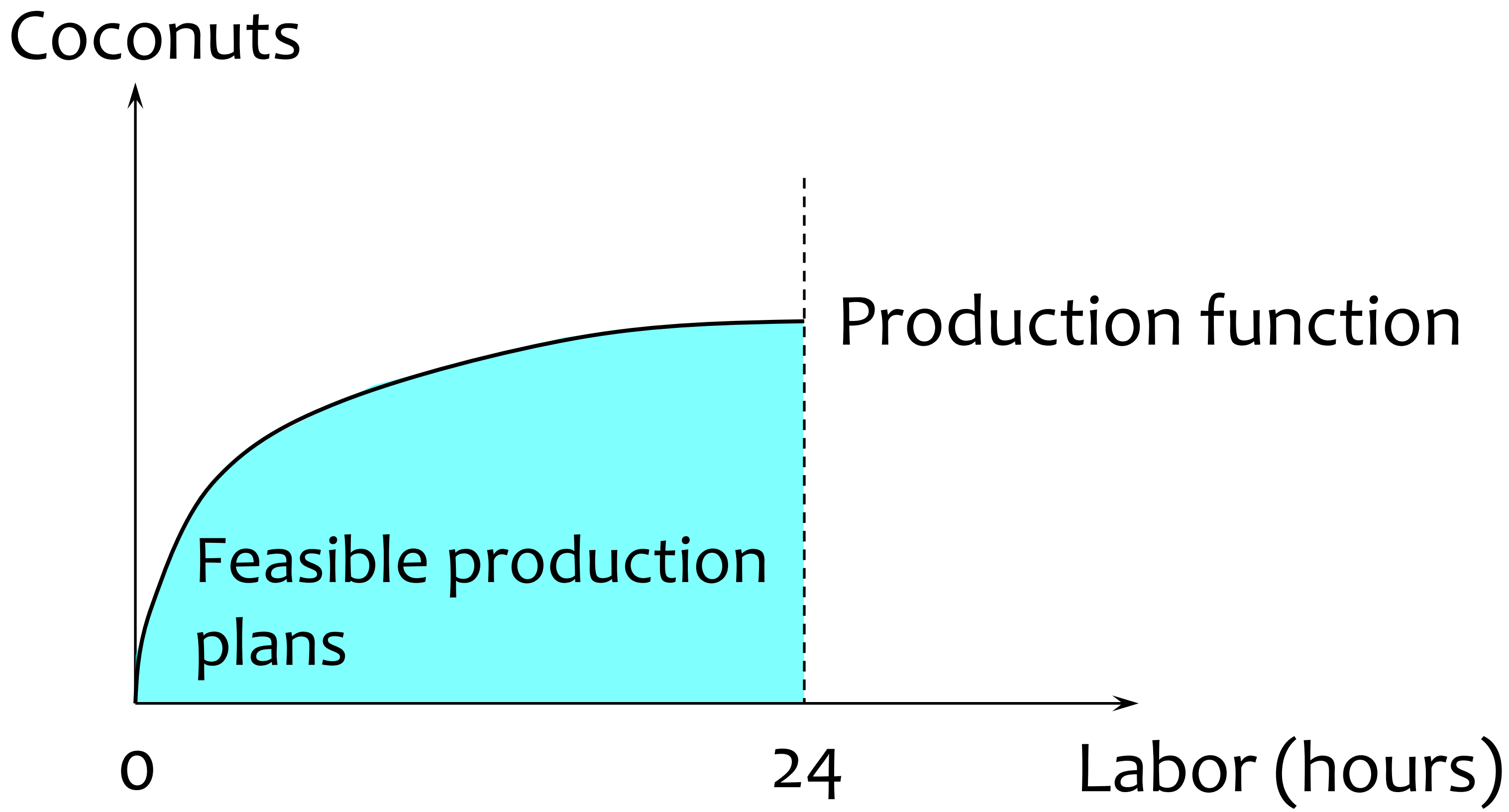
all combinations of labor and coconuts that yield profits of π

Isoprofit lines

$$C = \pi + wL$$



Profit-maximization



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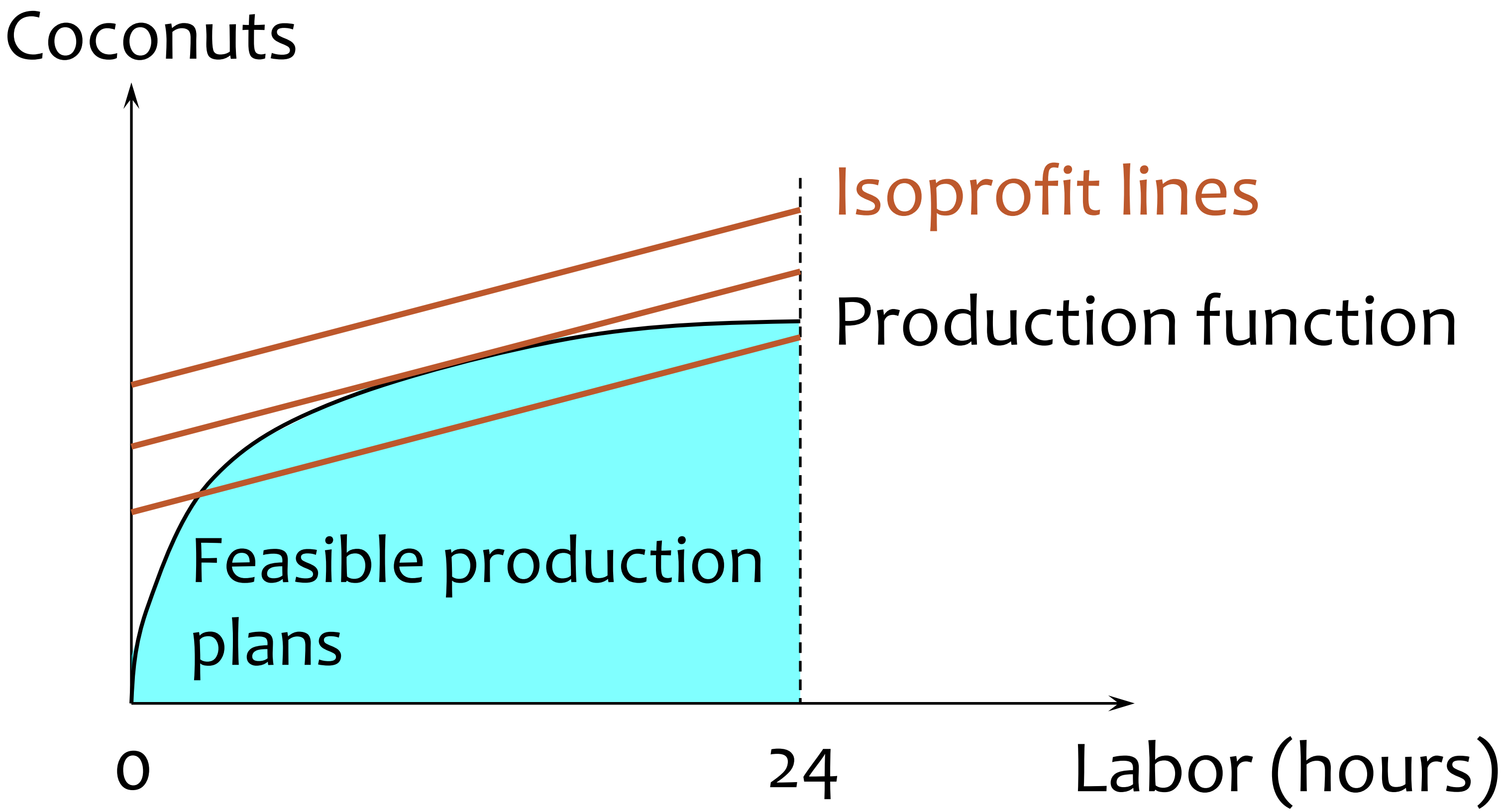

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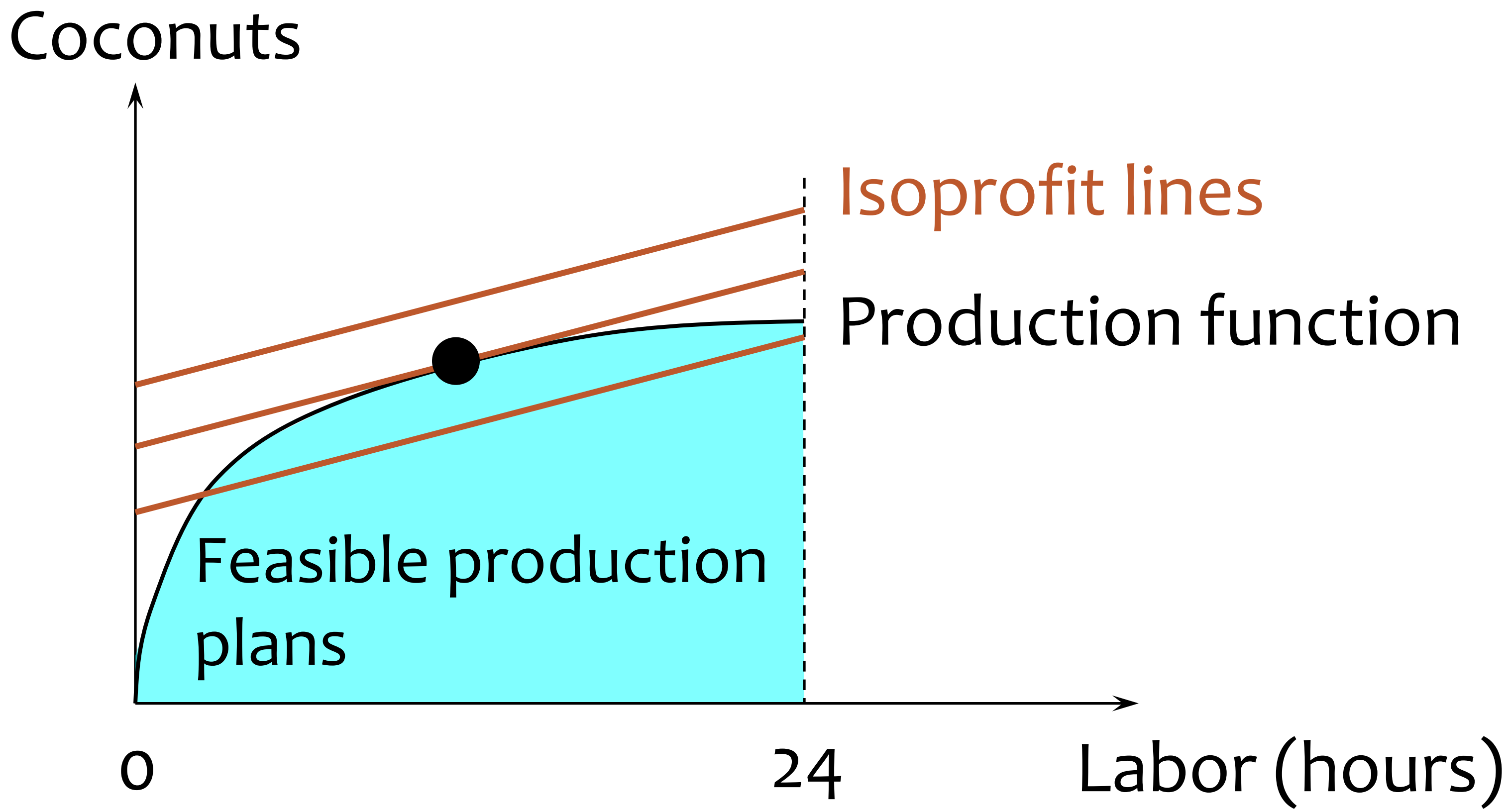
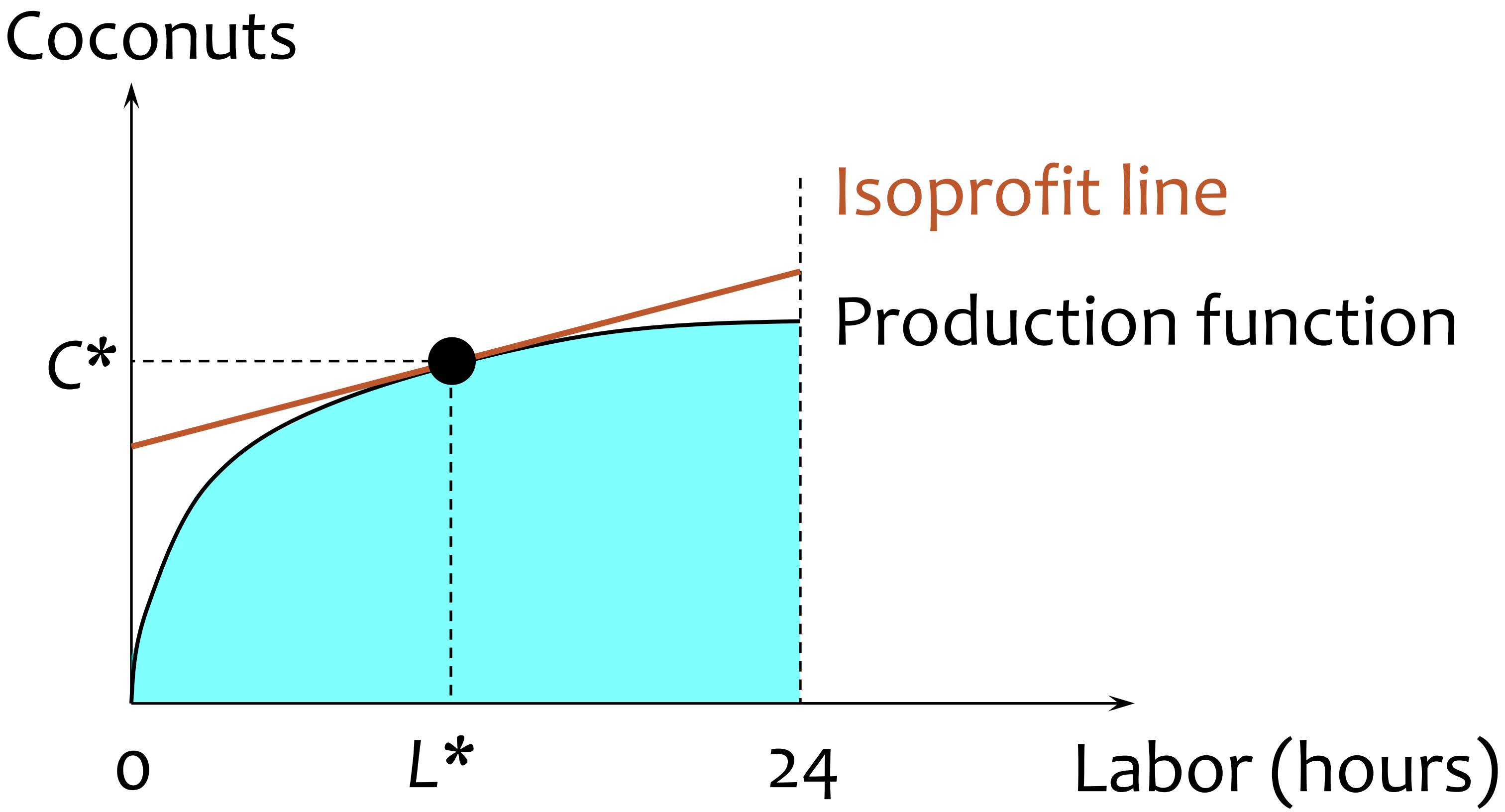
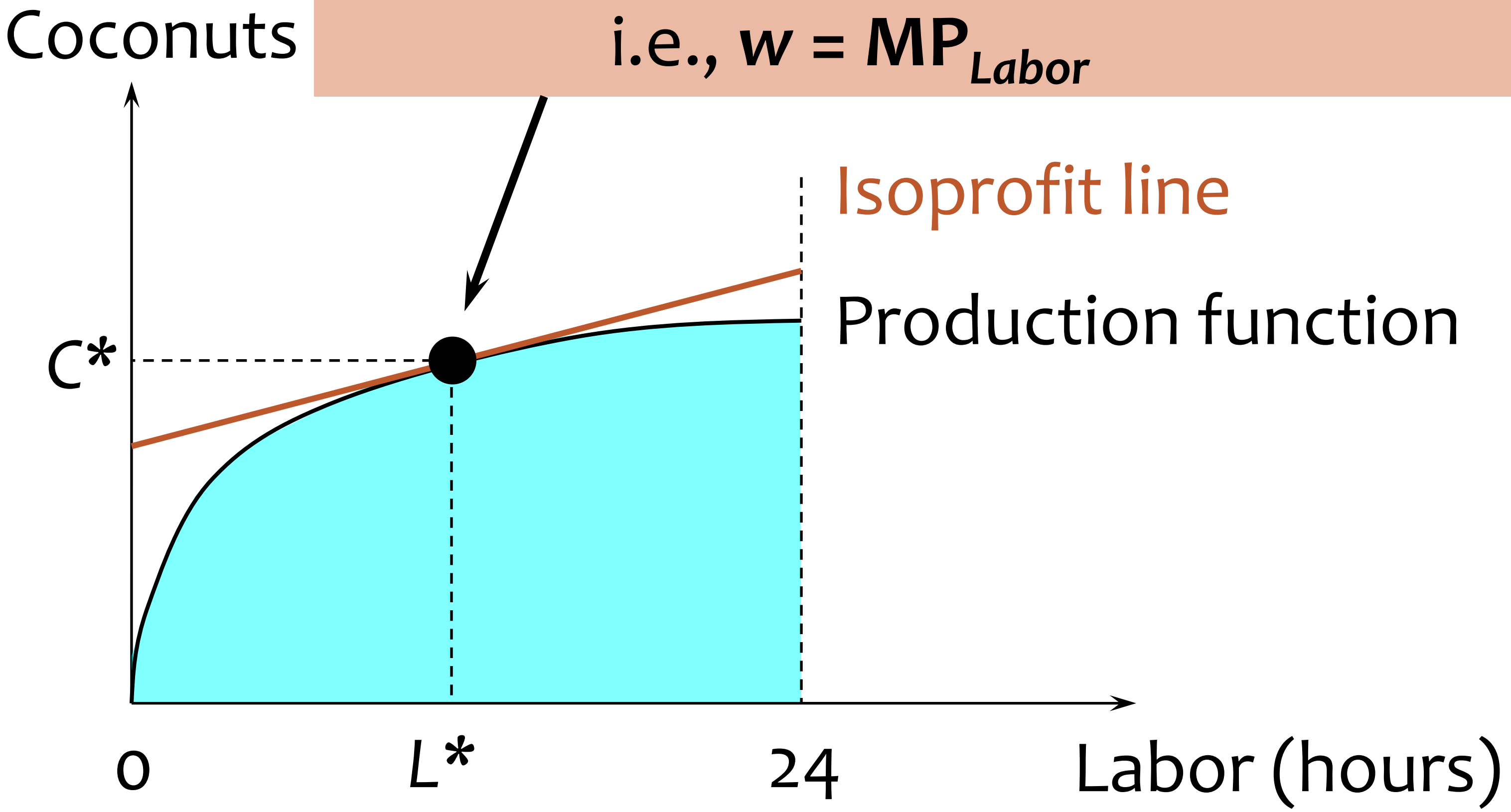


