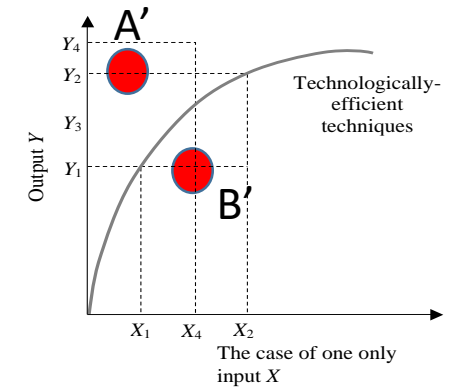
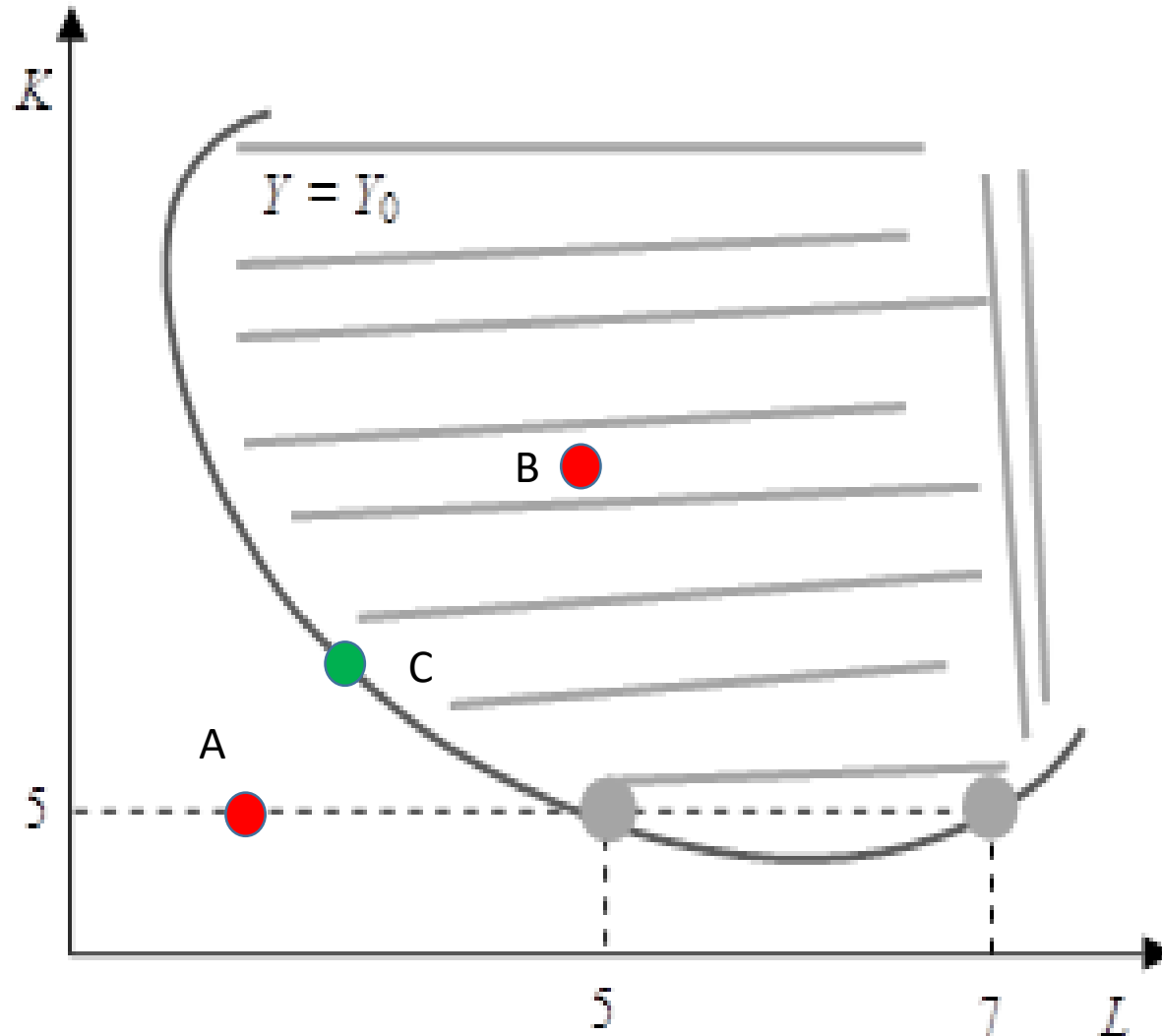




# An Isoquant: an output efficient locus



B': why produce  $Y_1$  with so much input?

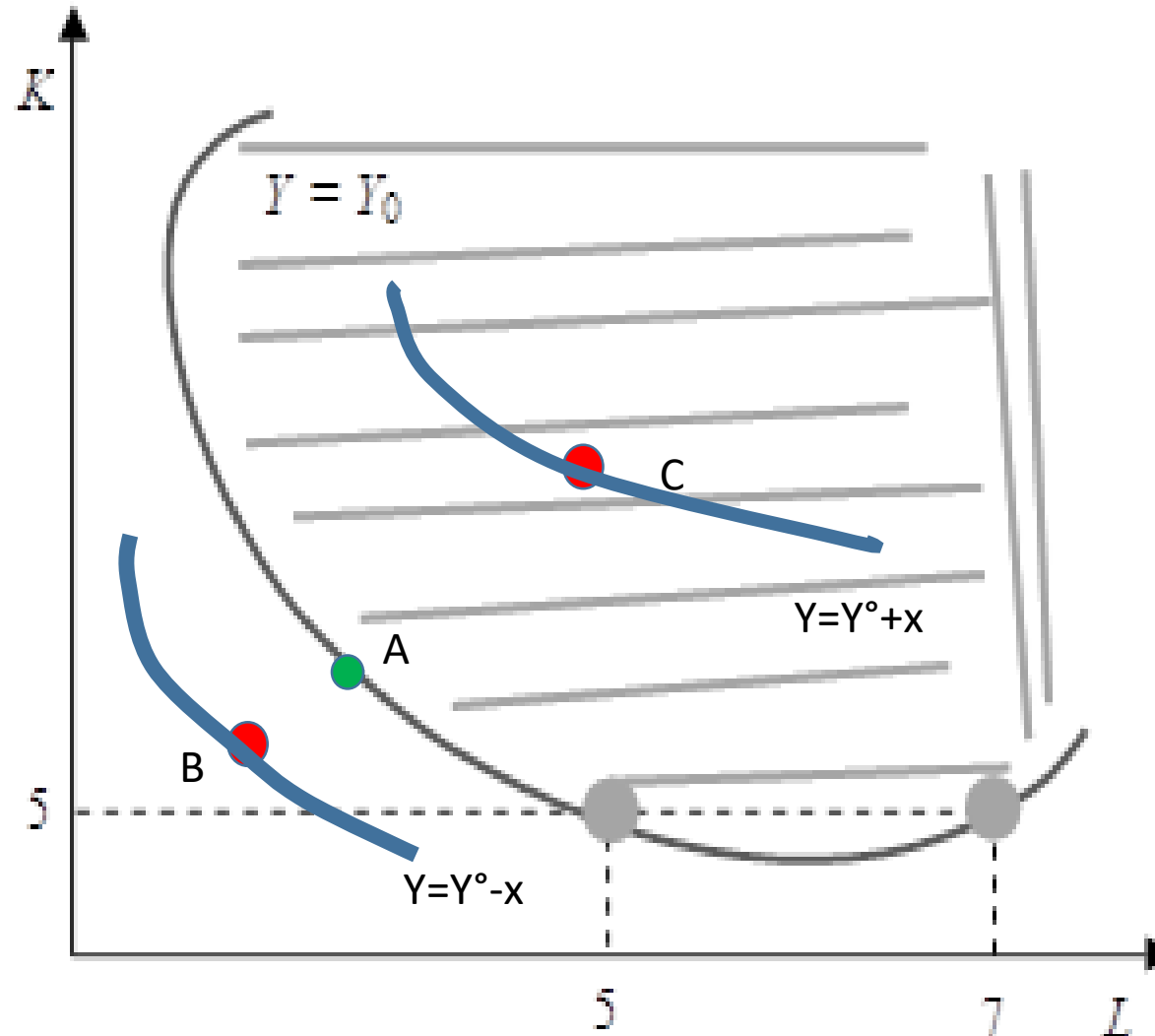
A': can't produce  $Y_2$  with that input.



## PS: a further clarification

B: technologically possible  
(for  $Y=Y^0-x$ )

C: output and  
technologically efficient  
(for  $Y=Y^0+x$ )

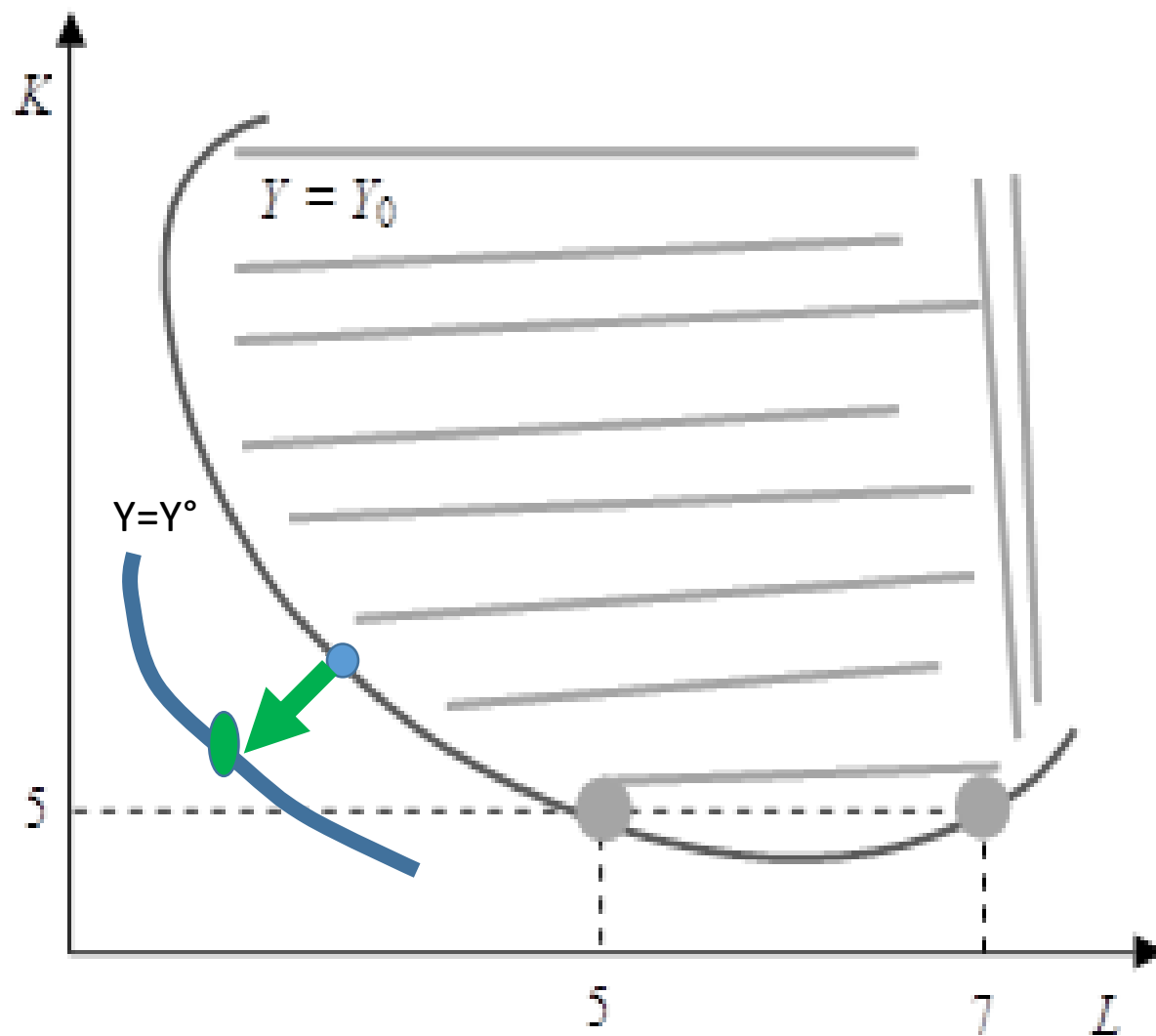


A: output efficient (and  
technologically efficient)  
for  $Y=Y^0$

B: technologically  
impossible (for  $Y=Y^0$ )