Profit-maximization



Profit-maximization

Isoprofit slope = Production function slope
i.e., w = $\mathbf{MP}_{Labor}$



Profit-maximization

Isoprofit slope = Production function slope
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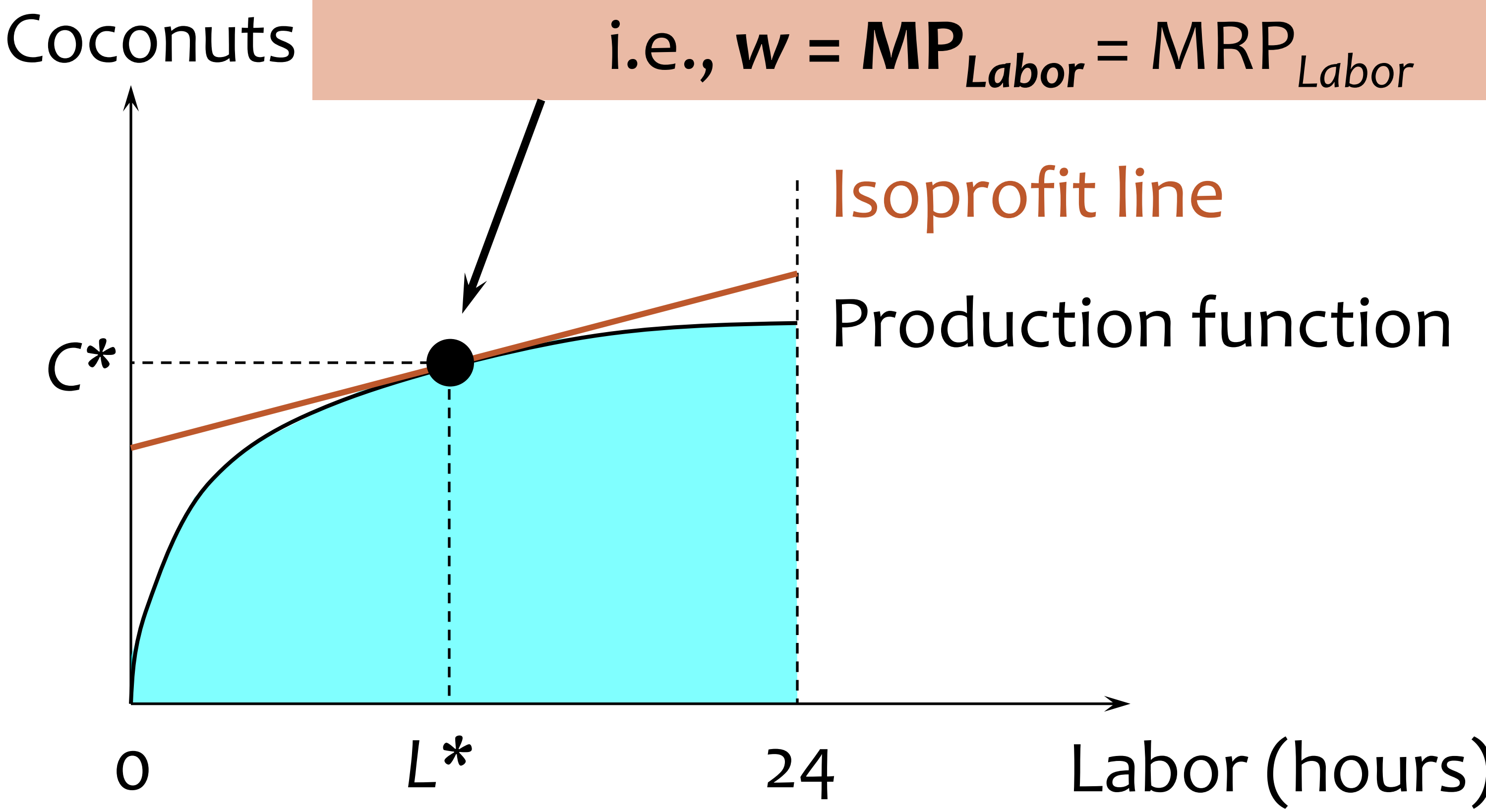


MP and MRP

Suppose that we increase the amount of the input a little bit, Δx. This will result in a small increase in output, Δy. The ratio of the increase in output to the increase in the input is the **marginal product** of the factor:

$$MP_x = \frac{\Delta y}{\Delta x} = \frac{f(x + \Delta x) - f(x)}{\Delta x}. \tag{27.1}$$

This increase in output will cause revenue to change. The change in revenue is called the **marginal revenue**.

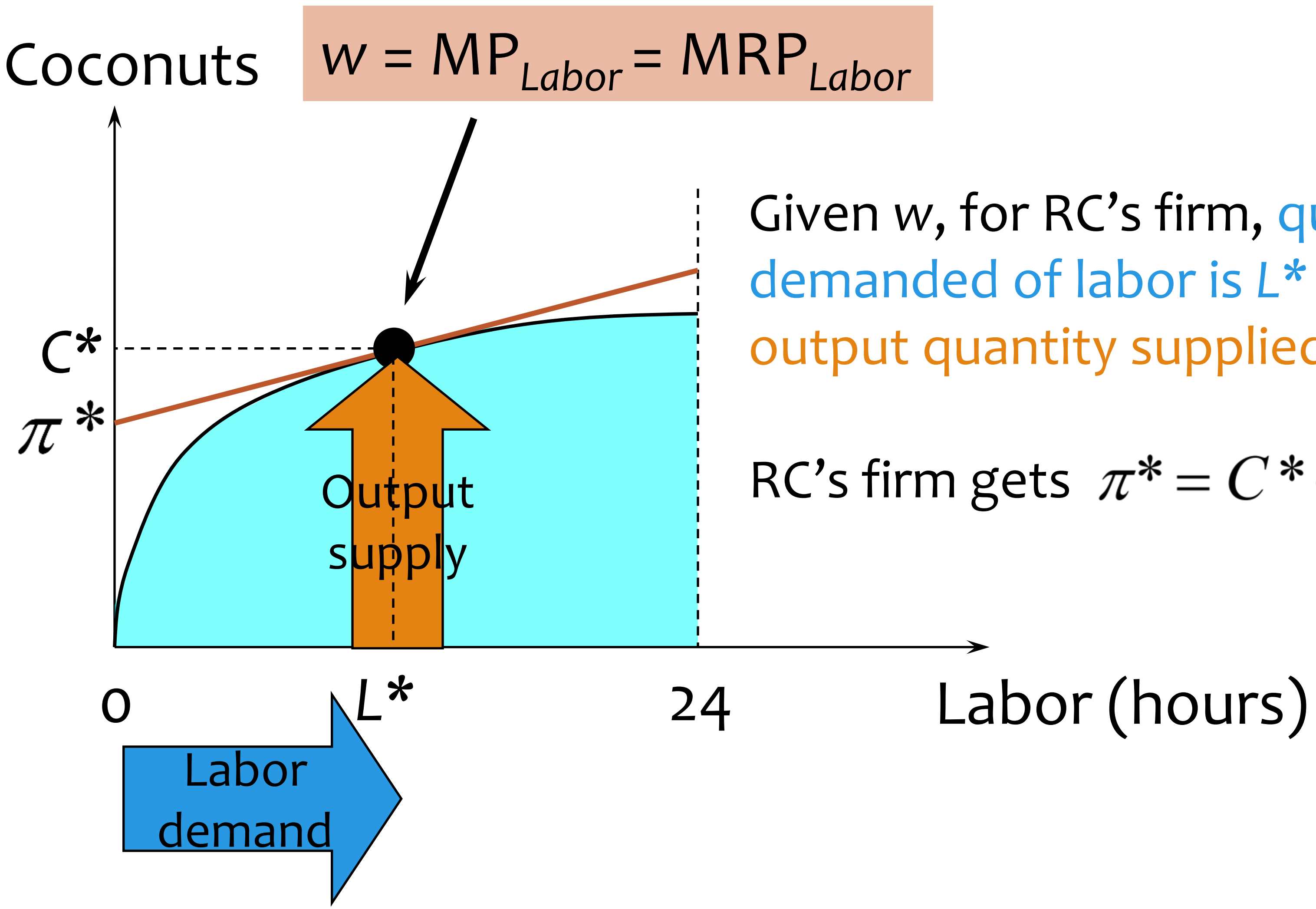
$$MR_y = \frac{\Delta R}{\Delta y} = \frac{R(y + \Delta y) - R(y)}{\Delta y}. \tag{27.2}$$

The effect on revenue due to the marginal increase in the input is called the **marginal revenue product**. Examining equations (27.1) and (27.2) we see that it is given by

$$\begin{aligned} MRP_x &= \frac{\Delta R}{\Delta x} = \frac{\Delta R}{\Delta y}\frac{\Delta y}{\Delta x} \\ &= MR_y \times MP_x. \end{aligned}$$

Source: Varian, Hal R. 2014. *Intermediate Economics*, 9th Ed, p. 504.

Profit-maximization



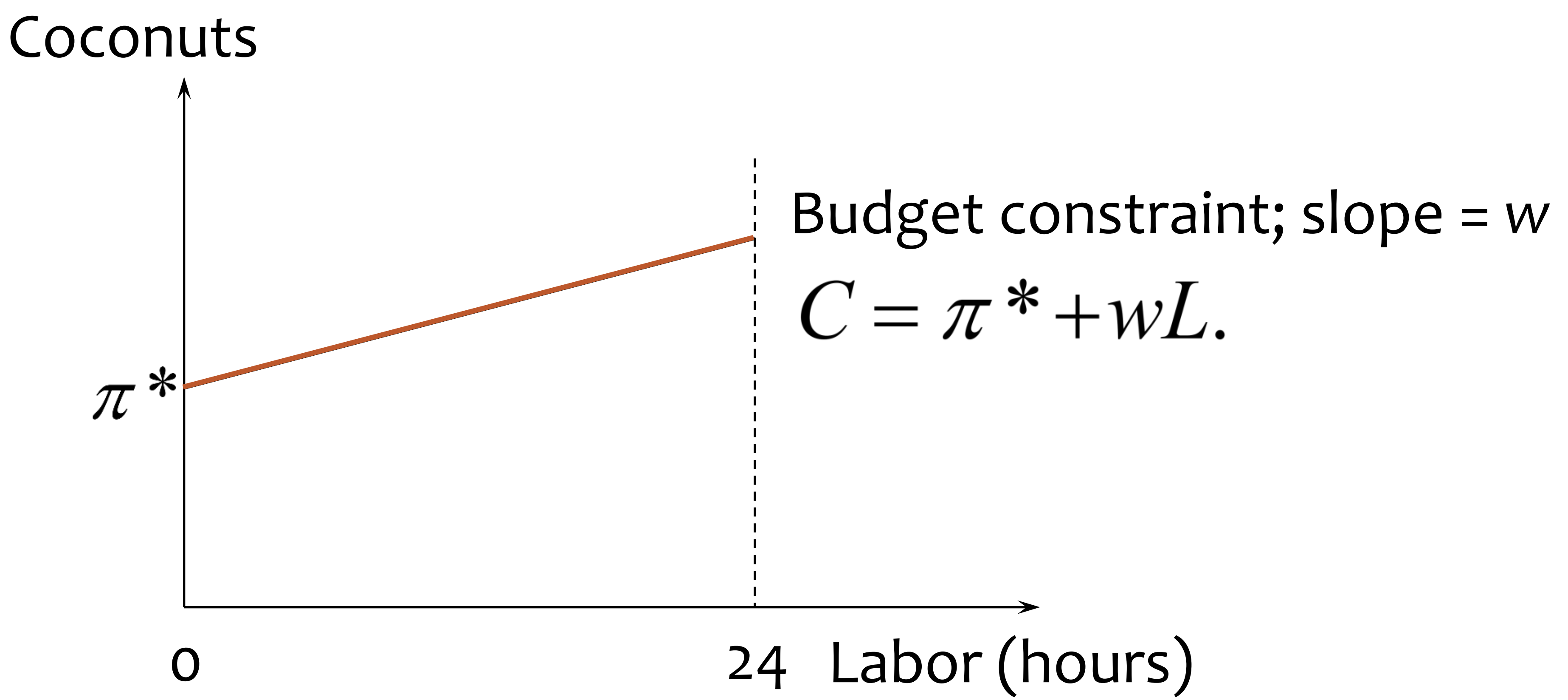
Given w, for RC's firm, quantity demanded of labor is L^* and output quantity supplied is C^*.