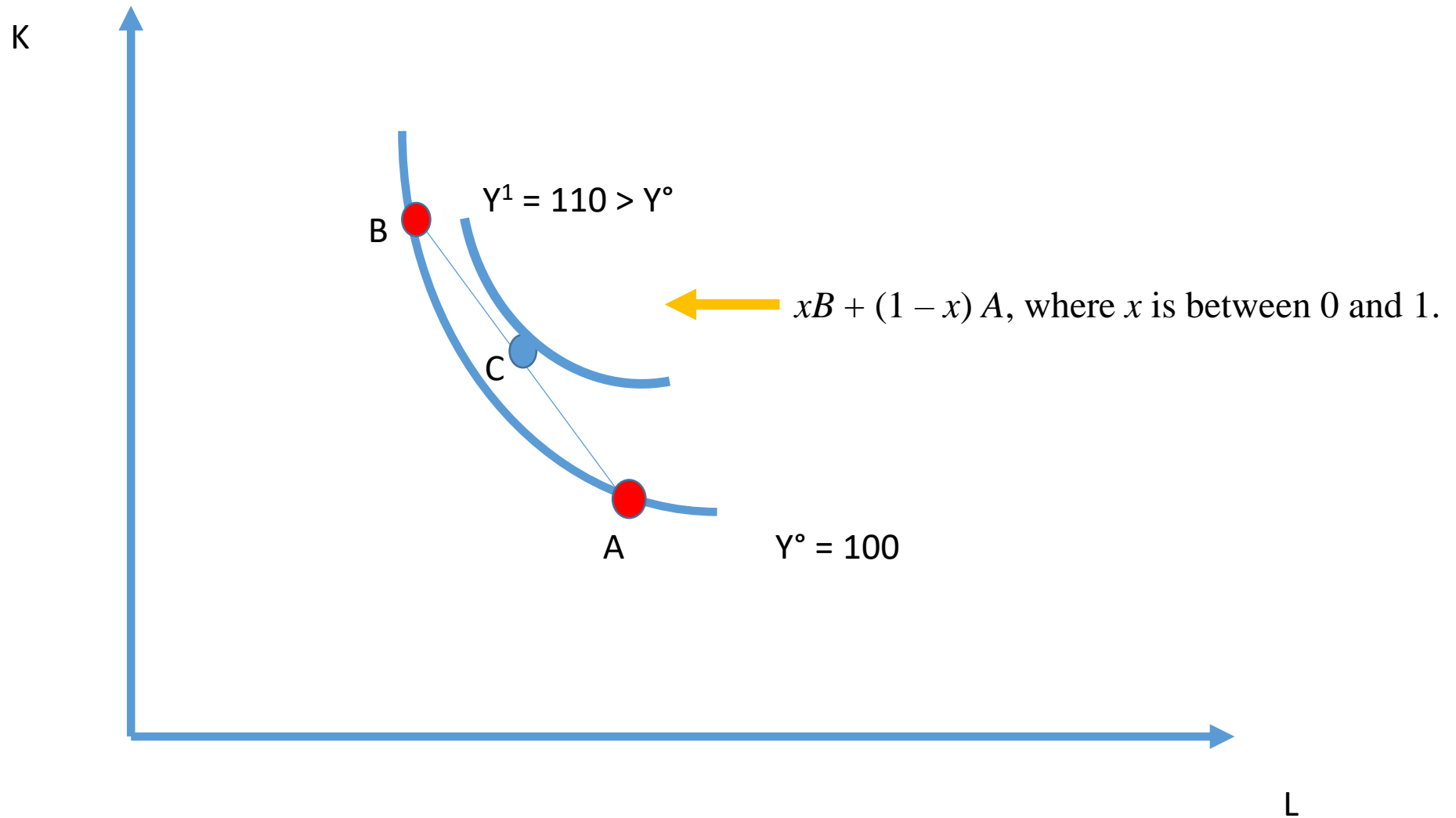
C: output and  
technologically inefficient  
(for  $Y=Y^0$ )

## PS: technological progress





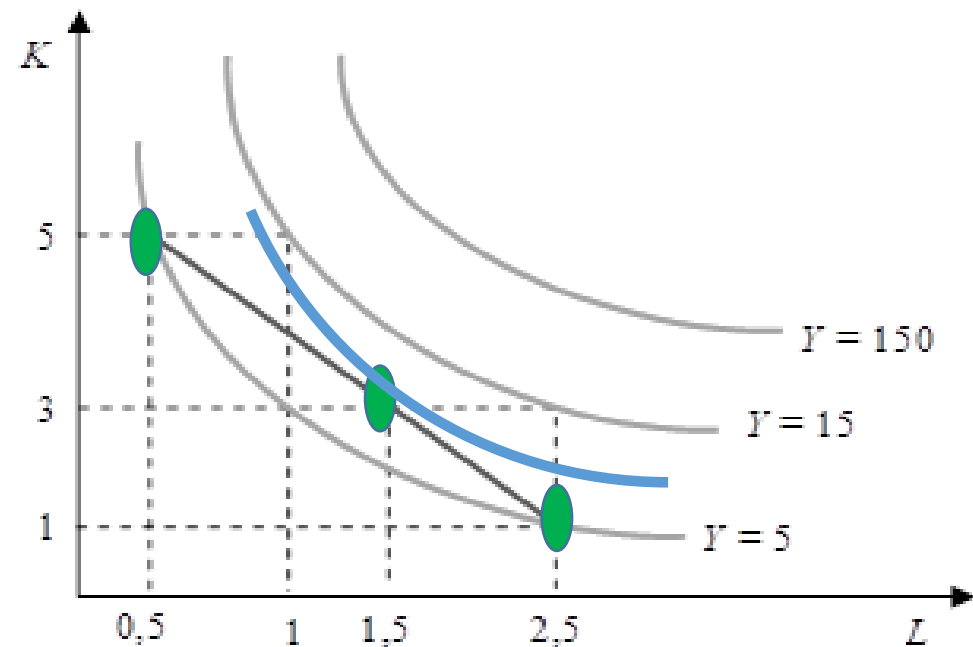
# Convex Isoquants





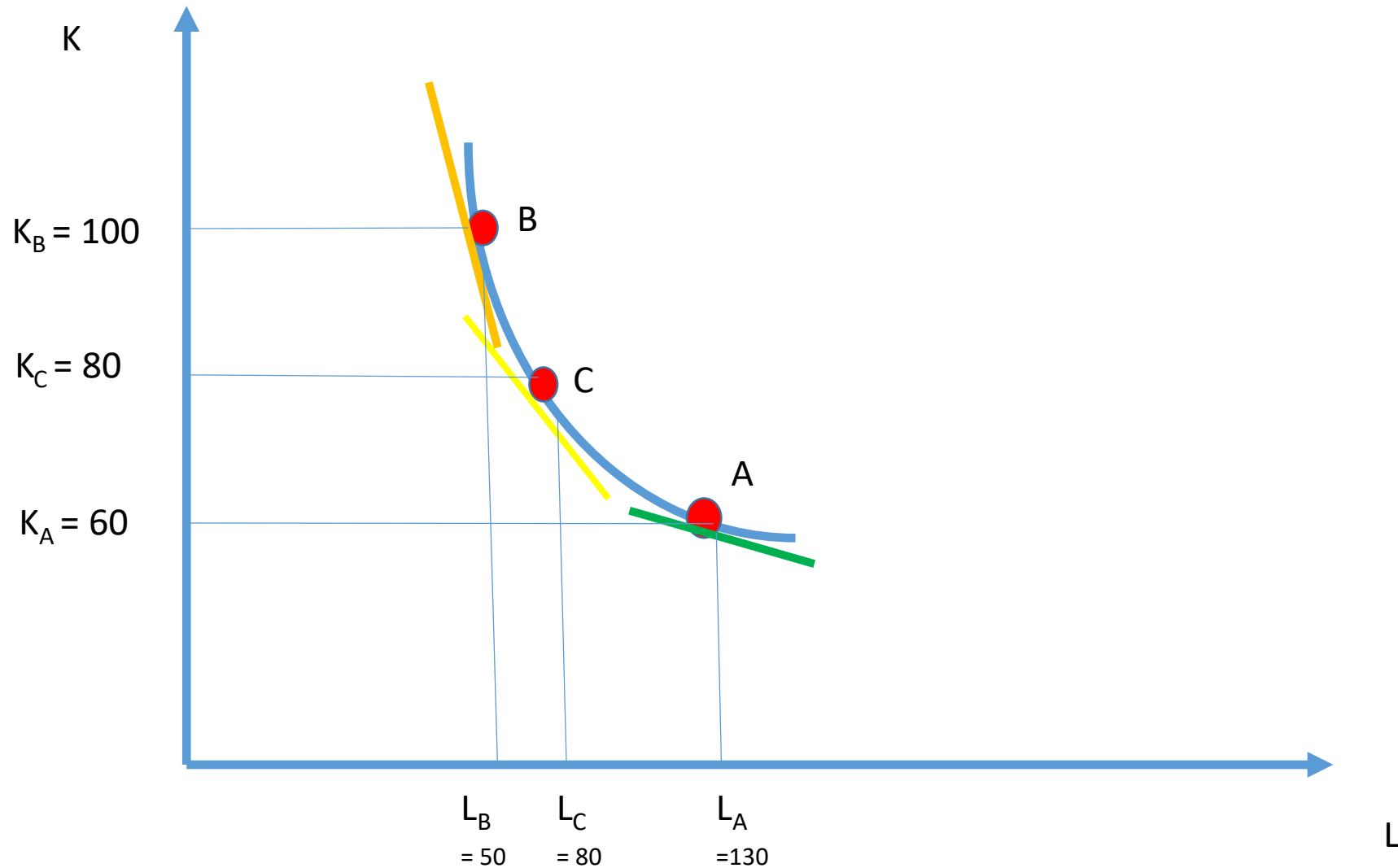
## Convex?