RC's firm gets $\pi^* = C^* - wL^*$

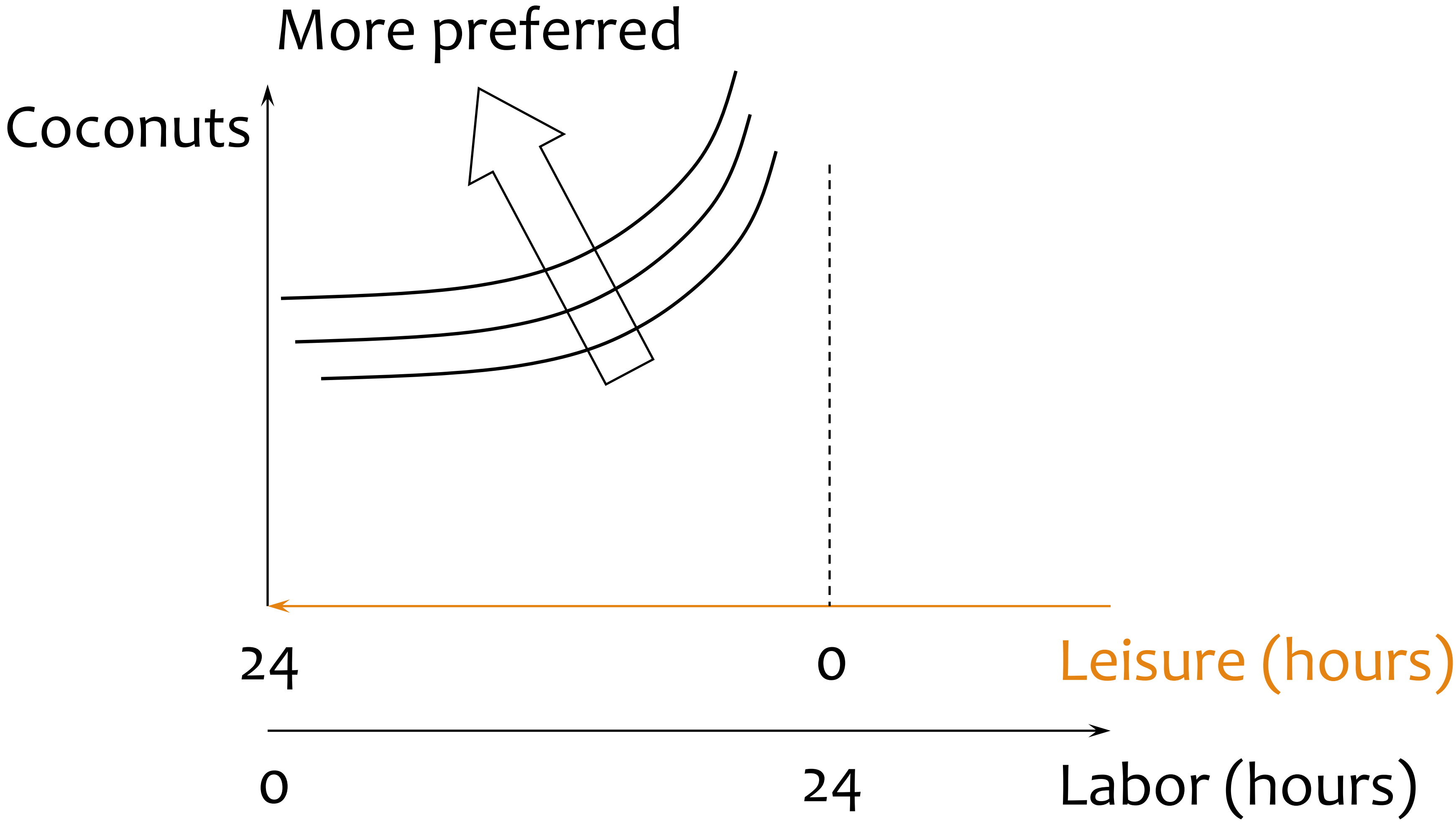
Utility-maximization

- Now consider RC as a consumer endowed with \$$\pi$* who can work for \$$w$ per hour
- What is RC's most preferred consumption bundle?
- Budget constraint is $C = \pi * + wL.$