While we can use the productive techniques  $(0,5; 5)$  and  $(2,5; 1)$  to produce efficiently 5 units of shirts, if we were to **combine** those two techniques, e.g. using half of the first  $(0,25$  of  $L$  and  $2,5$  of  $K$ ) and half of the second  $(1,25$  of  $L$  and  $0,5$  of  $K$ ) and so using  $(1,5$  of  $L$  and  $3$  of  $K$ ) we would obtain **greater** quantities of output.





# Convex curves: the slope declines as L grows





## The isoquant's slope?

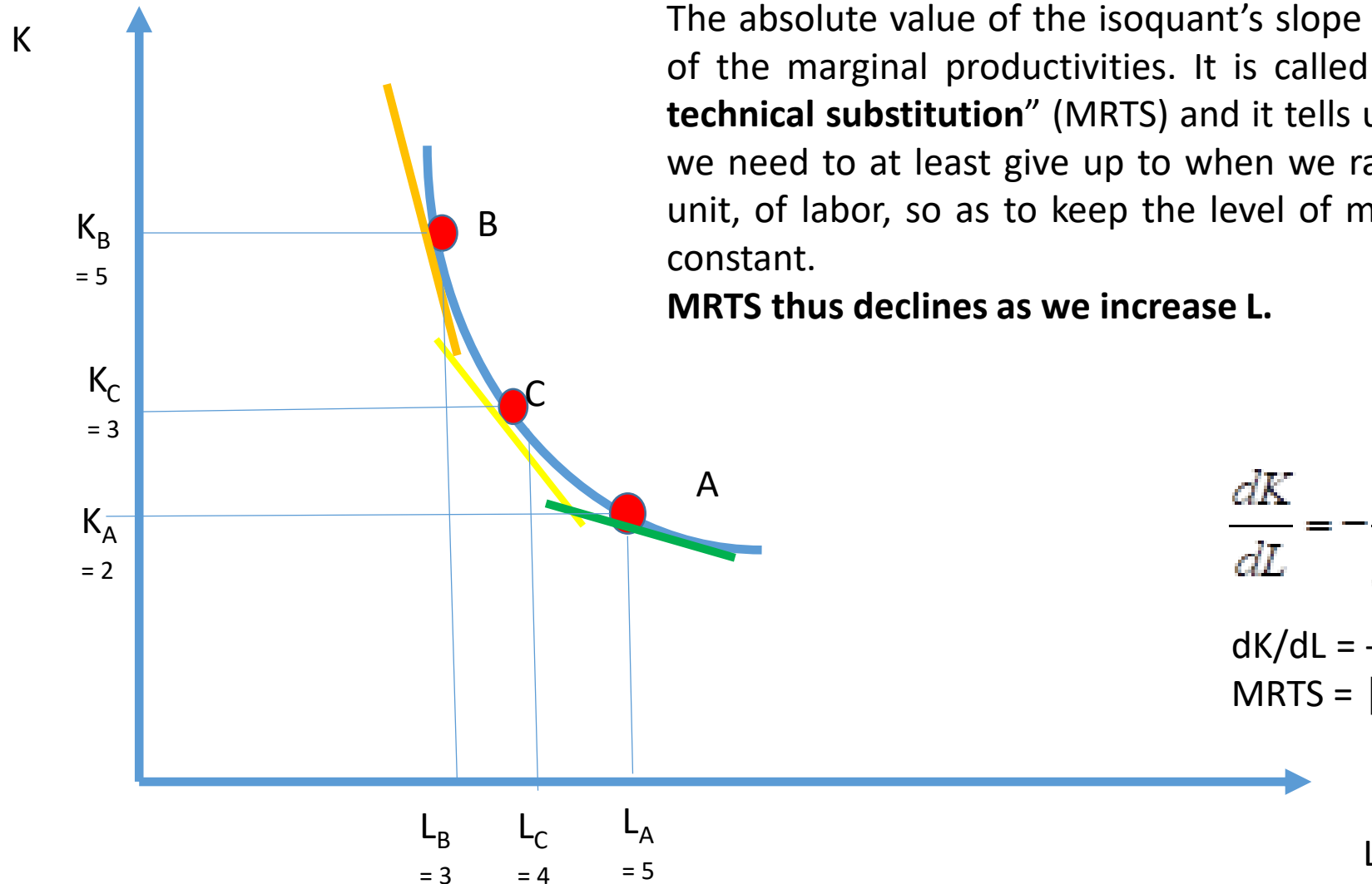
$$dY = 0 = dK \times \frac{\partial Y}{\partial K} + dL \times \frac{\partial Y}{\partial L} = f^K dK + f^L dL$$

$$\frac{dK}{dL} = - \frac{f^L}{f^K} = - \frac{P_{maL}}{P_{maK}}$$

Negative or positive slope?



## Convex curves: slope declining as L grows



The absolute value of the isoquant's slope is given by the ratio of the marginal productivities. It is called "**marginal rate of technical substitution**" (MRTS) and it tells us how much capital we need to at least give up to when we raise the use, by one unit, of labor, so as to keep the level of maximum production constant.

**MRTS thus declines as we increase L.**

$$\frac{dK}{dL} = -\frac{f^L}{f^K} = -\frac{P_{mL}}{P_{mK}}$$

$$dK/dL = - \text{MRTS}$$

$$\text{MRTS} = |dK/dL|$$

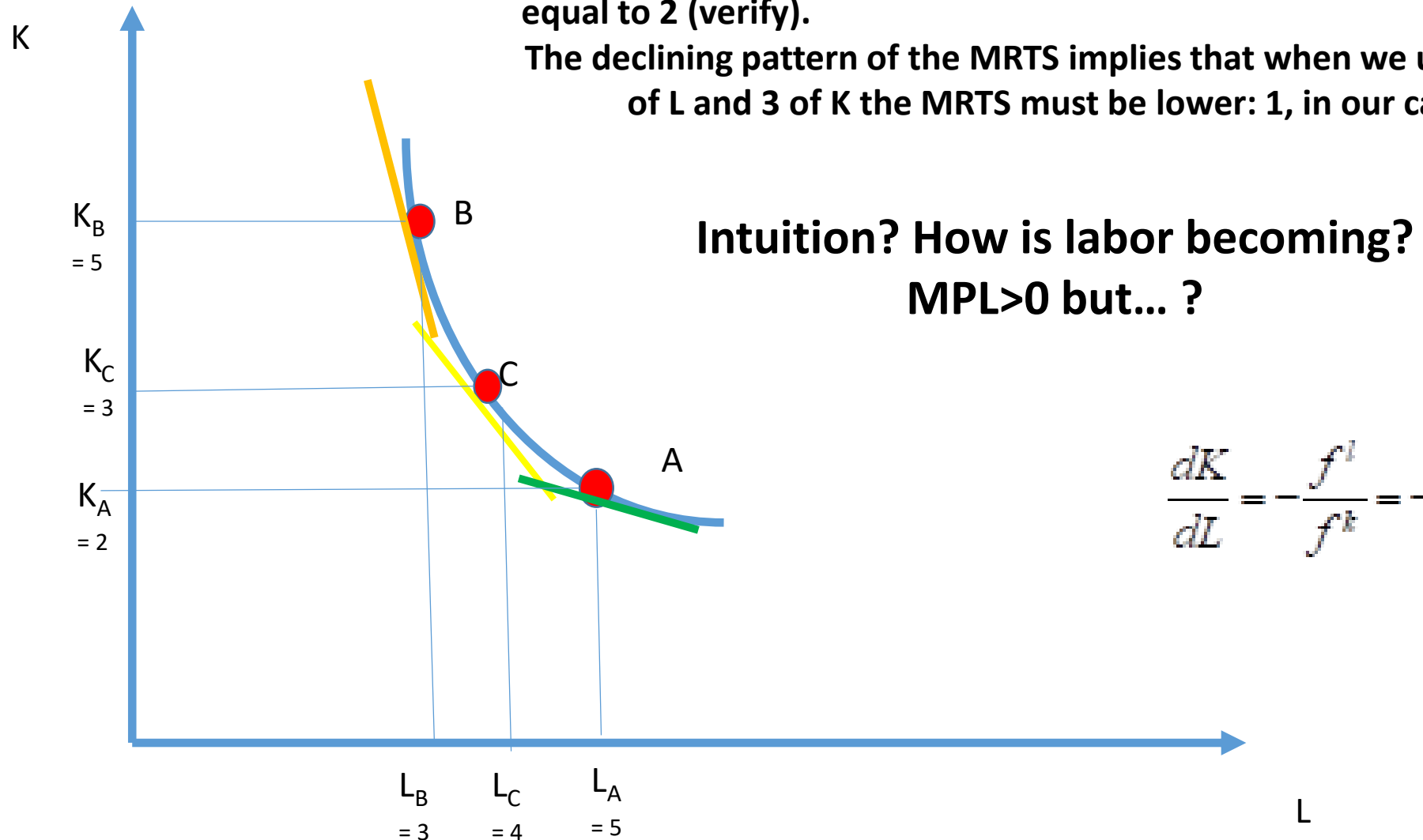




# Convex curves: slope declining as L grows

Example. When we use 3 units of L and 5 units of K the MRTS is equal to 2 (verify).

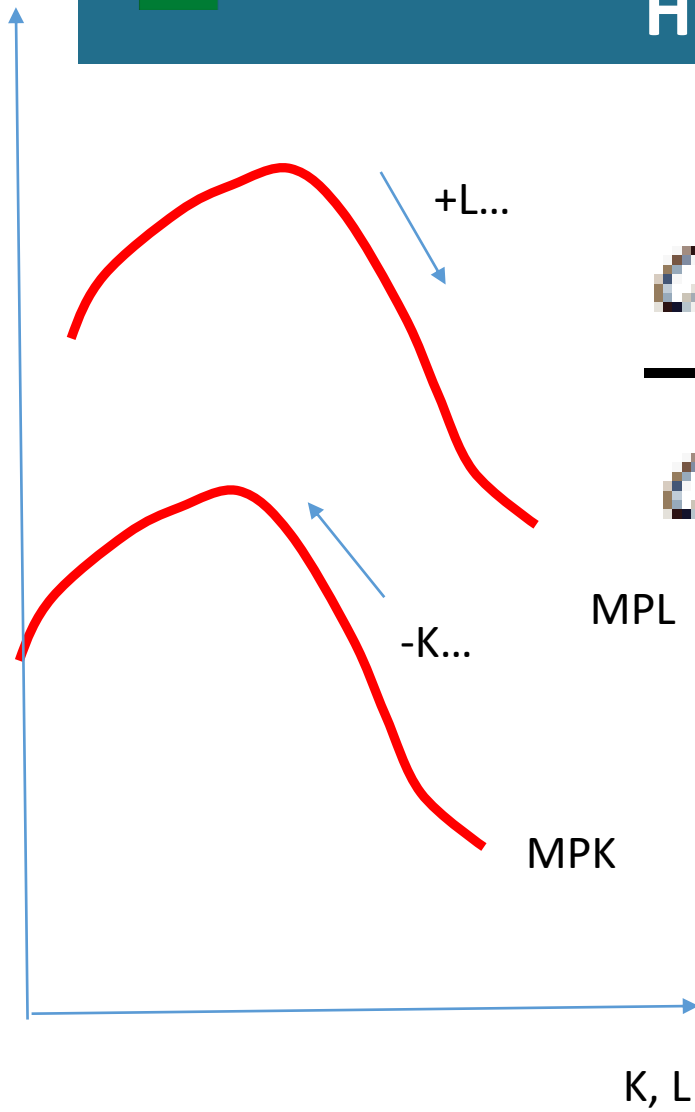
The declining pattern of the MRTS implies that when we use 4 units of L and 3 of K the MRTS must be lower: 1, in our case.