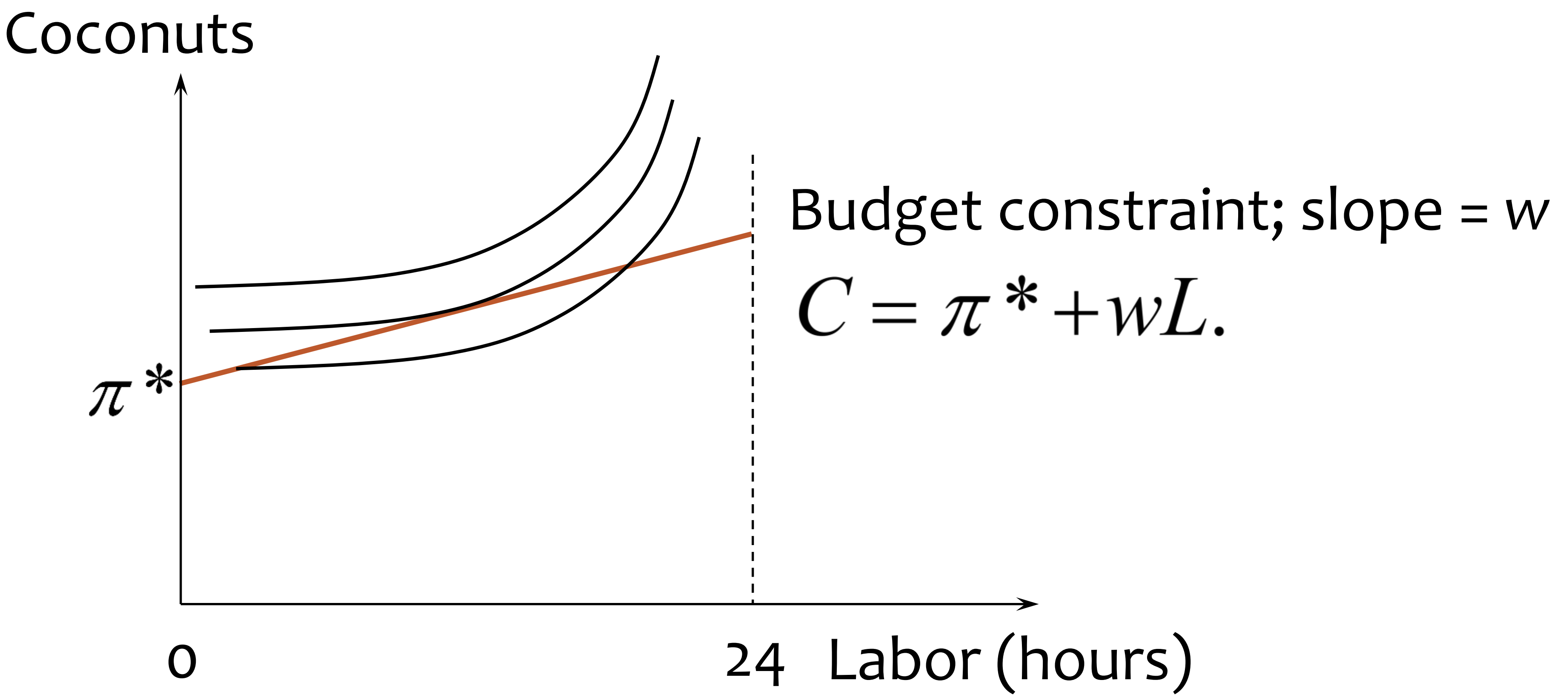
Utility-maximization



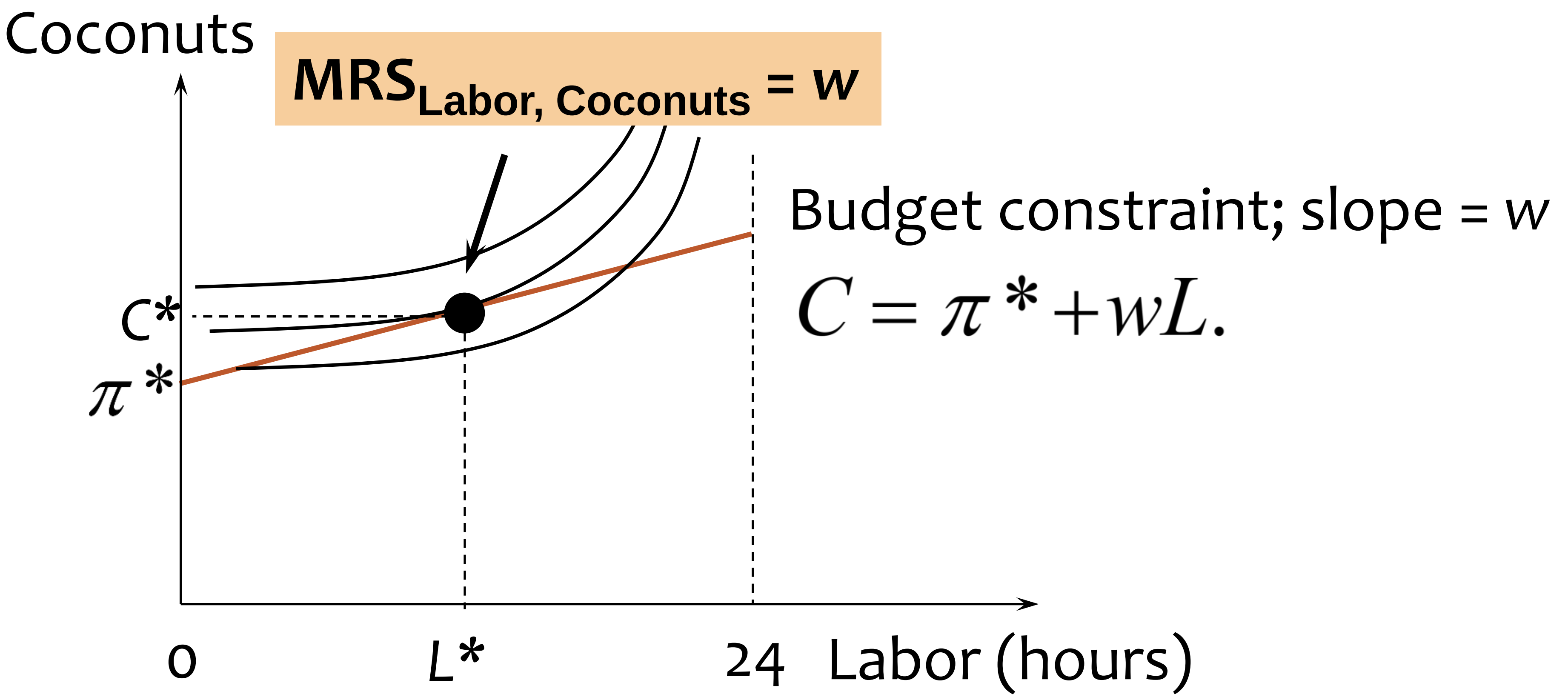
Robinson Crusoe's preferences



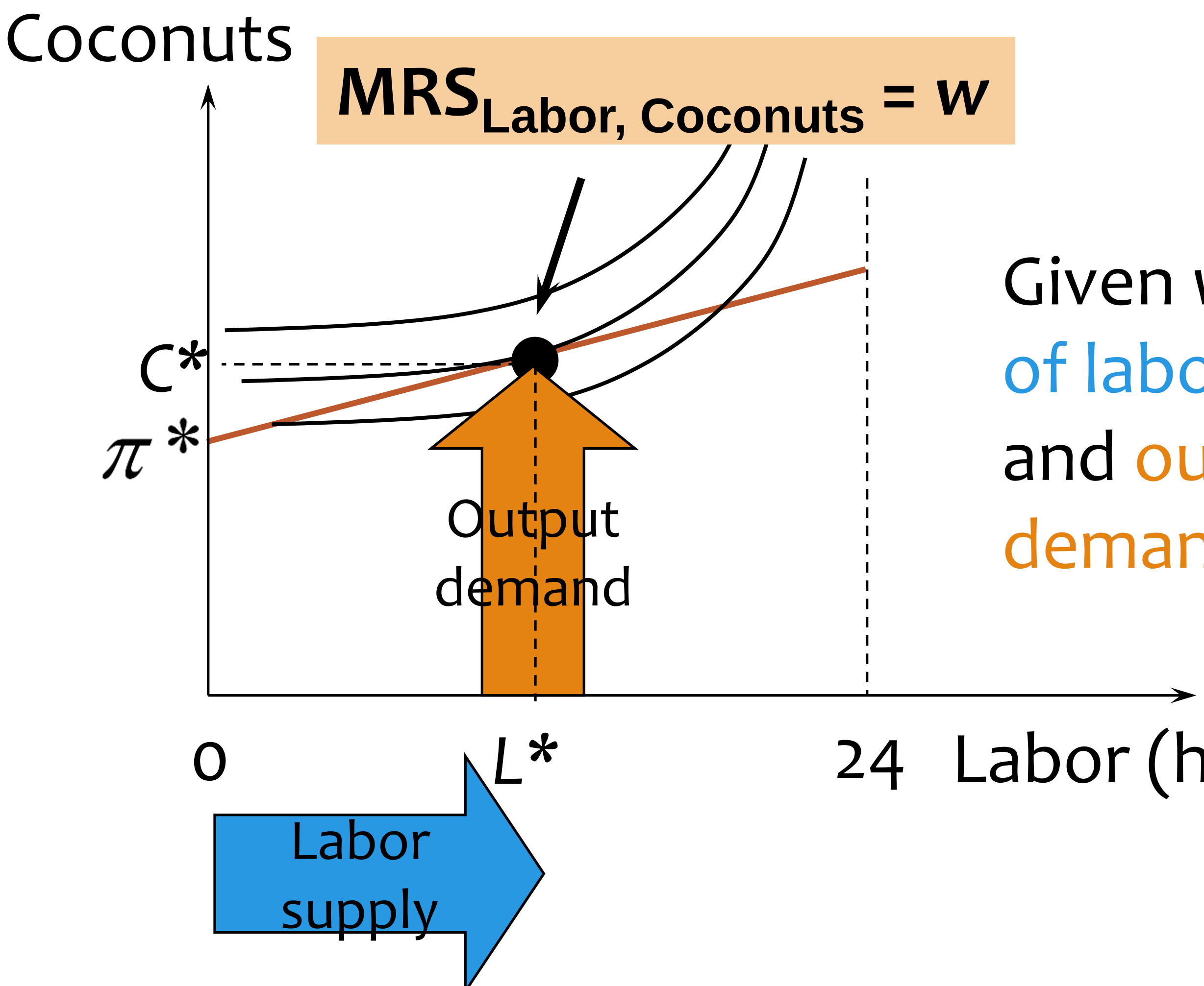
Utility-maximization



Utility-maximization



Utility-maximization



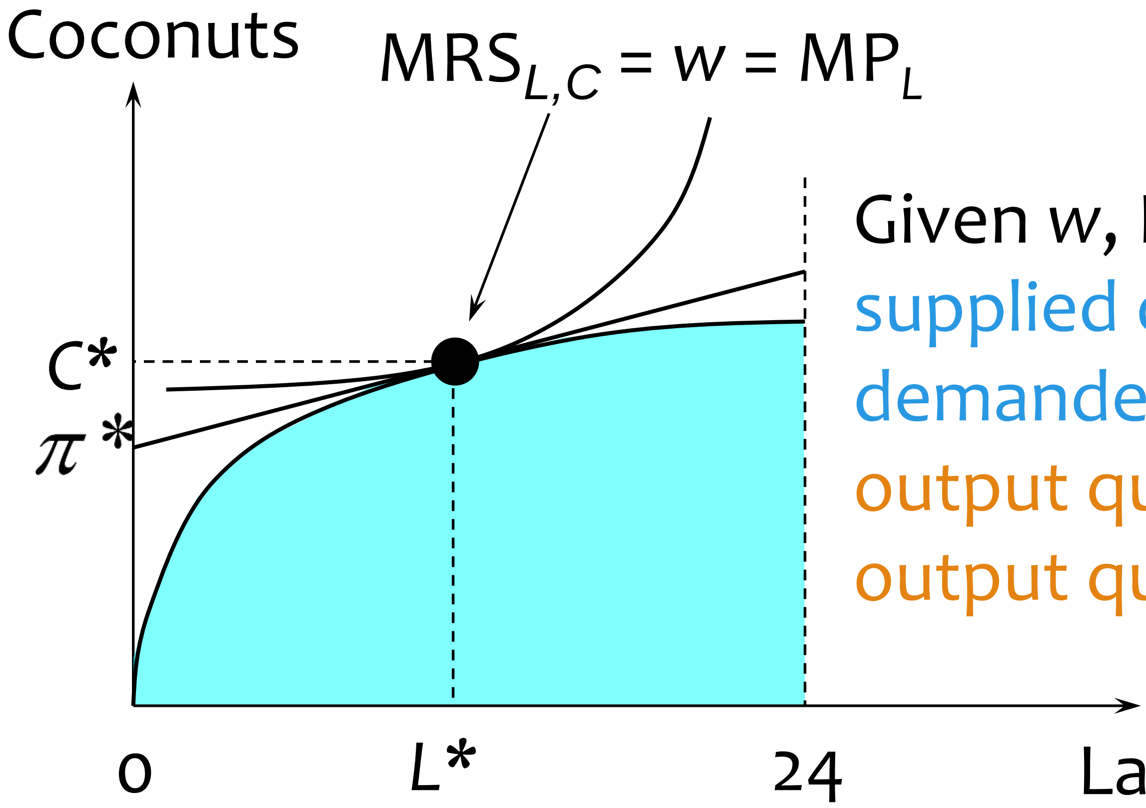
Given w, RC's quantity of labor supplied is L^* and output quantity demanded is C^*.

Utility-maximization & Profit-maximization

- Profit-maximization: **w = MP$_L$**
  - – quantity of output supplied = C^*
  - – quantity of labor demanded = L^*
- Utility-maximization: **w = MRS$_{L,C}$**
  - – quantity of output demanded = C^*
  - – quantity of labor supplied = L^*

Coconut and labor markets both clear.

Utility-maximization & Profit-maximization



Given w, RC's quantity supplied of labor = quantity demanded of labor = L^* and output quantity demanded = output quantity supplied = C^*.

Pareto efficiency

- Must have $MRS_{L,C} = MP_L$

Pareto efficiency

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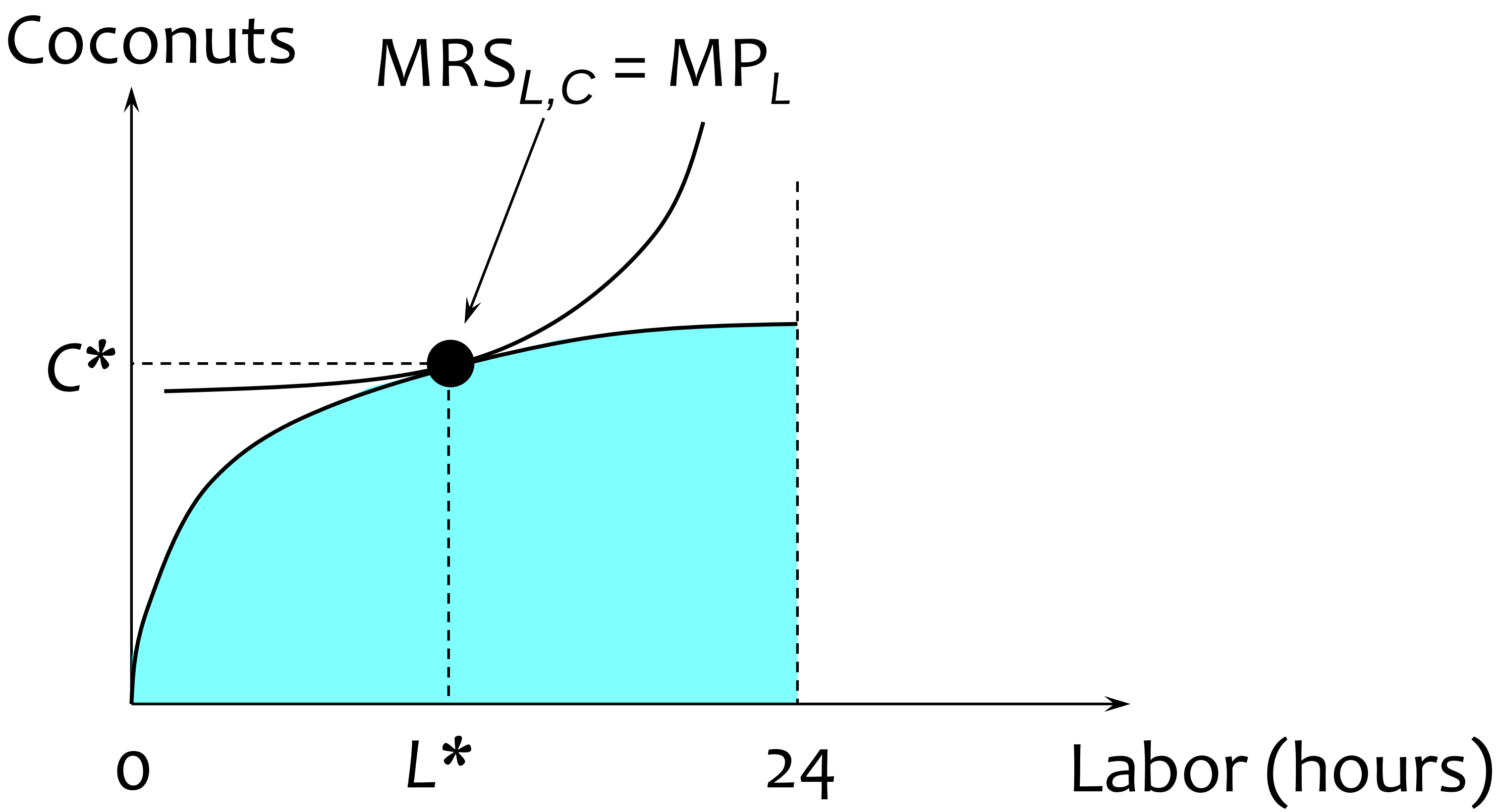
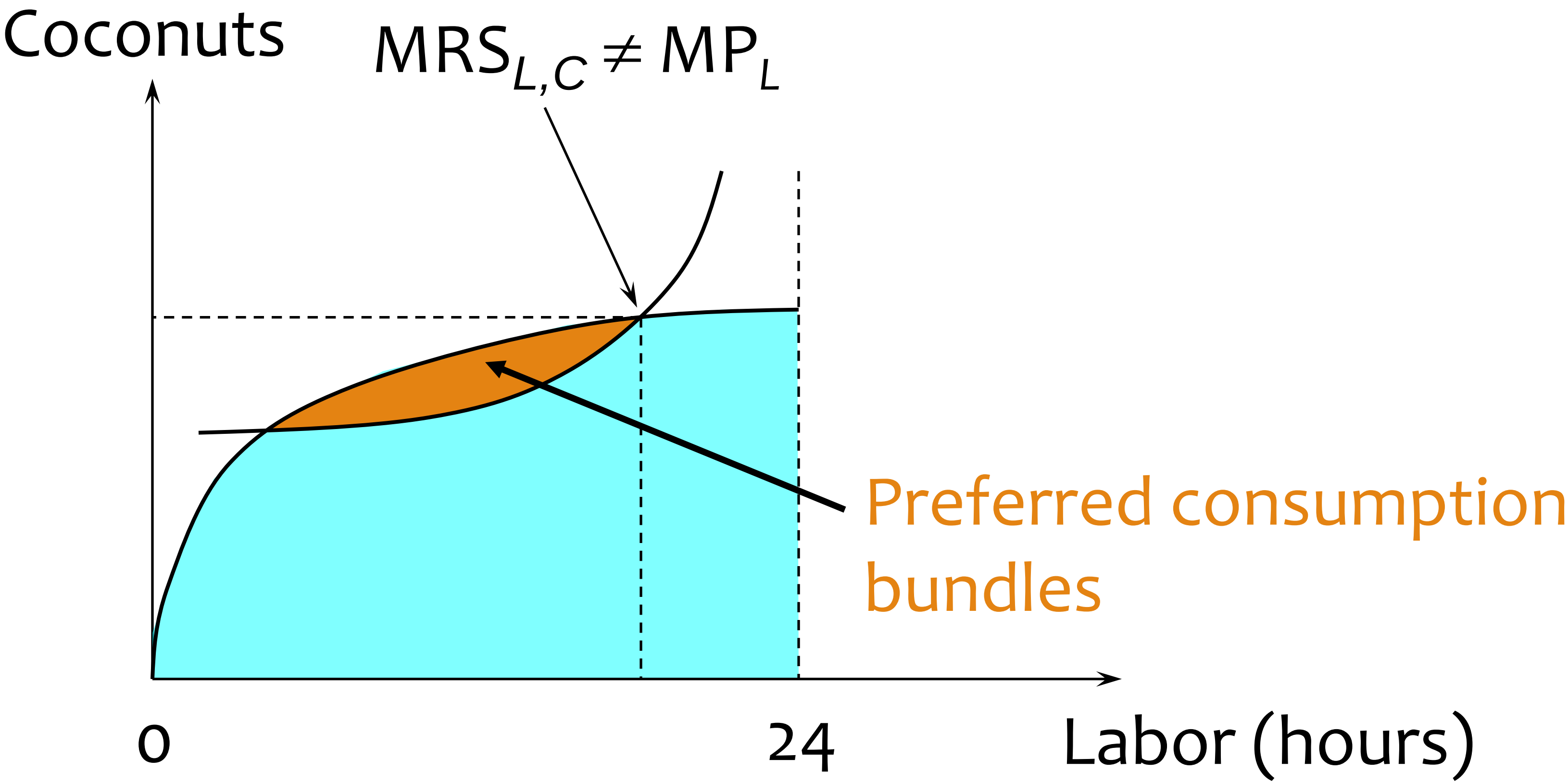