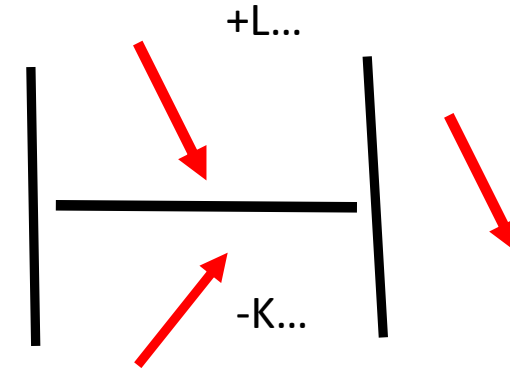
$$\frac{dK}{dL} = -\frac{f^L}{f^K} = -\frac{P_{mL}L}{P_{mK}K}$$



# How is the MRTS if both MP were both decreasing?



$$\frac{dK}{dL} = - \frac{f^L}{f^K} = - \frac{P_{mL}}{P_{mK}}$$



Example. When we use 3 units of L and 5 units of K.

MPL (3) = 12 and MPK (5) = 6

MRTS = 12/6 = 2

+ 1 L – 2K: now you use 4 L and 3 K.

If MPL and MPK are decreasing

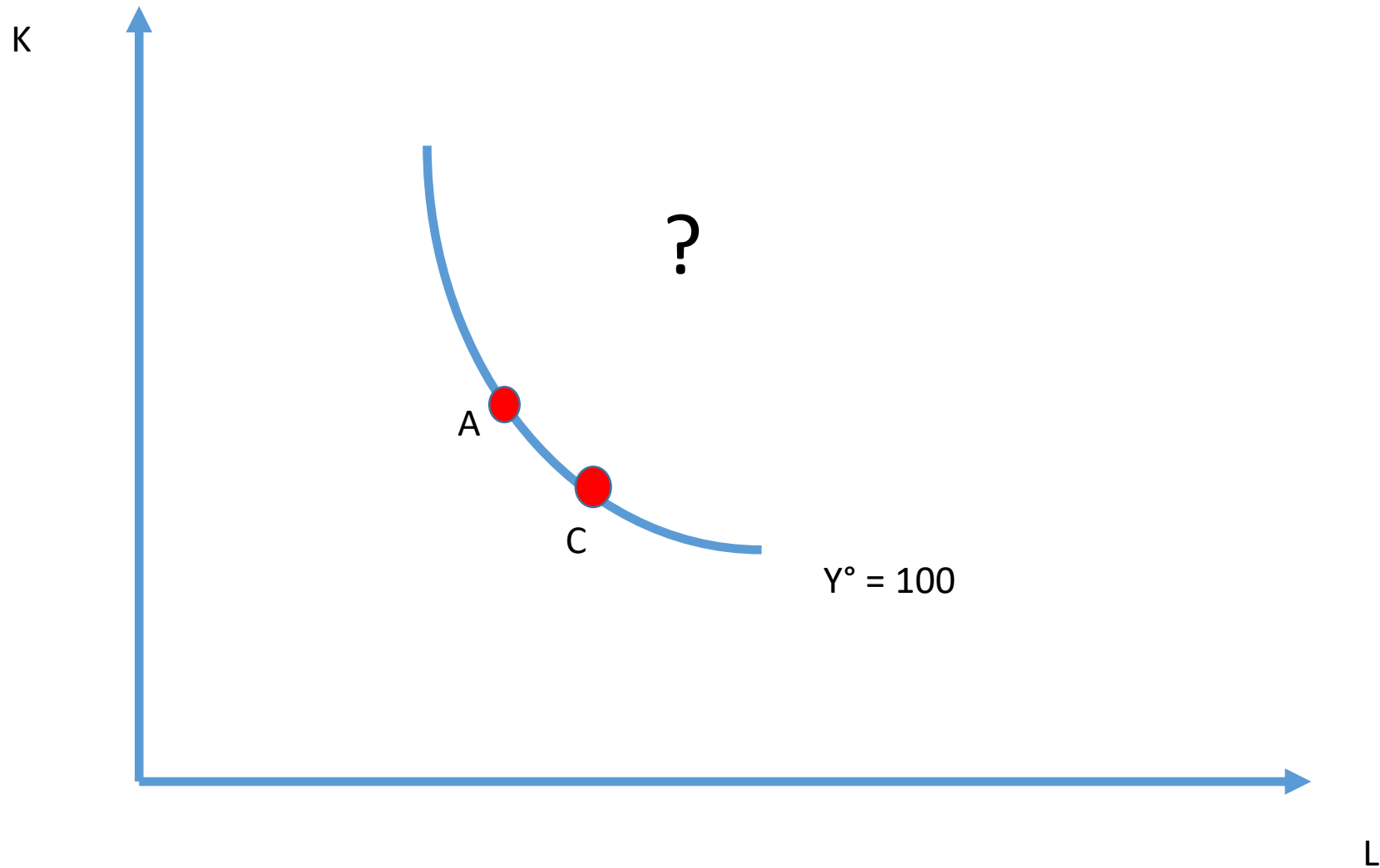
MPL (4) = 9 and MPK (3) = 9

MRTS = 9/9 = 1

When we use 3 units of L and 5 units of K the MRTS is equal to 2. The decreasing pattern of the MRTS with respect to L implies that when we use (more) 4 units of L and 3 of K the MRTS must be lower: 1, in our case.



# How to produce 100?



# The economic dimension of production

€





## Fixed and variable costs

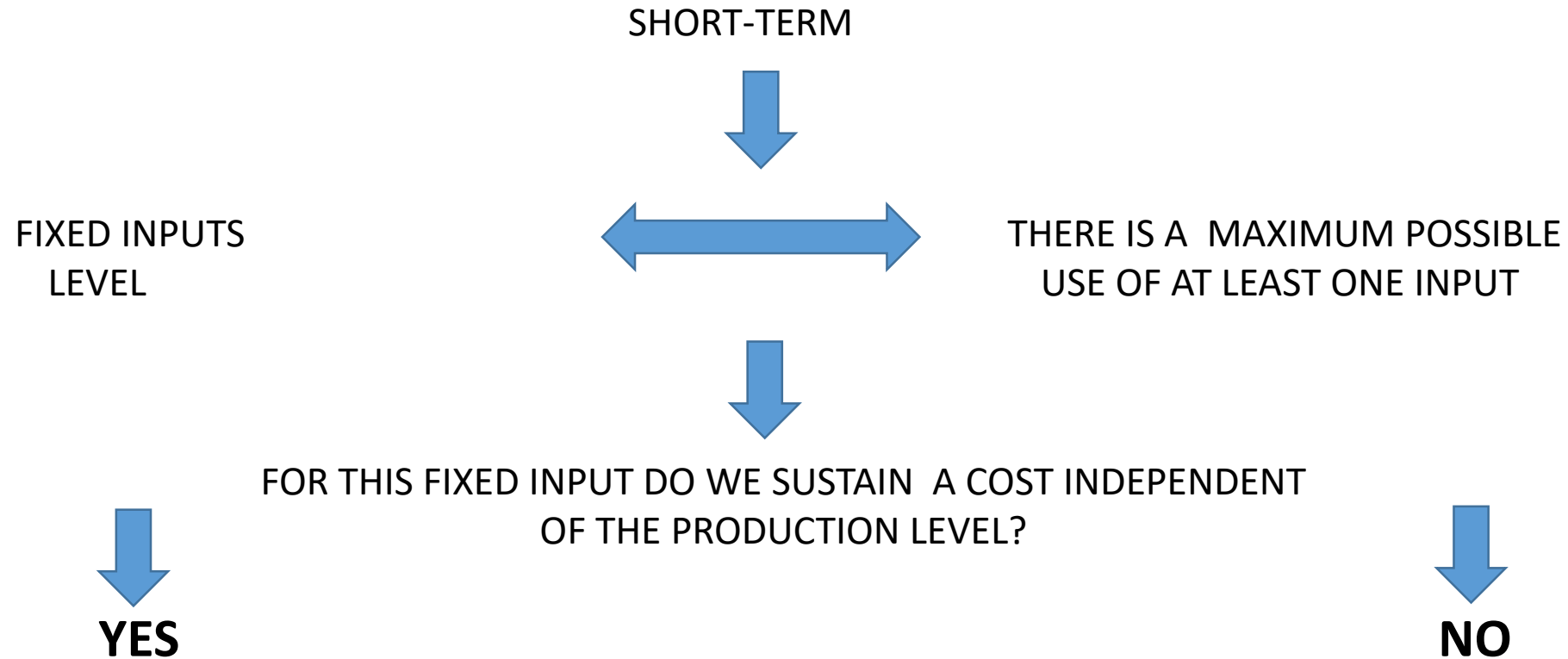
$$TC(Q) = FC + VC(Q)$$

$$TC^{\min}(Q) = FC + VC^{\min}(Q)$$

FC? What are they?



# Short-term horizon



# Short Term = Fixed input Costs - Examples

A) WAREHOUSE OF A GIVEN AREA IN SQUARE METERS, PAYING RENT

B) CLEANING SQUAD FOR AT MOST X HOURS, PAYING CLEANING FEES

2 FIXED INPUTS, WITH A MAXIMUM AMOUNT TO BE USED (SQ. MT., HRS.)

## LET'S READ THE CONTRACT

A) CAN'T CHANGE THE RENTED AREA OF THE WAREHOUSE ACCORDING TO USE (NOR SUBLET IT): FIRM NEEDS TO PAY FOR THE MAXIMUM AREA EVEN IF NOT USED.

B) CAN'T CHANGE THE QUANTITY OF CLEANING SERVICES ACCORDING TO USE (IF ONE CLEANS LESS AREA, THE SAME AMOUNT OF HOURS, THE MAXIMUM, IS PAID)

## WE HAVE A FIXED OR SUNK COST

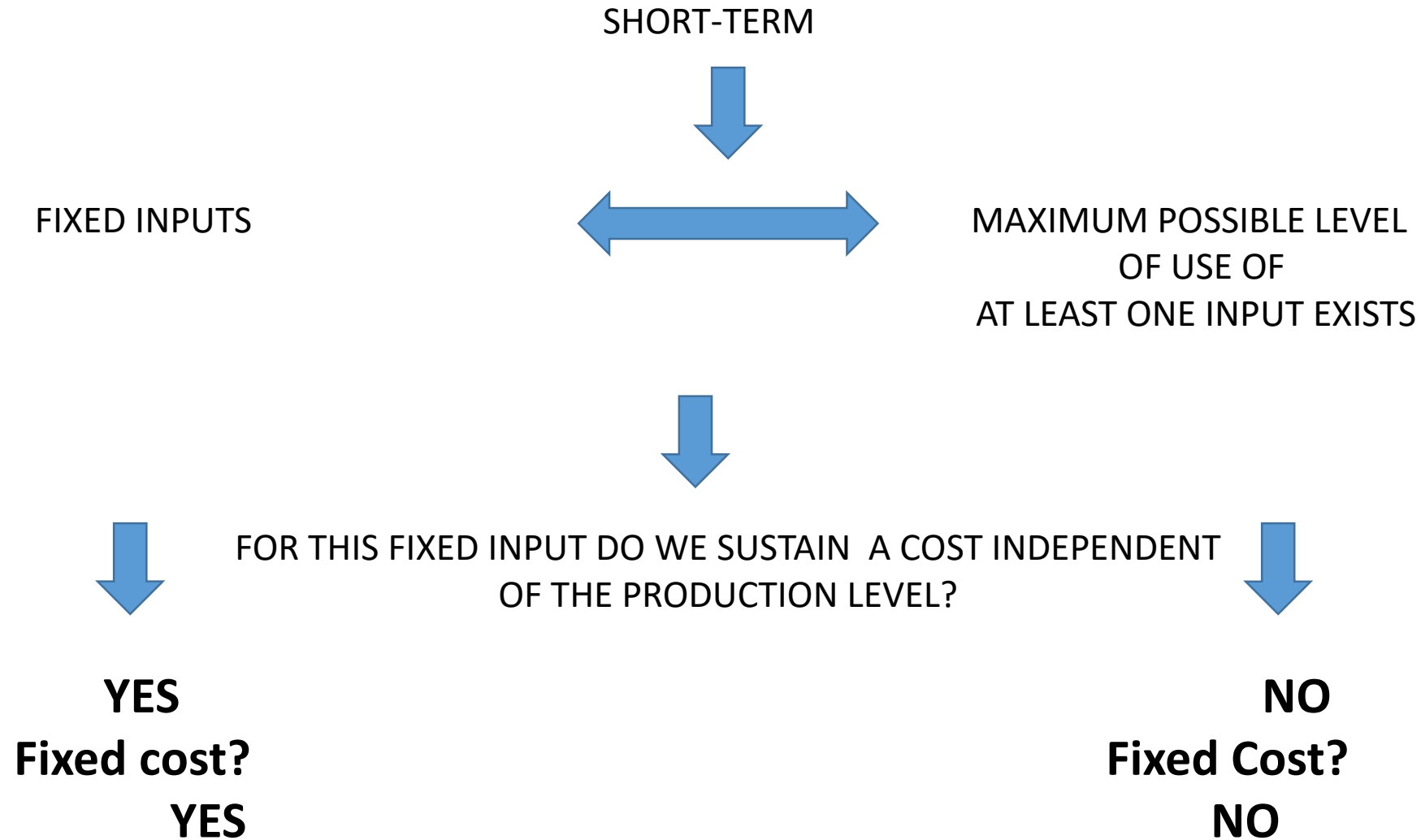
A') FIRM CAN SUBLET THE WAREHOUSE UNUSED

B') FIRM CAN PAY FOR HOURS USED WITHIN THE MAXIMUM AMOUNT

## WE HAVE A VARIABLE COST



# Short-term horizon

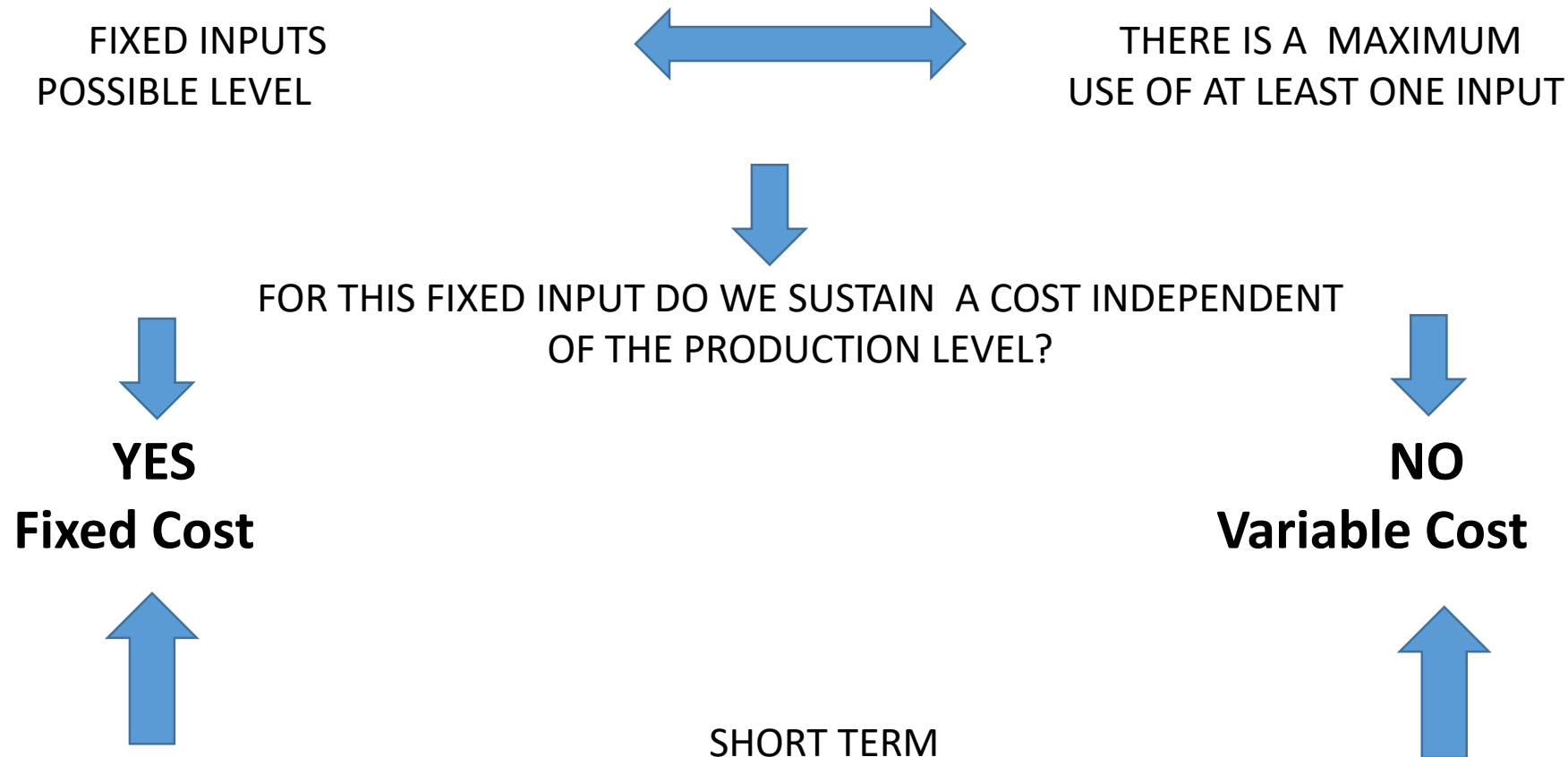




# Short- AND Long-term horizon

LONG TERM = all factors can be varied, no fixed cost

Today, an entrepreneur thinks also about the long-term





# THE LONG TERM PERIOD



**Given** the unitary costs of the 2 factors ( $w^\circ$ ,  $r^\circ$ ) (since the firm is price-taker) cost is equal to?

$$(w^\circ L + r^\circ K)$$

We will call **isocost curve** the locus of technical productive combinations of inputs **labor-capital** all sharing **the same** total cost.

So:

$$TC^0 = w^\circ L + r^\circ K$$

represents the locus of L-K combinations with the same total cost  $TC^0$ . We can rewrite such combinations as pertaining to the line:

Slope?  
Why decreasing?

$$K = \frac{TC^0}{r^\circ} - \left( \frac{w^\circ}{r^\circ} \right) \times L$$



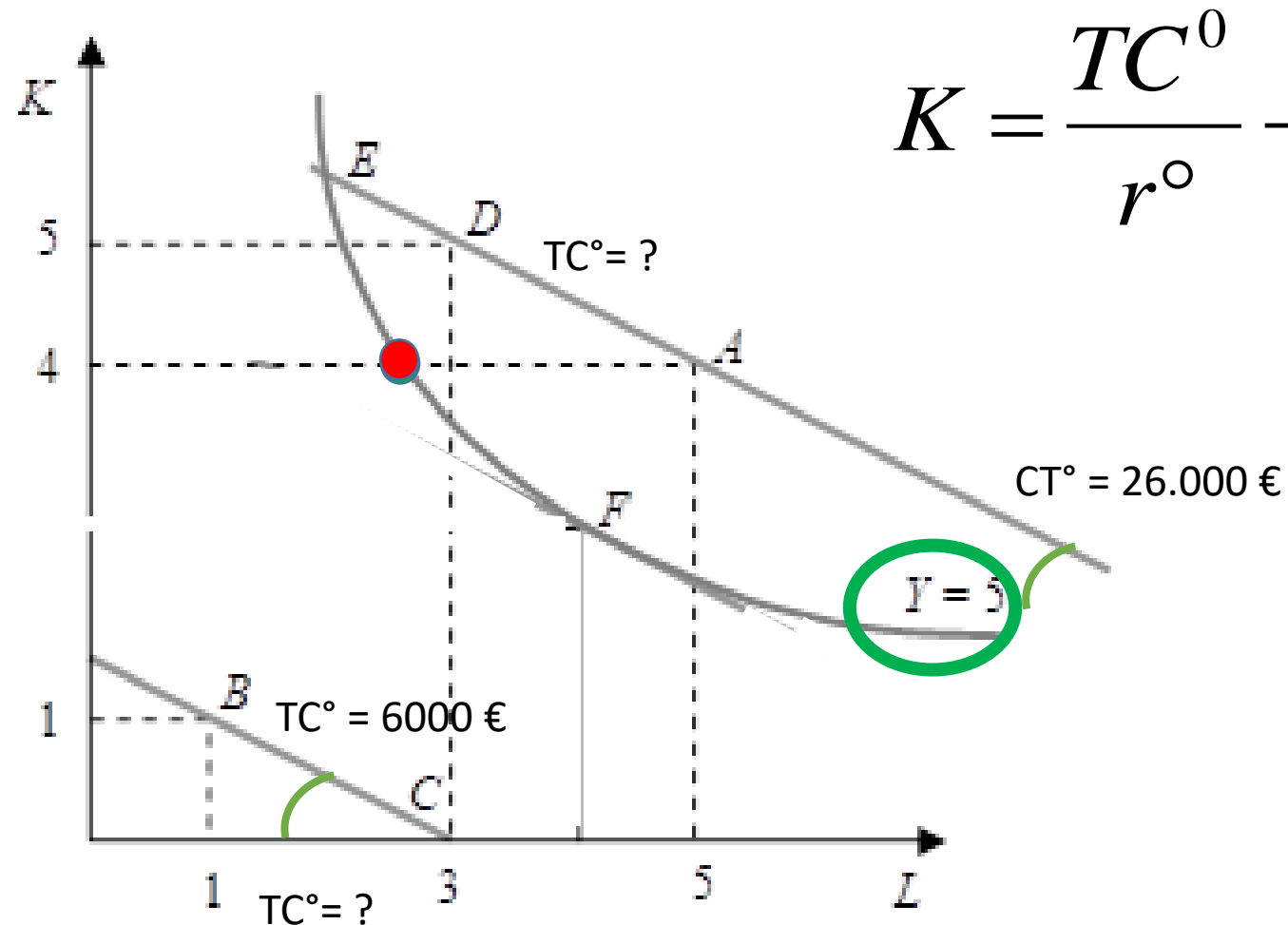
# An isocost

$$w^{\circ} = 2000 \text{ €}$$

$$r^{\circ} = 4000 \text{ €}$$

Iso-cost curves  
moving north-  
east are ....?