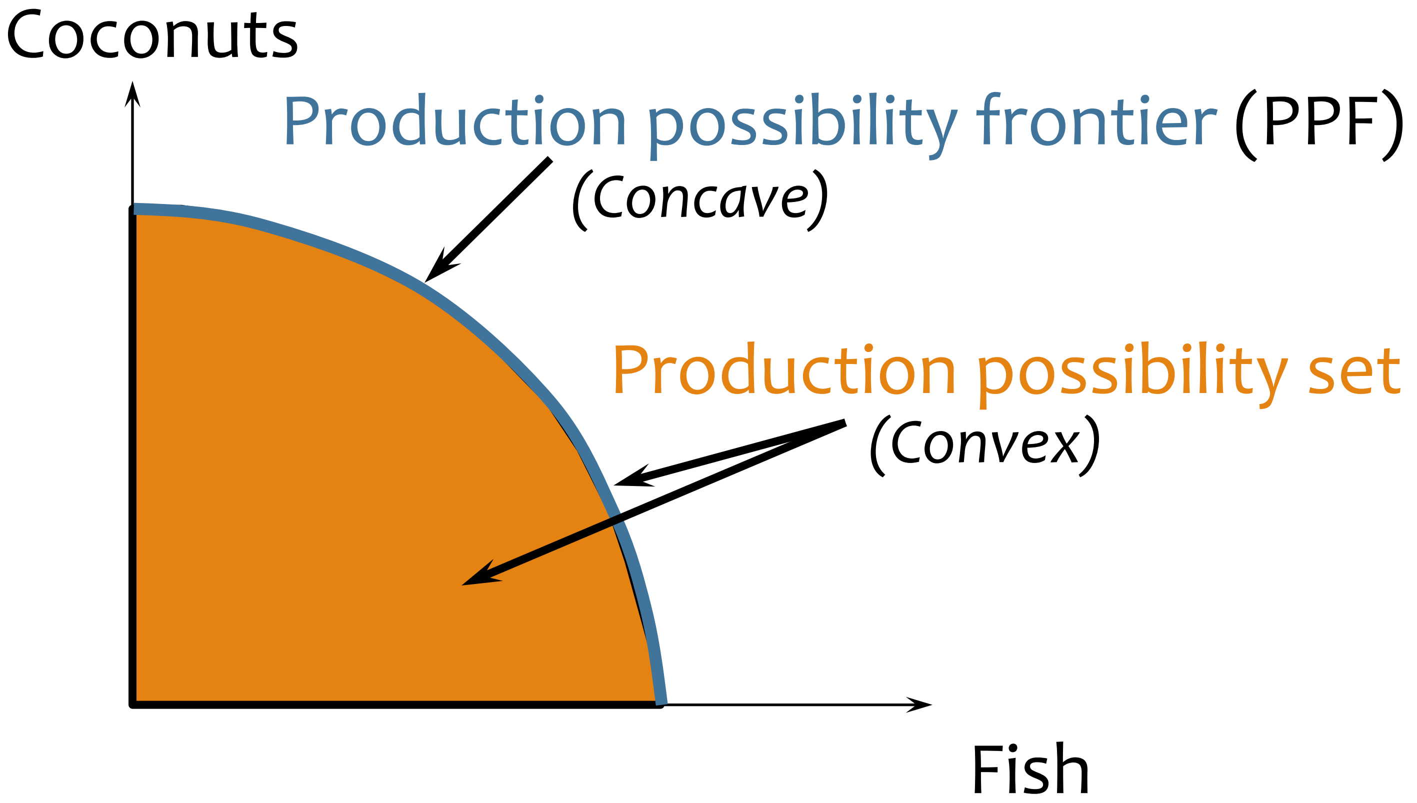
Pareto efficiency



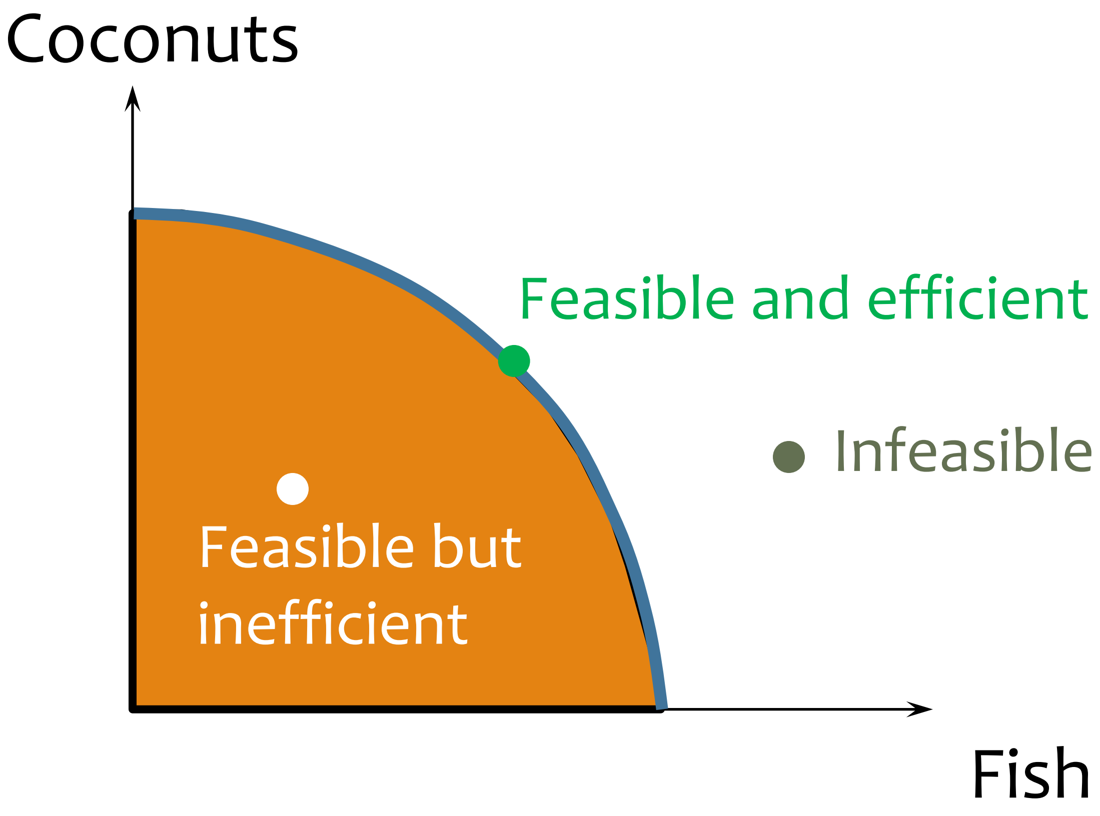
Production possibilities

- Resource and technological limitations restrict what an economy can produce.
- The set of all feasible output bundles is the economy's production possibility set.
- The set's outer boundary is the production possibility frontier.
- (The production function discussed in Micro II depicts the relationship between the input good and the output good.
  In contrast, the production possibilities set depicts *only* the set of *output* goods feasible.)

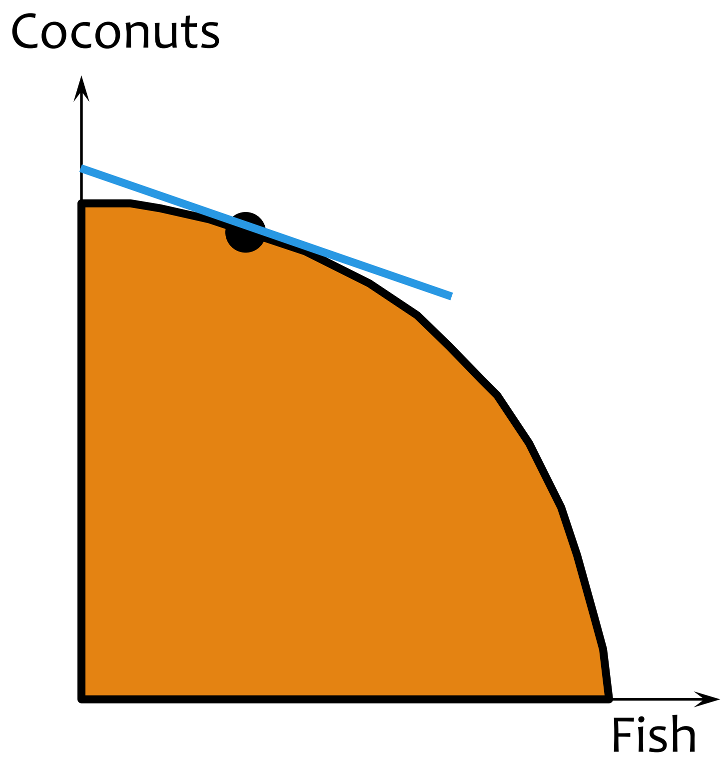
Production possibilities



Production possibilities



Production possibilities



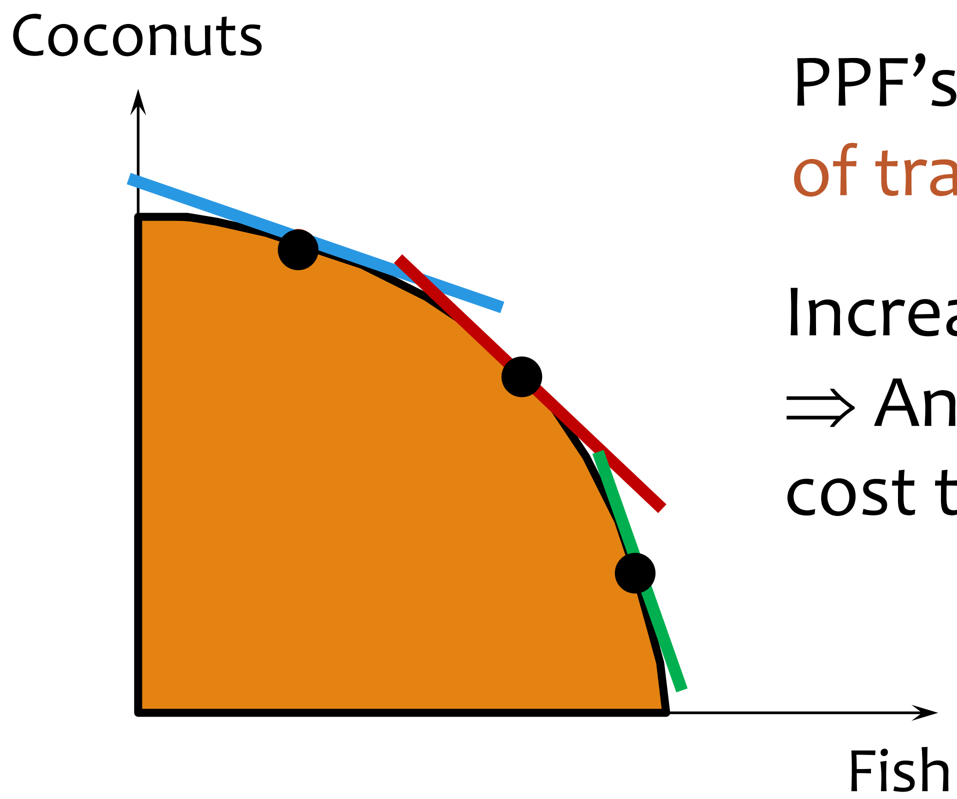
Production possibility frontier (PPF) – *T*(*F*,*C*)

$$MRT_{FC} = -\frac{\partial T(F,C)/\partial F}{\partial T(F,C)/\partial C} = \frac{dC}{dF}$$

PPF's slope is the marginal rate of transformation (MRT).

- How many units of one good have to stop being produced in order to produce an extra unit of the other good, while keeping constant the use of production factors and the technology.
- The rate at which one good must be sacrificed in order to produce an extra unit (or a marginal unit) of another good, assuming that both goods require the same inputs.
- An opportunity cost of one good defined in terms of the other good.

Production possibilities



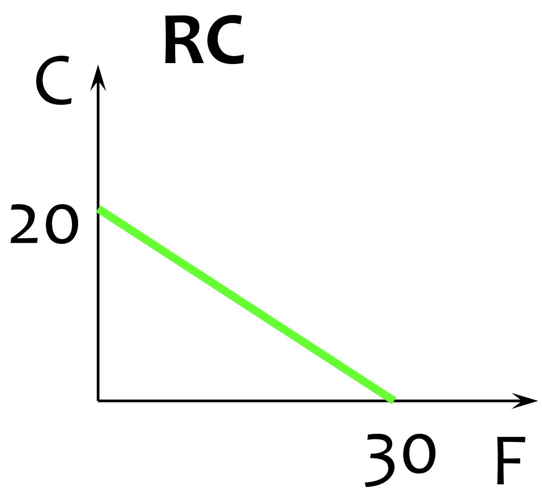
PPF's slope is the marginal rate of transformation (MRT).

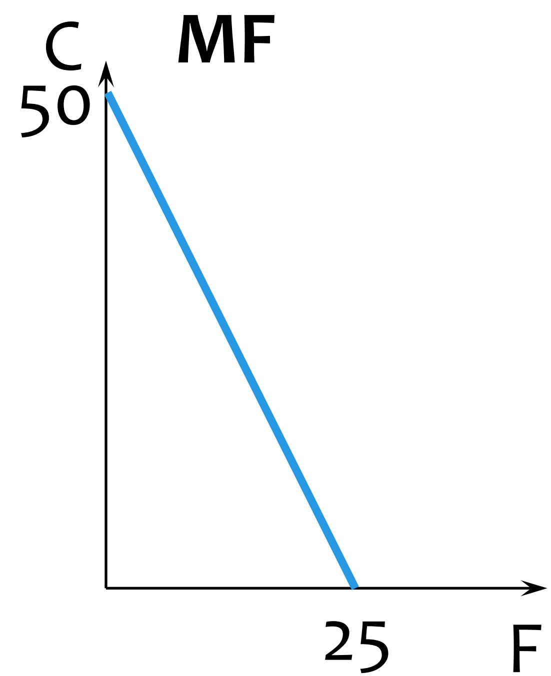
Increasingly negative MRT
$\Rightarrow$ An increasing opportunity cost to specialization.

If there are no production externalities, then a PPF will be concave, because efficient production requires exploitation of comparative advantages.

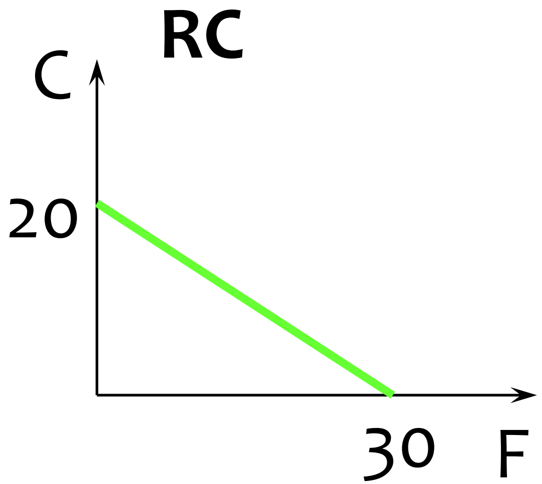
Comparative advantage

- Two agents, RC and Man Friday (MF).
- RC can produce (collect) at most 20 coconuts or 30 fish.
- MF can produce (collect) at most 50 coconuts or 25 fish.



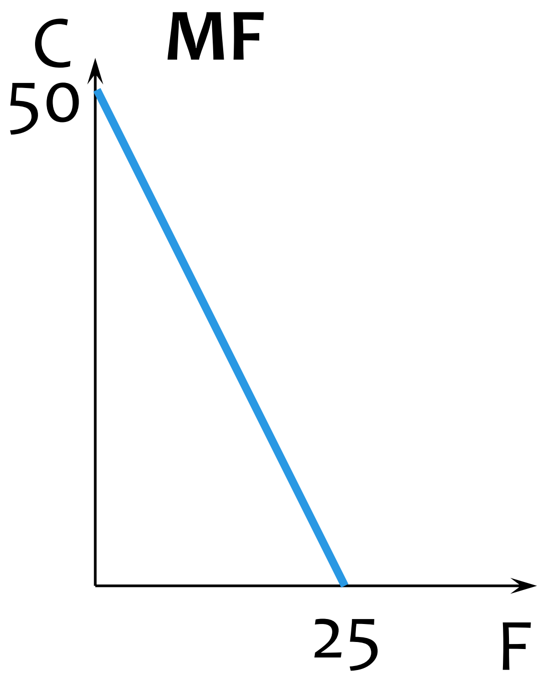


Comparative advantage



$MRT_{FC} = -2/3$

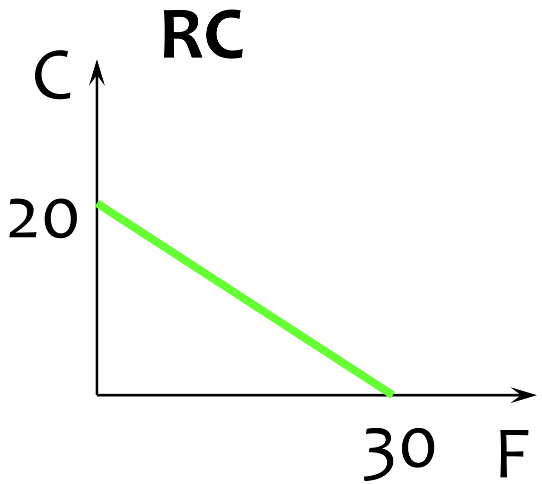
An opportunity cost of one more fish is 2/3 foregone coconuts. (2/3 C = F)



$MRT_{FC} = -\,2$

An opportunity cost of one more fish is 2 foregone coconuts. (2 C = F)

Comparative advantage



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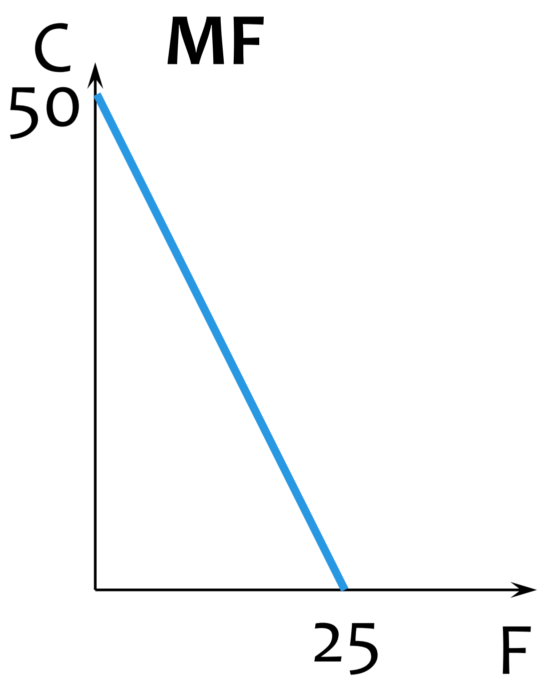
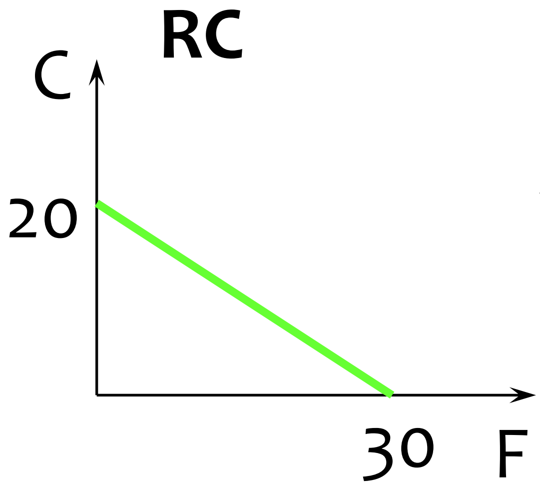
RC has the comparative advantage in collecting fish.