To produce  $Y^{\circ}$  will  
you choose B?  
D? or E? Or ● ?



$$K = \frac{TC^0}{r^0} - \left( \frac{w^0}{r^0} \right) \times L$$

Isocost slope =  
 $-w^{\circ}/r^{\circ}$



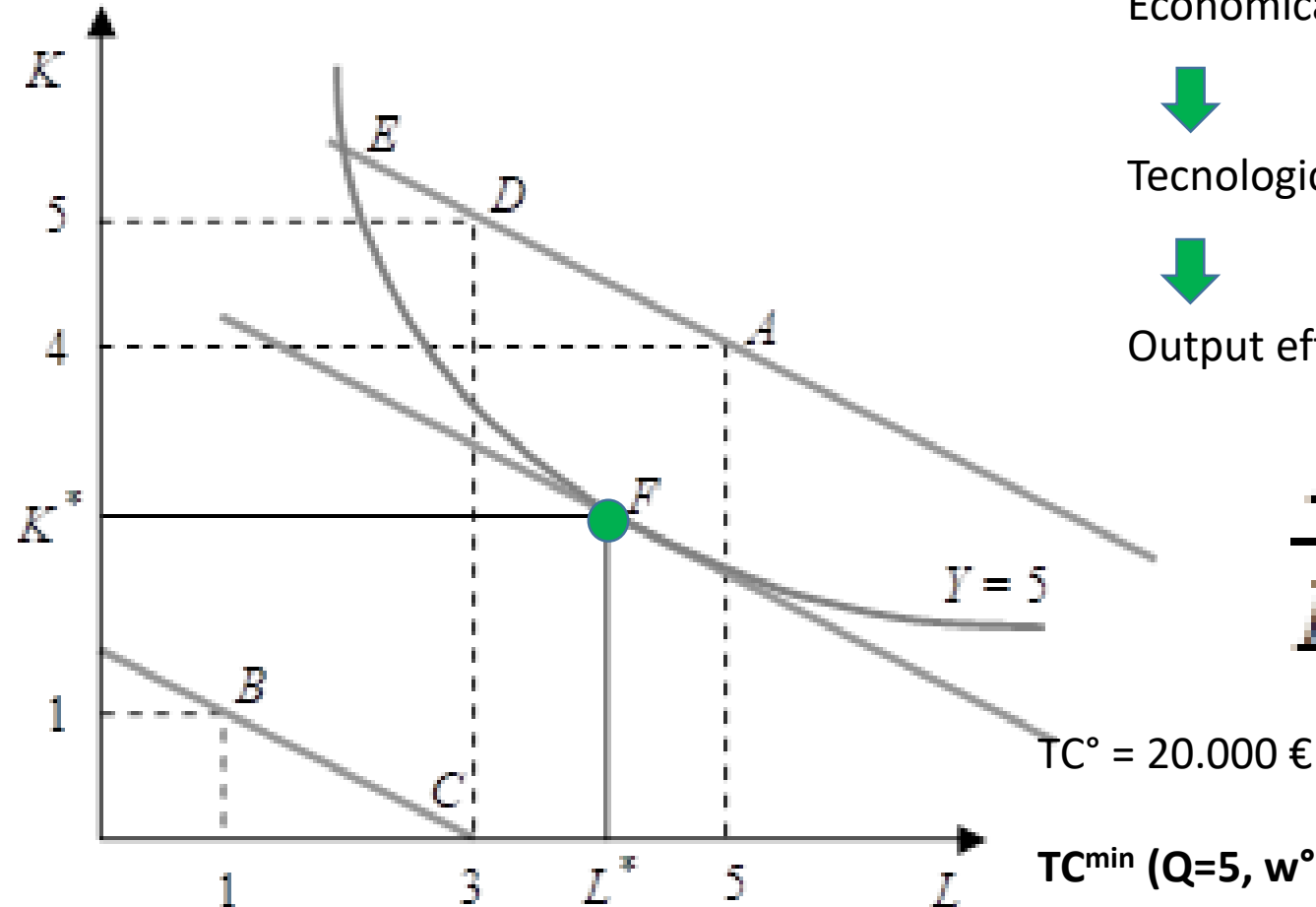
# The economically efficient technique

$$w^{\circ} = 2000 \text{ €}$$

$$r^{\circ} = 4000 \text{ €}$$

$$L^* = 4$$

$$K^* = 3$$



Economically efficient



Tecnologically efficient



Output efficient

$$\frac{P_{maL}}{P_{maK}} = \frac{w}{r}$$

$$TC^{\circ} = 20.000 \text{ €}$$

$$TC^{\min} (Q=5, w^{\circ}=2000, r^{\circ}=4000) = 20.000 \text{ €}$$

The first point of your

$TC^{\min}$  function !

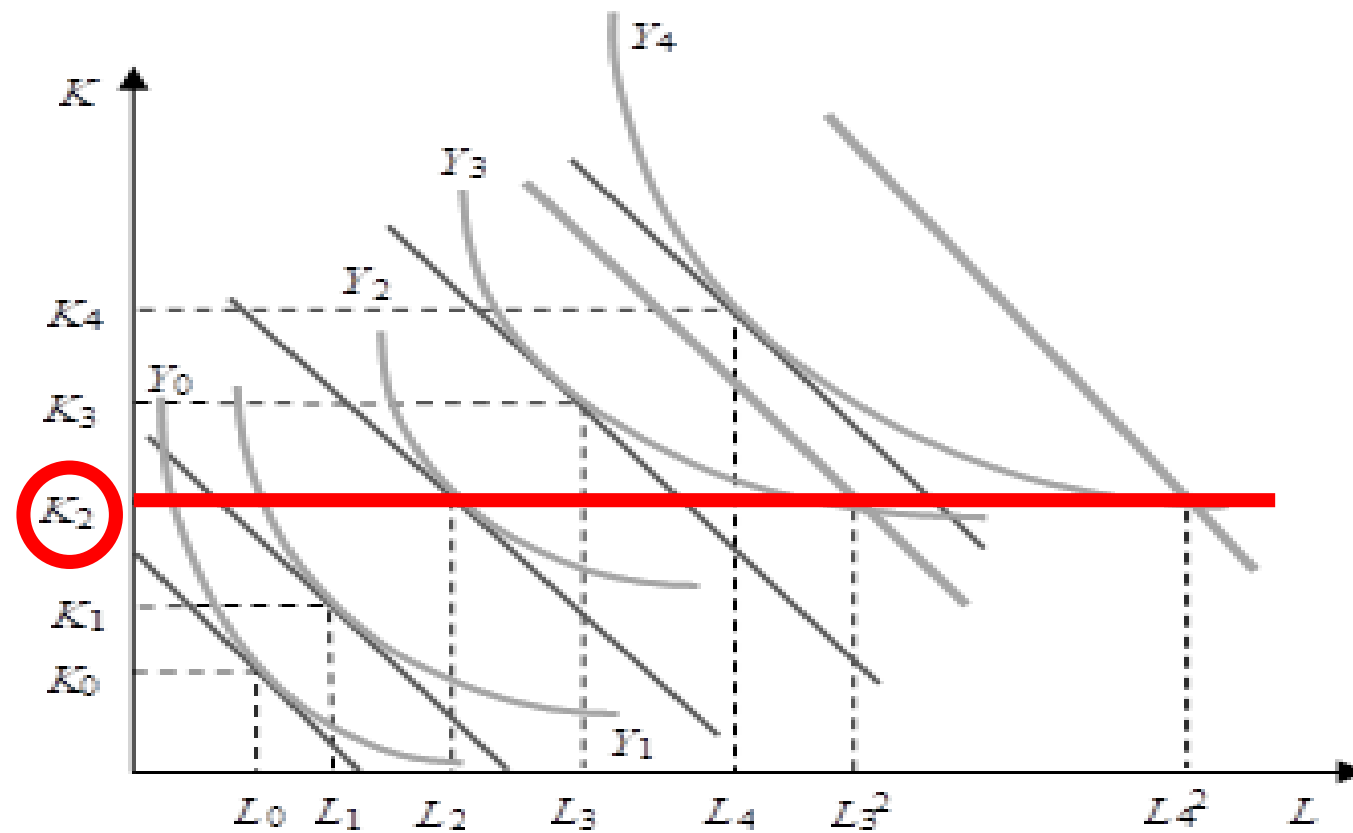
# Cost function

## Short Term





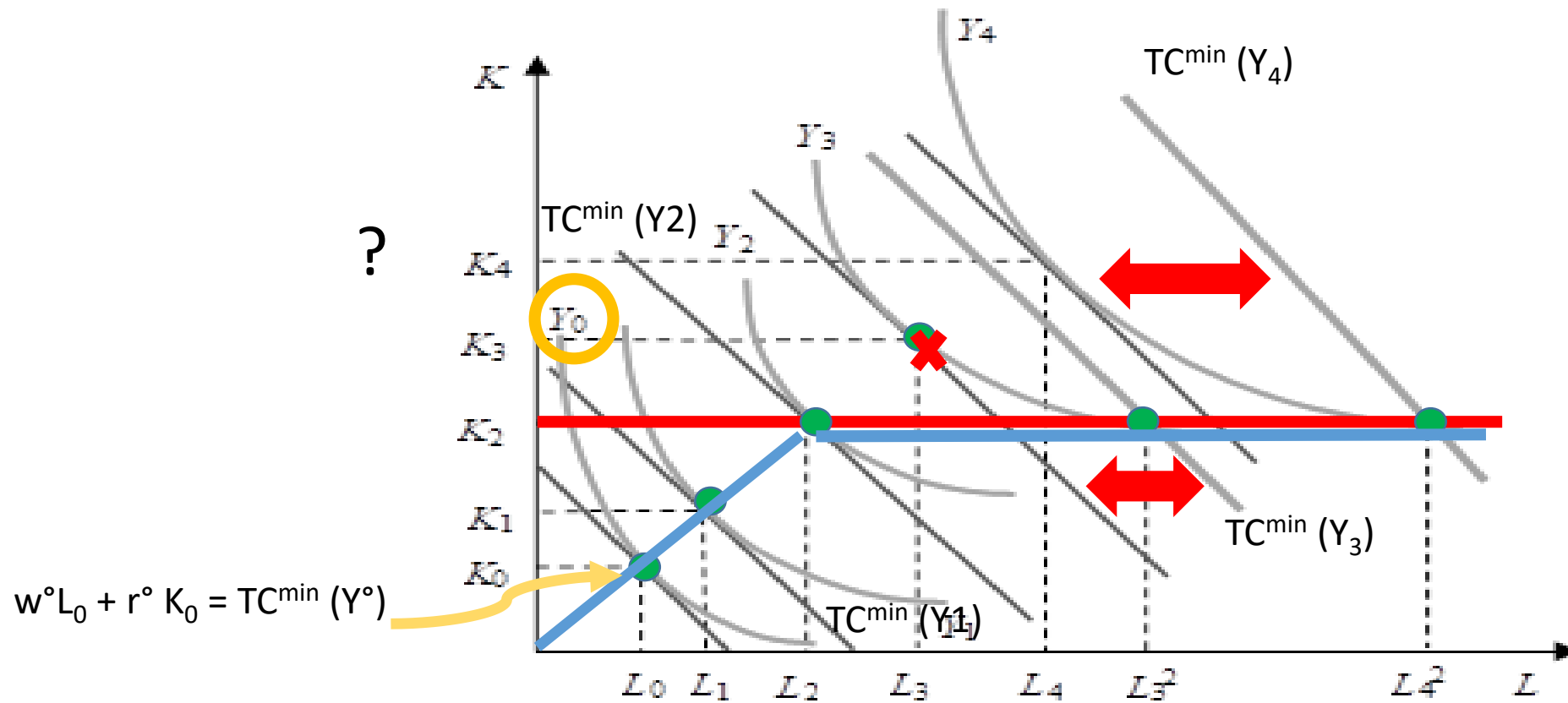
## Short-term: Fixed Input (ST)