$MRT_{FC} = -\ 2$

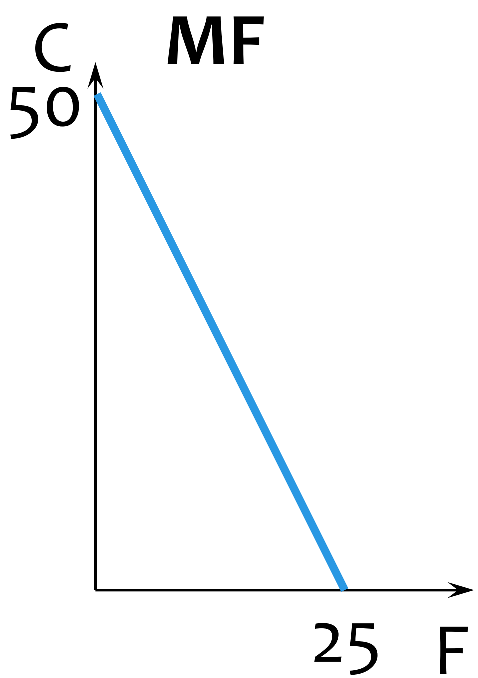
An opportunity cost of one more fish is 2 foregone coconuts. (2 C = F)

Comparative advantage



$MRT_{CF} = -3/2$

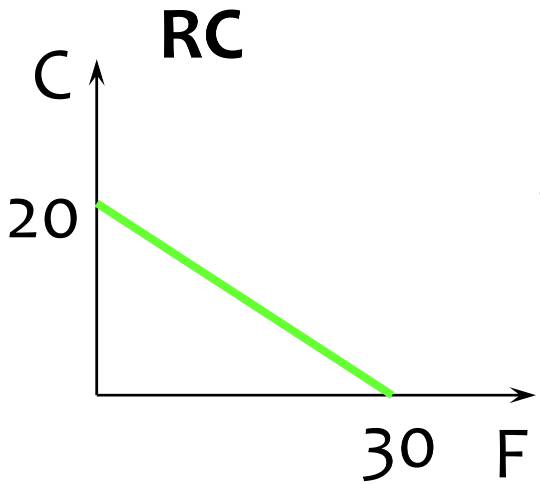
An opportunity cost of one more coconut is 3/2 foregone fish. (3/2 F = C)



$MRT_{CF} = -1/2$

An opportunity cost of one more coconut is 1/2 foregone fish. (1/2 F = C)

Comparative advantage



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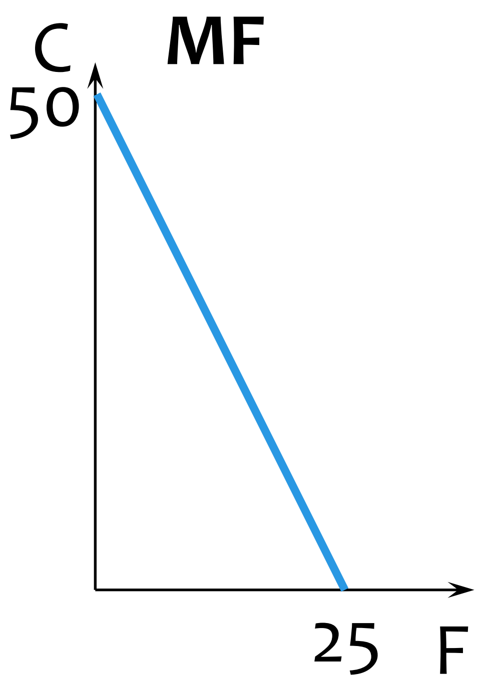

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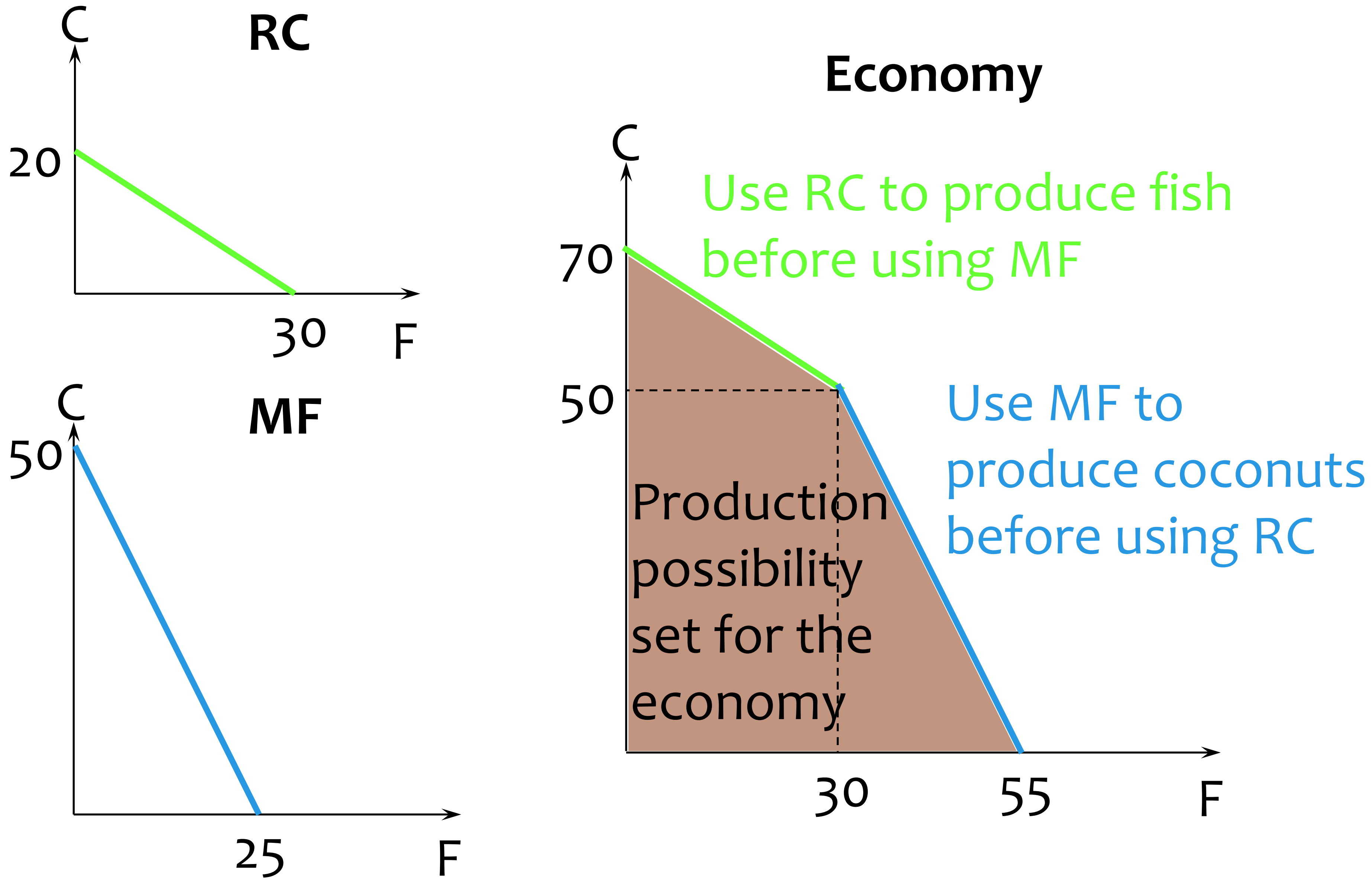
An opportunity cost of one more coconut is 1/2 foregone fish. (1/2 F = C)

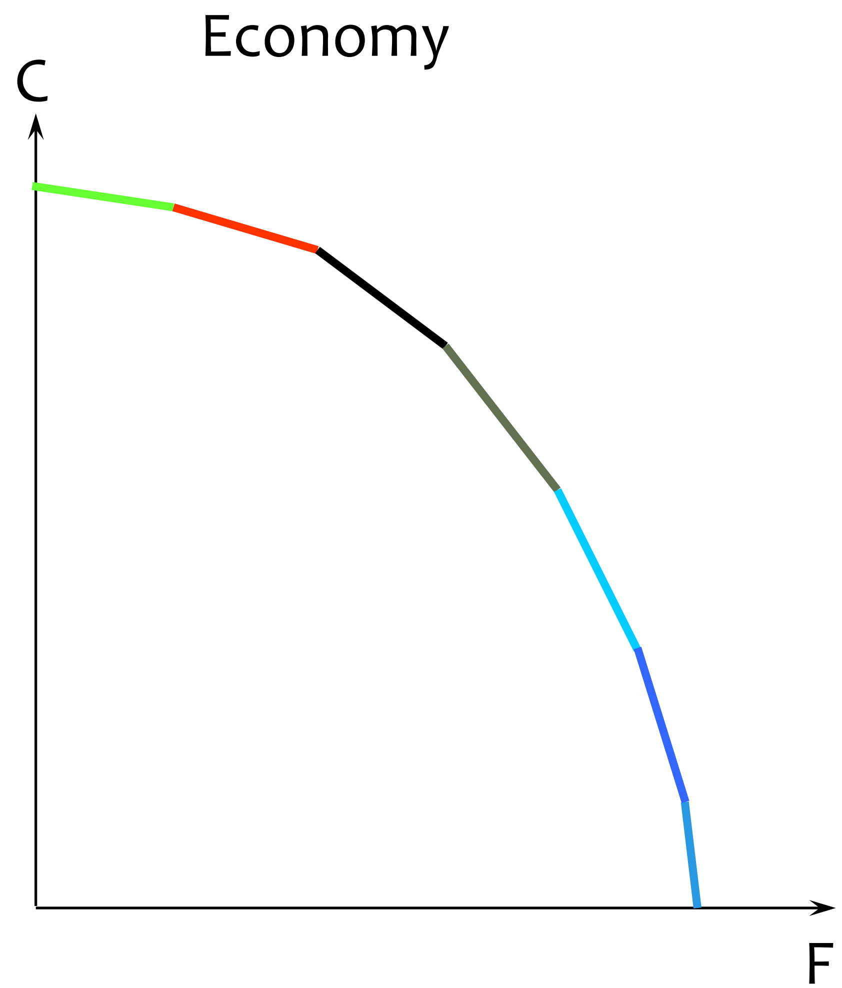
MF has the comparative advantage in collecting coconuts.

Comparative advantage



Comparative advantage

More producers with different opportunity costs "smooth out" the PPF.



Coordinating production and consumption

- The PPF contains many technically efficient output bundles.
- Which are Pareto efficient for consumers?
- **$MRS_{XY} = MRT_{XY}$ is the necessary condition for a Pareto efficient economy state.**

Why is $MRS_{XY} = MRT_{XY}$ needed for Pareto efficiency?

- Say a consumer's $|MRS_{XY}|$ is 1: The consumer is willing to substitute good X for good Y on a one-to-one basis.
- Suppose $|MRT_{XY}| = 2$: Giving up one unit of X will allow society to produce two units of Y.
- It makes sense to reduce the production of X by one unit – this will generate two extra units of Y.
- The consumer was indifferent between giving up one unit of X and getting one unit of Y in exchange, so she will be better off by getting two extra units of Y.

Decentralized coordination of production and consumption

- RC and MF jointly run a firm producing coconuts and fish.
- RC and MF are also consumers who can sell their labor.
- p_C – price per coconut (C); p_F – price per fish (F)
- w_{RC} – RC's wage rate; w_{MF} – MF's wage rate
- L_{RC}, L_{MF} – amounts of labor purchased from RC and MF

The firm's profit-maximization problem
is to choose C, F, L_{RC} and L_{MF} to

$$\max \pi = p_C C + p_F F - w_{RC} L_{RC} - w_{MF} L_{MF}$$

The firm's profit-maximization problem is to choose C, F, L_{RC} and L_{MF} to

$$\textbf{max}\ \pi = p_C C + p_F F - w_{RC} L_{RC} - w_{MF} L_{MF}.$$

Isoprofit line equation:

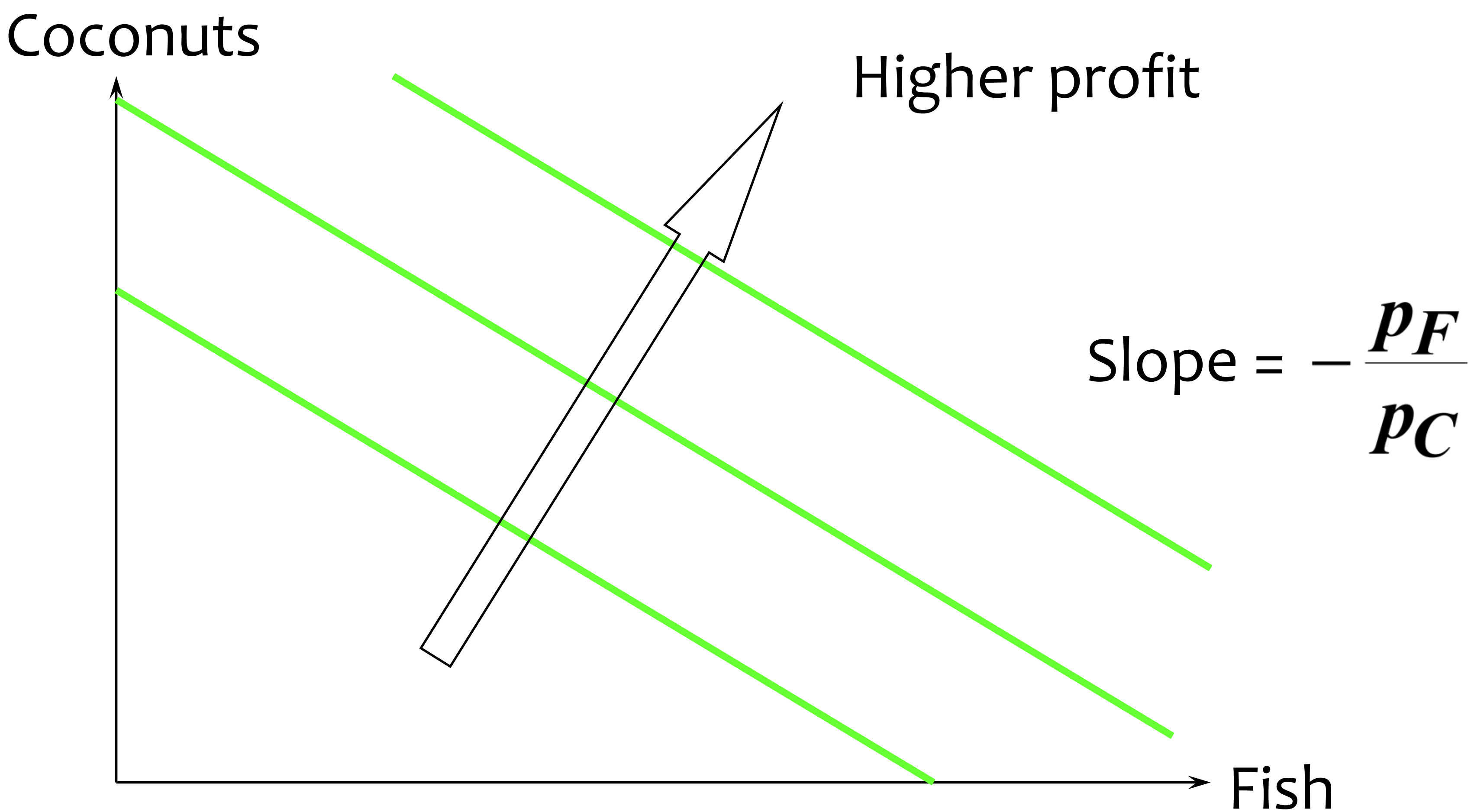
$$\textbf{constant}\ \pi = p_C C + p_F F - w_{RC} L_{RC} - w_{MF} L_{MF}$$

can be rearranged into

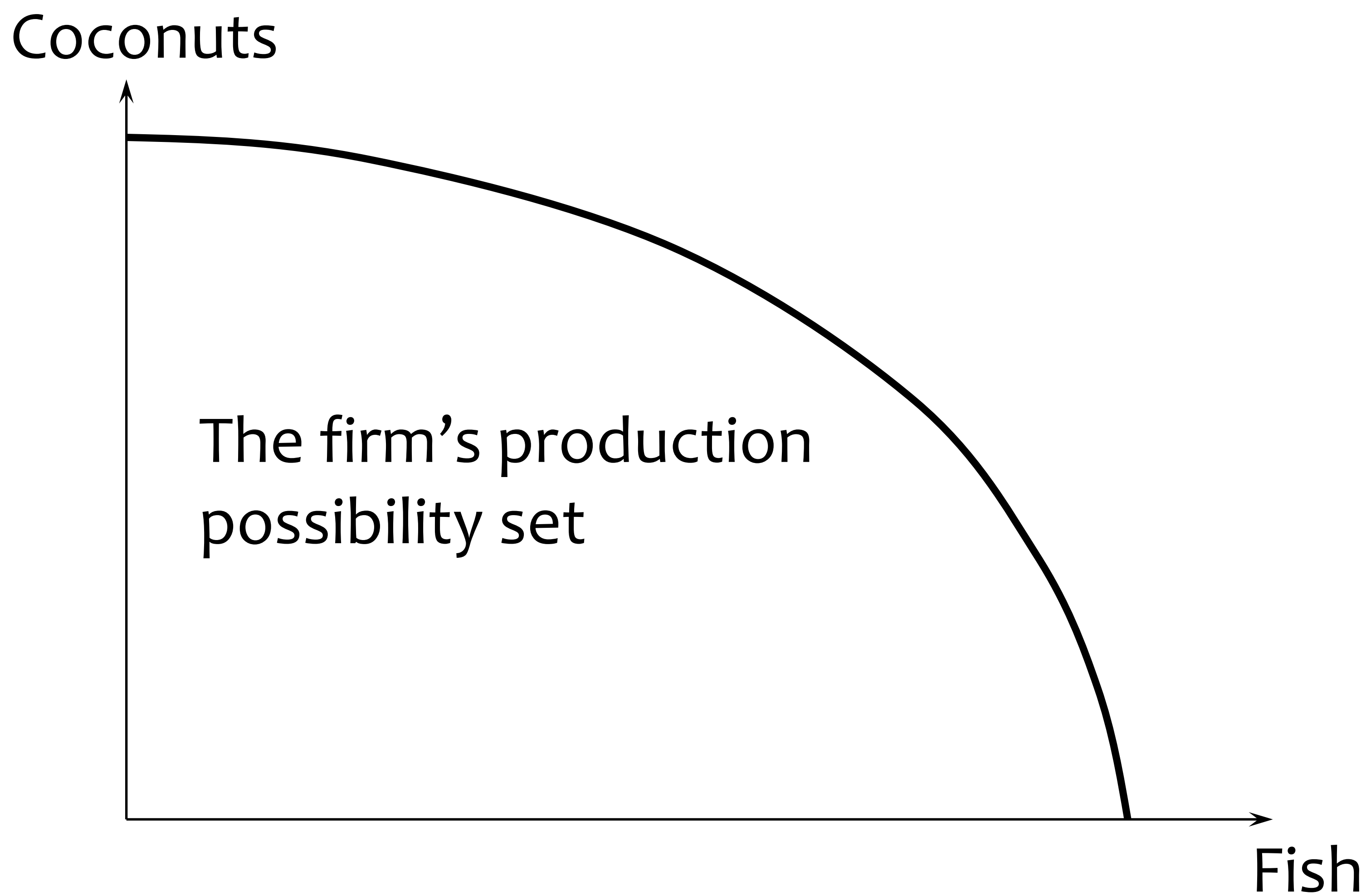
$$C = \underbrace{\frac{\pi + w_{RC} L_{RC} + w_{MF} L_{MF}}{p_C}}_{\text{Intercept}} - \underbrace{\frac{p_F}{p_C}}_{\text{Slope}} F.$$

Isoprofit lines

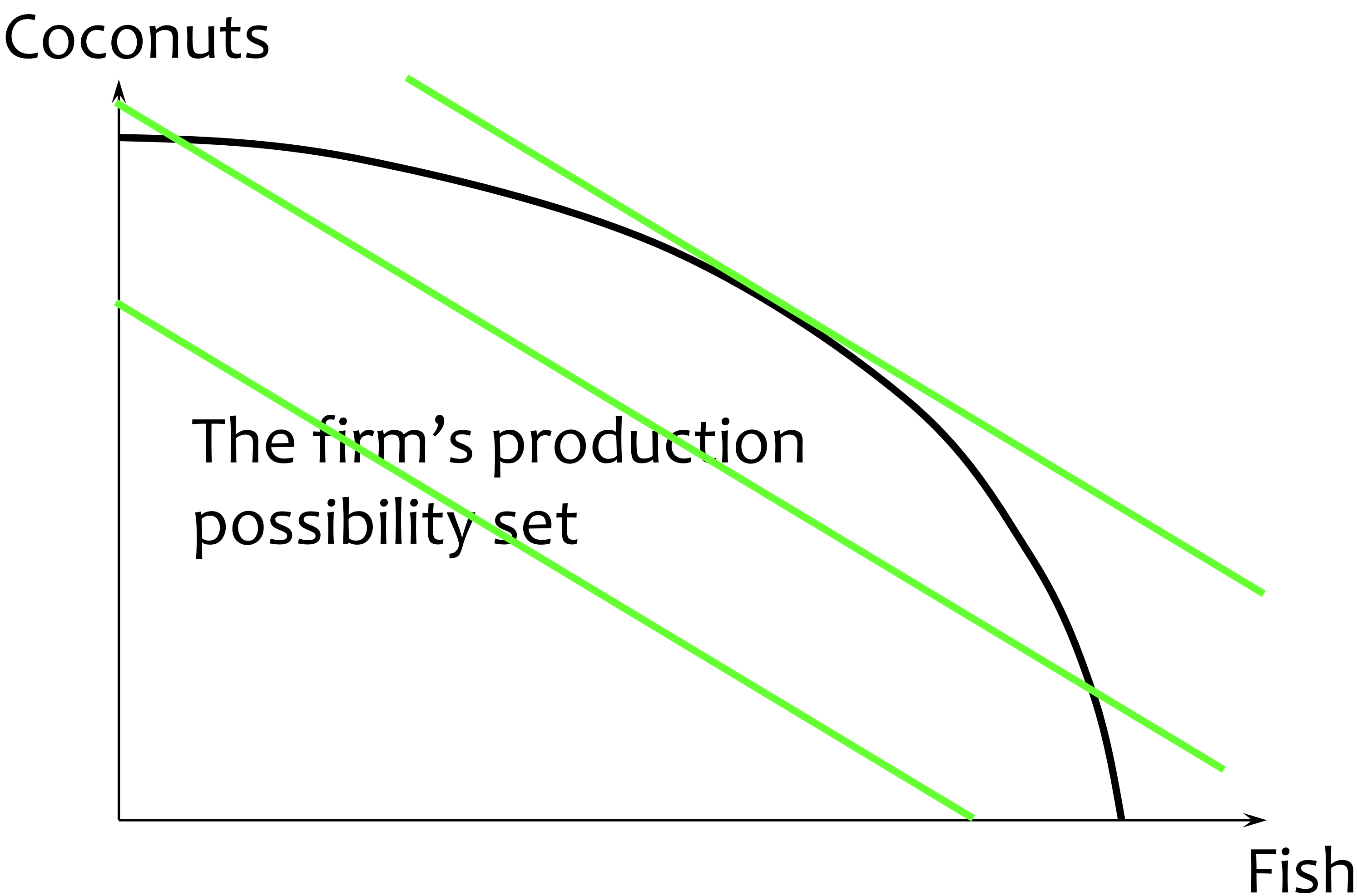
$$C = \frac{\pi + w_{RC} L_{RC} + w_{MF} L_{MF}}{p_C} - \frac{p_F}{p_C} F$$



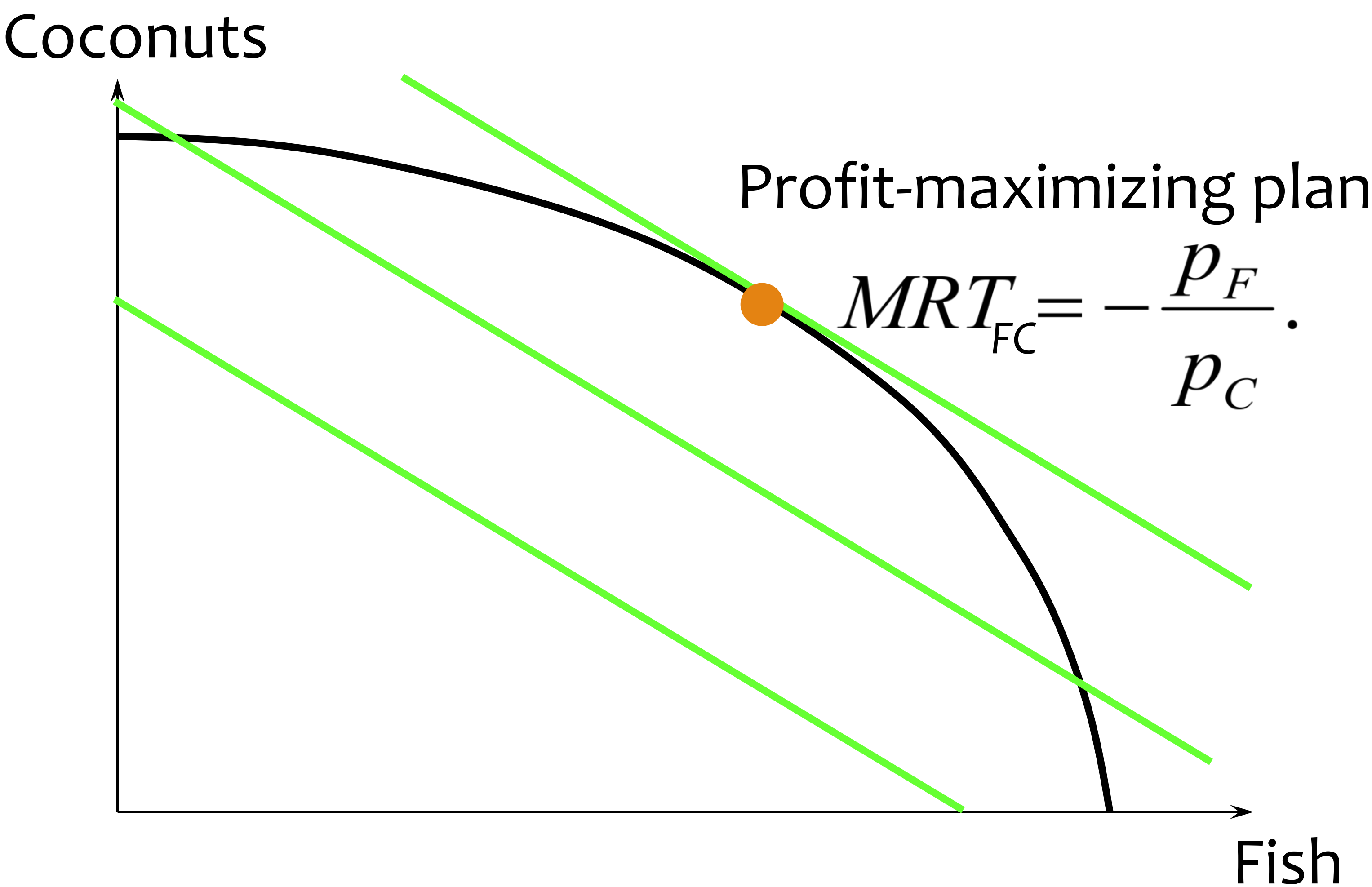
Decentralized coordination of production and consumption