$$K \leq K_2$$



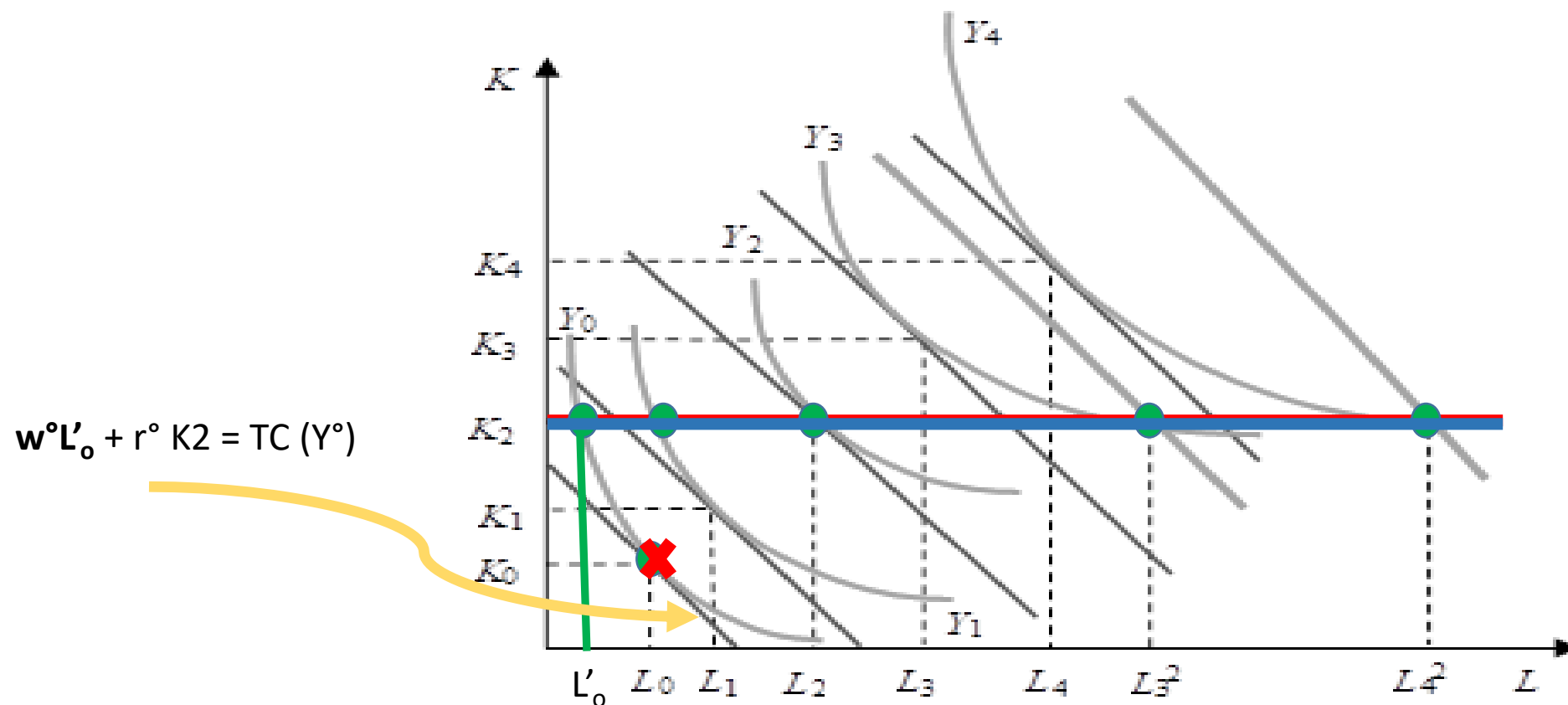
# Fixed Input, **variable costs**: ST technology expansion path (e.g., subletting possible)





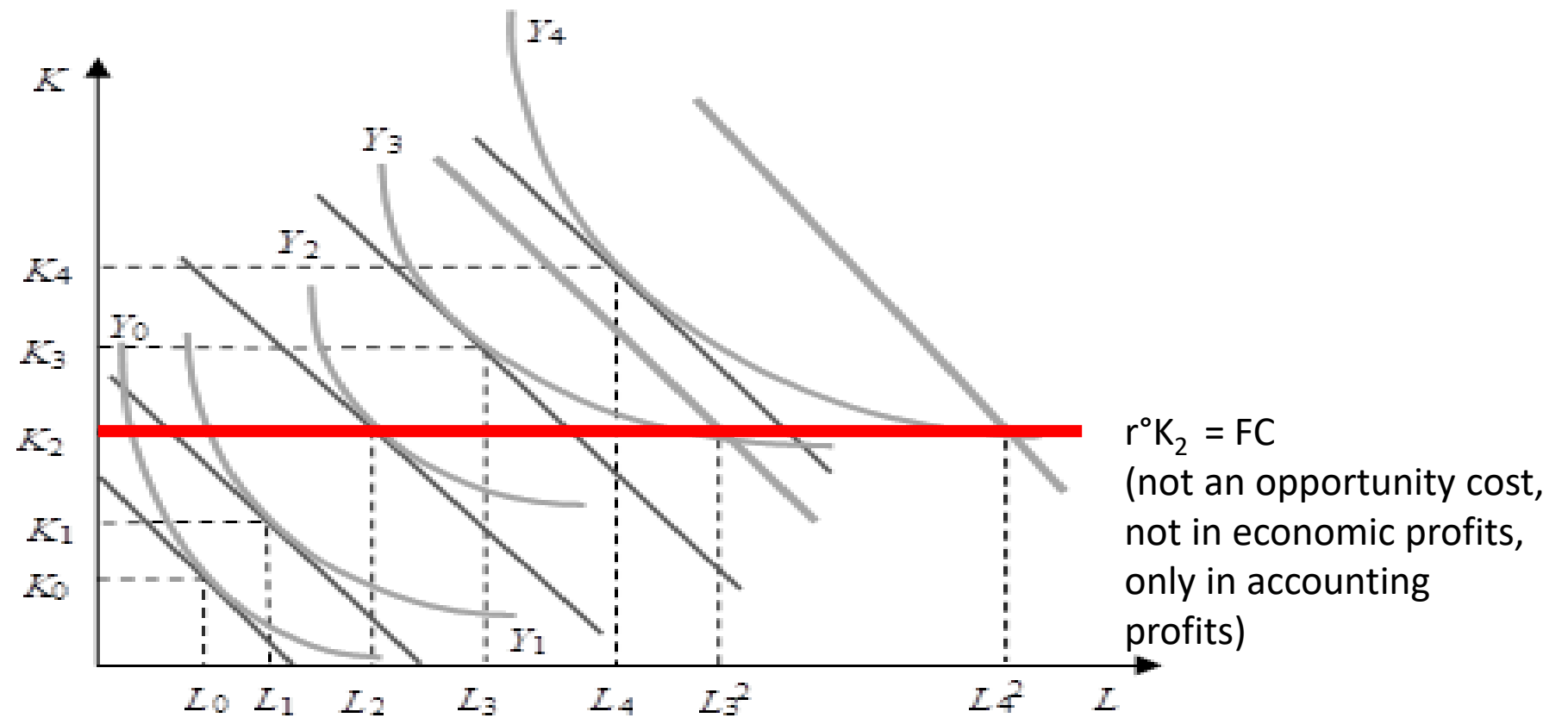


# Fixed Input, Sunk Costs (e.g., subletting impossible): technology expansion path





# Fixed Input, Sunk Cost = Fixed Cost





# Short term Cost Functions, L variable input

$$TC(Q(L, K^0), w_0, r_0, K_0) = FC + VC(Q, w_0) = r_0 K_0 + VC(Q, w_0)$$

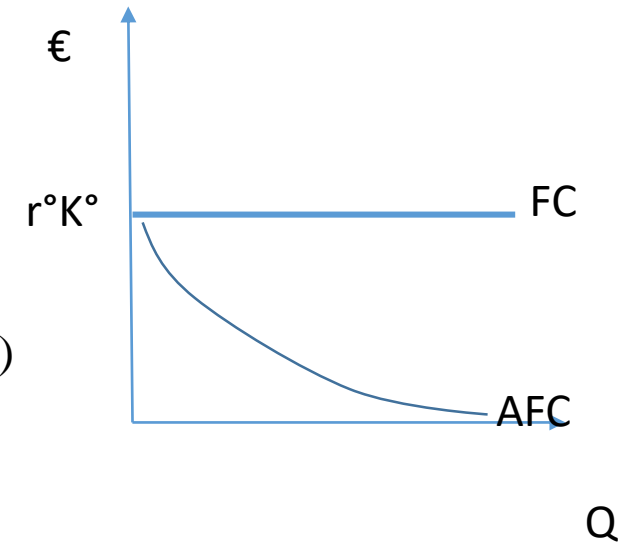
$$ATC(Q) = TC(Q)/Q$$

$$ATC(Q, w_0, r_0) = \frac{r_0 K_0}{Q} + \frac{VC(Q, w_0)}{Q} = AFC(Q, r_0) + AVC(Q, w_0)$$

PS: what  
about  
economic  
profits?