Decentralized coordination of production and consumption



Decentralized coordination of production and consumption



Decentralized coordination of production and consumption

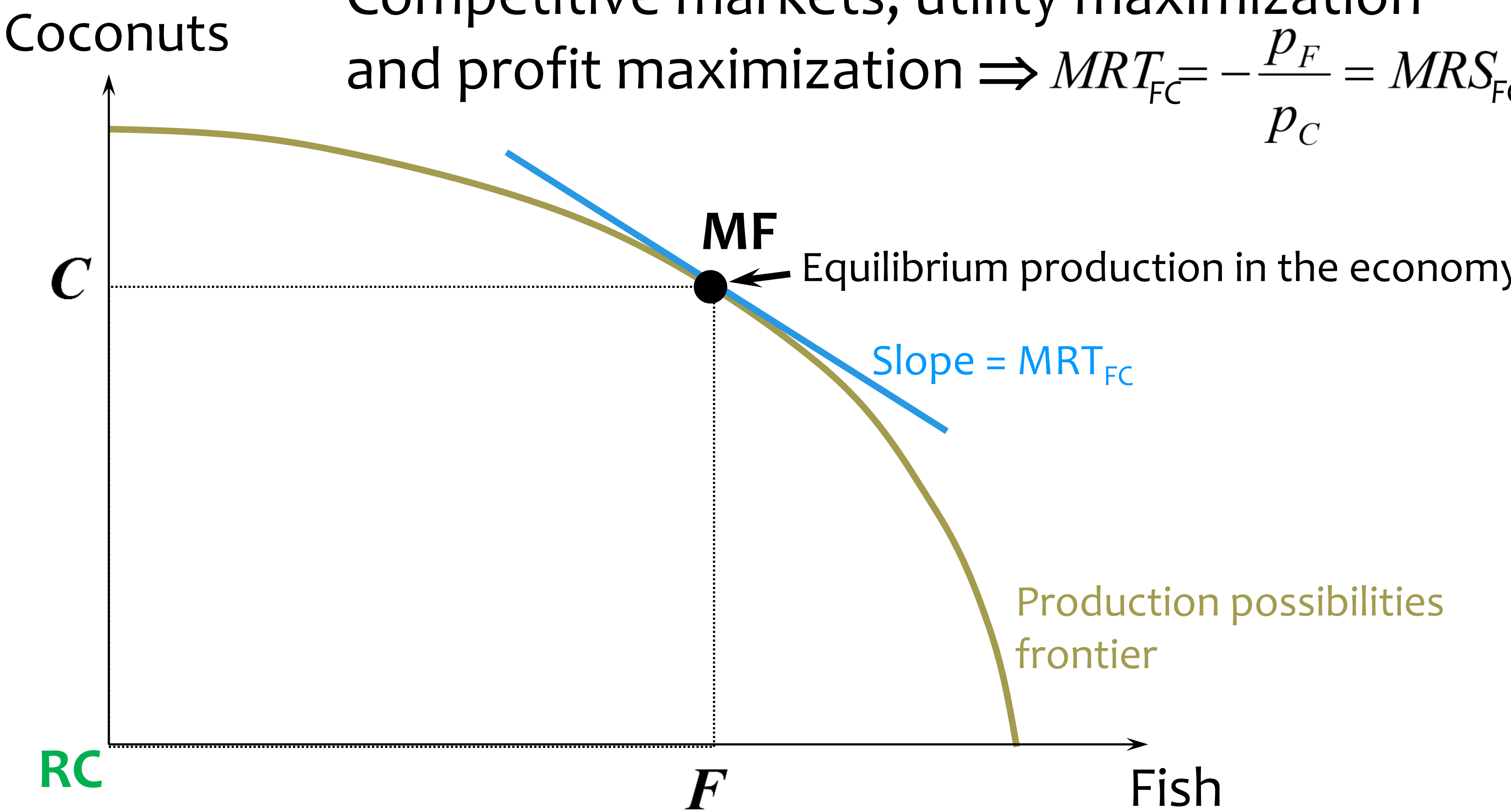
Competitive markets, profit maximization, and utility maximization all together cause

$$MRT_{FC} = -\frac{p_F}{p_C} = MRS_{\hat{F}C}$$

The condition is necessary for a Pareto efficient economic state.

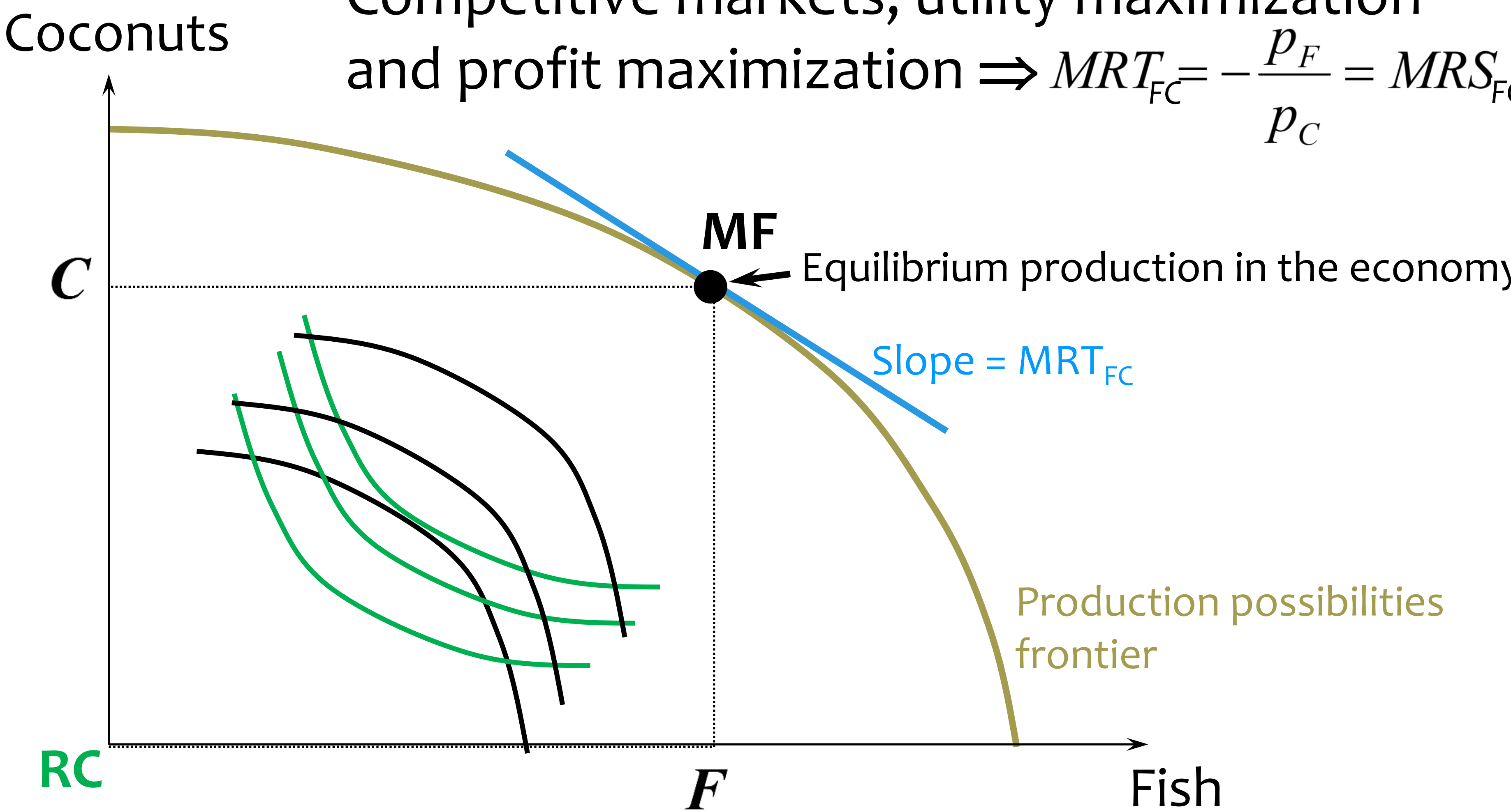
Decentralized coordination of production and consumption

Competitive markets, utility maximization and profit maximization $\Rightarrow MRT_{FC} = -\dfrac{p_F}{p_C} = MRS_{FC}$



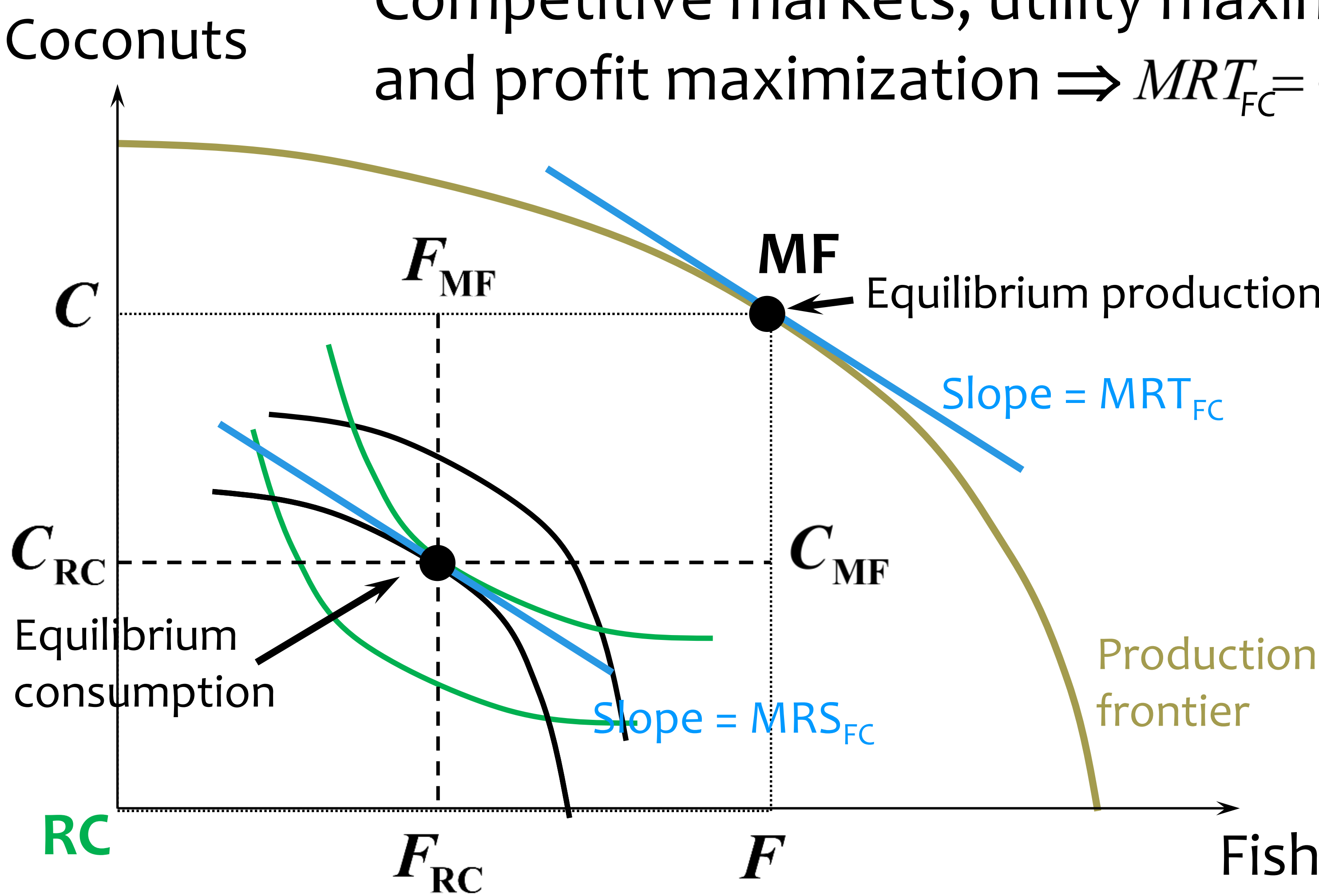
Decentralized coordination of production and consumption

Competitive markets, utility maximization and profit maximization $\Rightarrow MRT_{FC} = -\dfrac{p_F}{p_C} = MRS_{FC}$



Decentralized coordination of production and consumption

Competitive markets, utility maximization and profit maximization $\Rightarrow MRT_{FC} = -\frac{p_F}{p_C} = MRS_{FC}$



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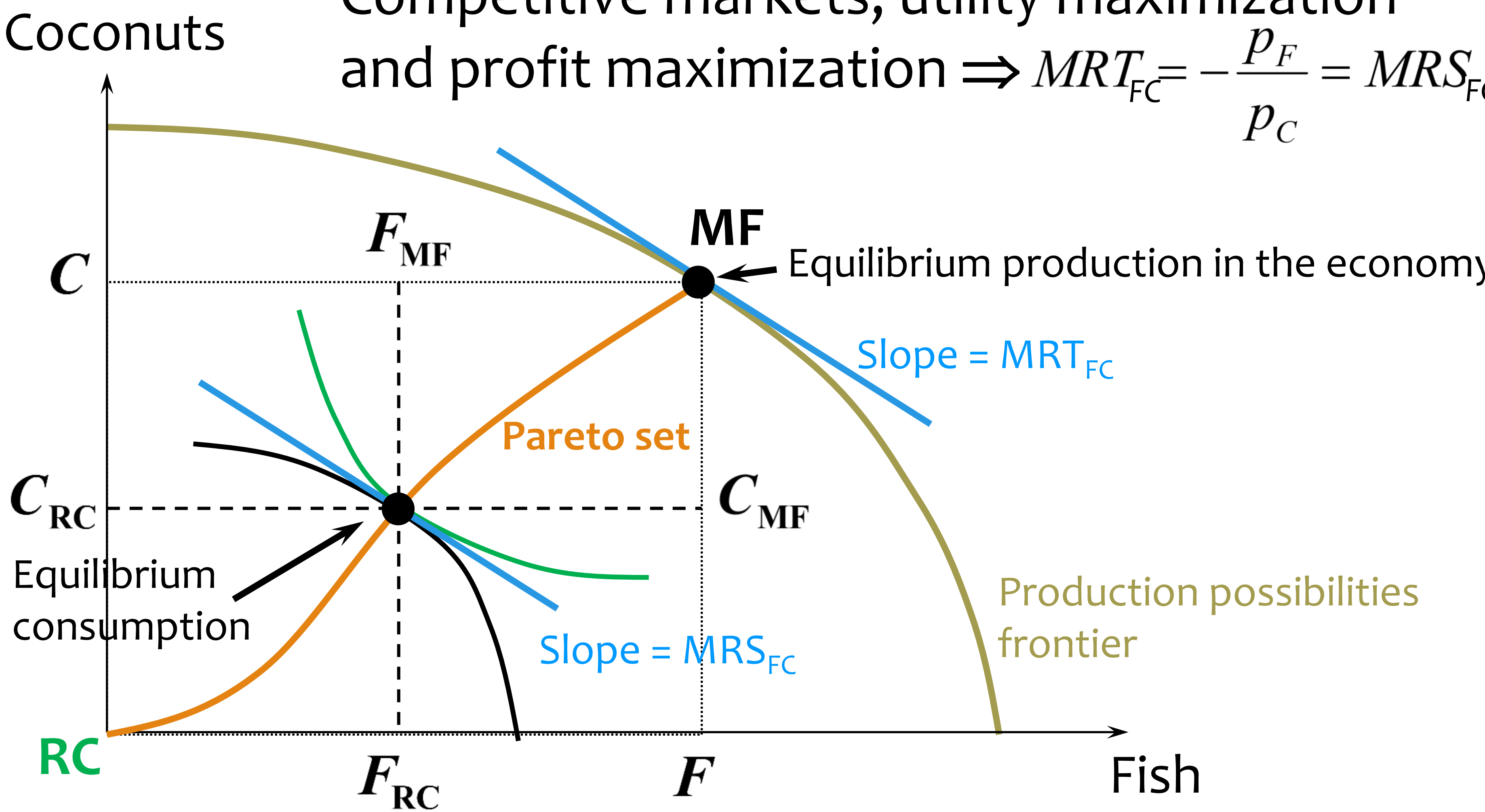

Decentralized resource allocation

- Although very simple, the model provides useful insights, particularly about the relationship between individuals' private goals (utility and profit maximization) and the social goals (efficient use of resources).
- The great virtue of a competitive market is that each individual and each firm only has to worry about its own maximization problem:
  - Each individual solves her own problem of what to consume.
  - Firms face the prices of the goods and decide how much to produce.
- If all firms pursue a competitive profit-maximizing policy and all consumers choose consumption bundles to maximize their own utility, then the resulting competitive equilibrium must be a Pareto efficient allocation.
- The virtue of competitive markets is that they provide a way to achieve an efficient allocation of resources by decentralizing production and consumption decisions.