$$\Pi(Q, w_0, r_0, K_0) = TR(Q) - TC(Q, w_0, r_0, K_0) = p(Q)Q - Q ATC(Q, w_0, r_0, K_0)$$

$$\Pi(Q, w_0, r_0, K_0) = (p(Q) - ATC(Q, w_0, r_0, K_0)) Q$$



$$\Pi^E(Q) = [p(Q) - \text{AVC}(Q, w^0)]Q$$

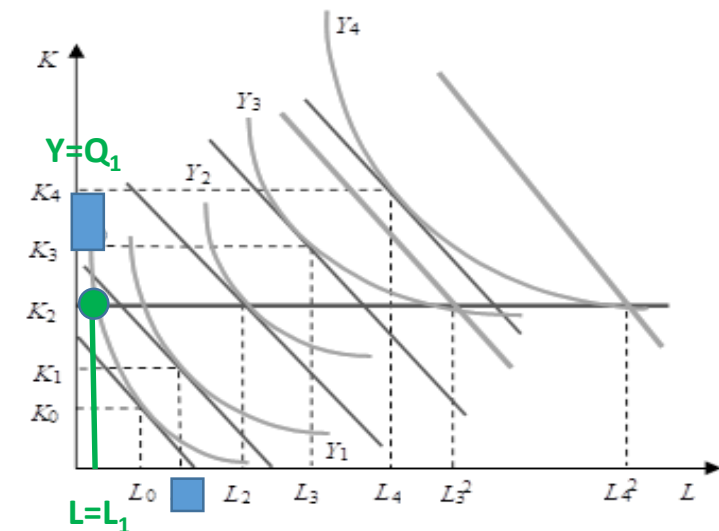
$$Q=Q_1; VC(Q_1)?$$

$$VC(Q_1, w_0) = w_0 L_1 \text{ €}$$

$$ATC(Q_1, w_0, r_0) = \frac{r_0 K_0}{Q_1} + \frac{w_0 L_1}{Q_1}$$

$$\text{With } AVC(Q_1; w_0) = [w_0 L_1]/Q_1$$

$$\text{With } ATC(Q; w_0) = [r^0 K_0 + w_0 L]/Q(L, K_0)$$





# Short term Cost Functions and Technology

With  $AVC(Q; w_0) = [w_0 L]/Q(L)$

$$APL(L, K_0) = \frac{Q(L, K_0)}{L}$$

The **quality** of workers ....  $(Q/L) = APL(L, K^0)$ ?  
 $Q = L \times APL(L, K^0)$

$$AVC(Q(L, K_0), w_0) = \frac{w_0 L}{Q(L, K_0)} = \frac{w_0 \times L}{L \times APL(L, K_0)} = \frac{w_0}{APL(L, K_0)}$$

$$\Pi^E(Q) = [p(Q) - \text{AVC}(Q, w^0)]Q$$

THE TABLE ATTENDED FOR A CENTURY: WHO ARE THEY? WHAT DO THEY SAY?





# Average Variable Costs and **economic** unitary profits

L	wL	Q	APL	AVC $wL/Q = w/APL$	PQ	Mark-up, unitary economic profit (P-AVC)	Economic Profits (P-AVC)Q
<b>P = 5€ w= 10€</b>							
1	10 €	2	2	5	10€	5-5	0
2	20 €	5	2,5	4	25€	5-4	1x5 €
3	30 €	15	5	2	75€	5-2	3x15 € = 45
4	40€	16	4	2,5	80€	5-2,5	2,5x16 € =40

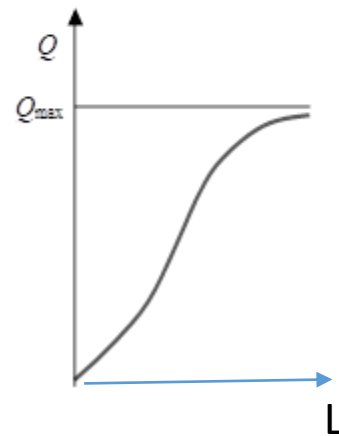
The West in the face of China? «A given (international?) price can only be sustained with AVC such that economic profits are positive»

or...

China facing the West? «A given low-price aggressive strategy wiping out competitors can only be sustained with low AVC such that economic profits are positive»

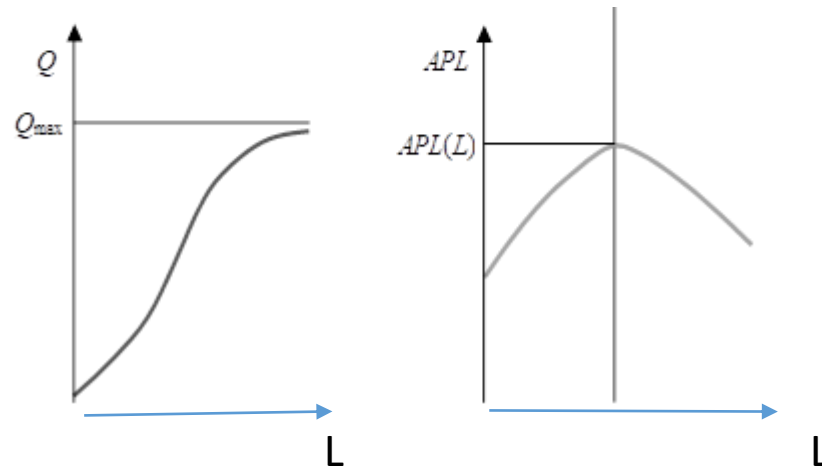
# Short term Cost Function

$$Q = f(L, K^o)$$





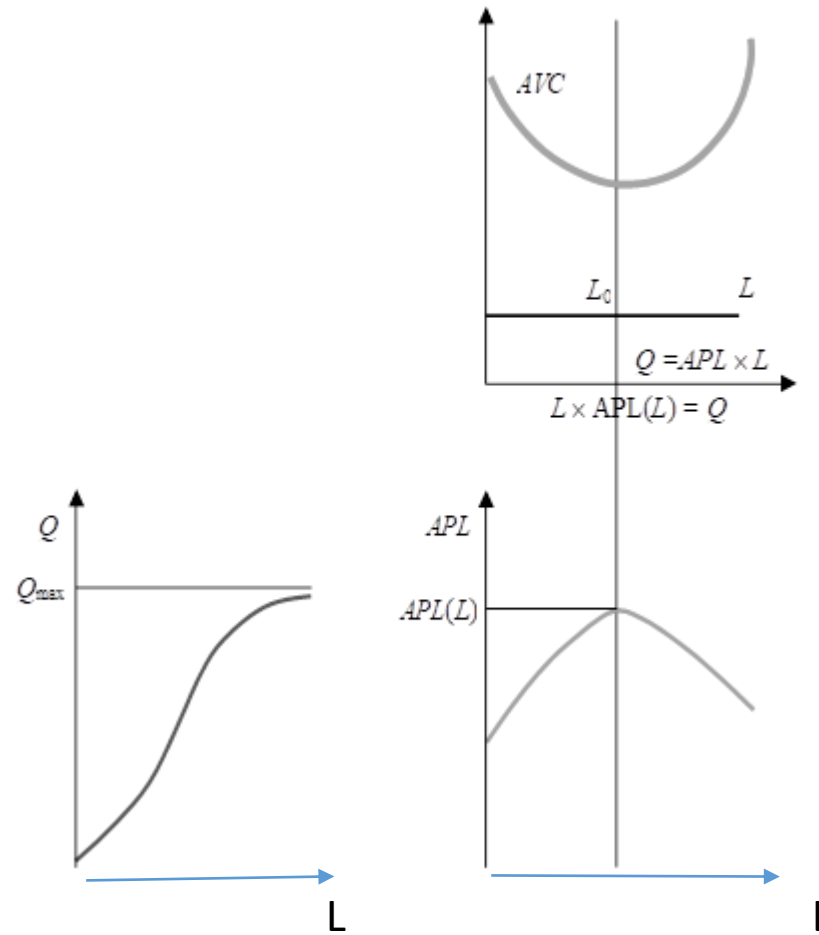
# Short term Cost Function



$$AVC (Q(L,K^0),w^0) = w^0/APL (L,K^0)$$



# Short term Cost Function

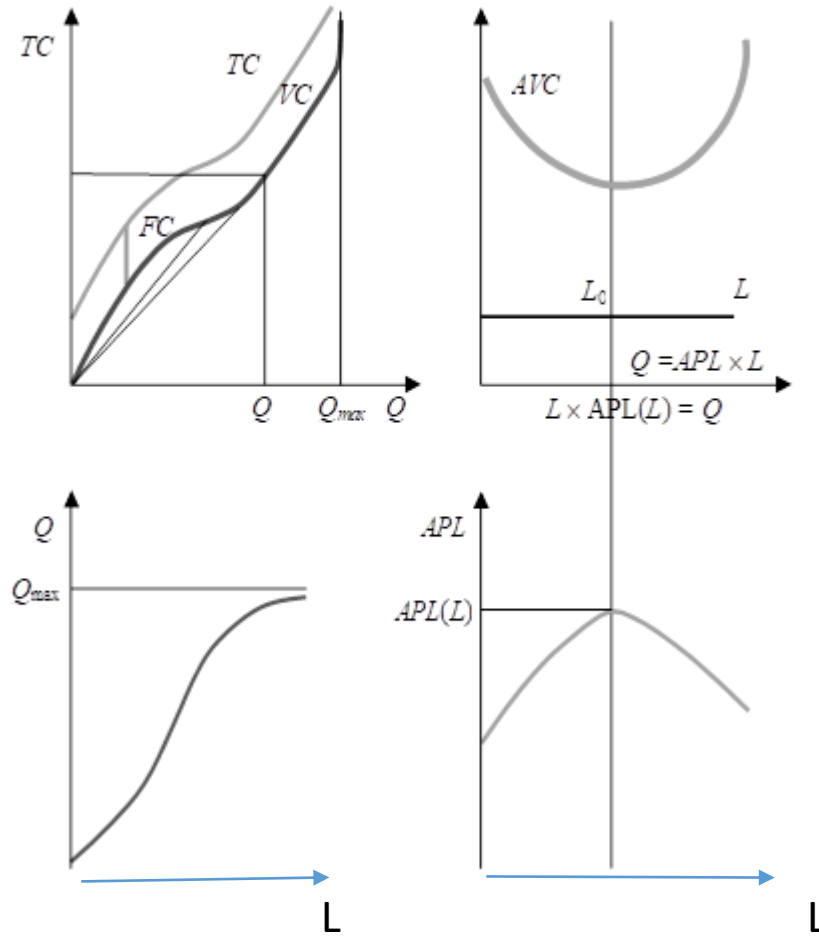


$$AVC (Q(L,K^0),w^0) = w^0/APL (L,K^0)$$





# Short term Cost Function





## Short-Term: marginal costs and technology

$$MC(Q(L, K_0); w_0) \equiv \frac{\delta CT(Q(L, K_0); w_0)}{\delta Q} = \frac{\delta(w_0 L + r_0 K_0)}{\delta Q} =$$

FC?

$$= \frac{\delta(w_0 L)}{\delta Q} + \frac{\delta(r_0 K_0)}{\delta Q} = w_0 \frac{\delta L}{\delta Q} + 0 = w_0 \frac{1}{MPL(Q, K_0)} = \frac{w_0}{MPL(Q(L, K_0); K_0)}$$

$$MC(1) = \frac{CT(1) - CT(0)}{1 - 0} = CF + CV(1) - CF - CV(0) = \frac{CV(1)}{1} = AVC(1)$$



## Marginal and average, again

If MPL goes up and then down, MC goes down and then up: what about AVC?

Entering the room...	Average?
1,80	1,80
1,70	1,75
1,60	1,70
1,50	1,65
1,60	1,64
<b>1,63</b>	<b>1,63</b>
1,70	1,66

Draw ATC, AVC, MC



# Short term cost functions VIP!

