Long Run Production - production in the time frame long enough to change every input. ⇒ no fixed cost.

i.e. in LR, if $Q=0$, Total cost $=0$.

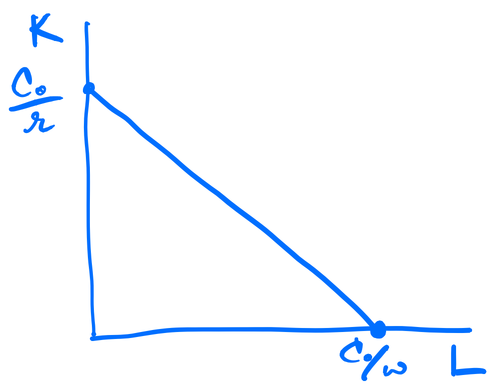
There are two problems in LR that each firm faces.

① max Q = output under the constraint of given cost $= C_0$ $\Longleftrightarrow$ $\max Q = f(L,K)$ s.t. $w.L + rK = C_0$

② min Cost $= C$ under the constraint of attaining output Q_0 $\Longleftrightarrow$ $\min C = wL + rK$ st. $f(L,K) = Q_0$

$Q = f(L,K)$ is the production function
w = wage - price of L
r = interest - price of K.

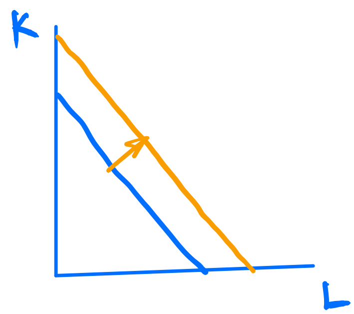
Isocost. - given C_0, $wL + rK = C_0$ is a line called Isocost because every point on this line is the quantity $L+K$ that the firm has to pay the same cost C_0.



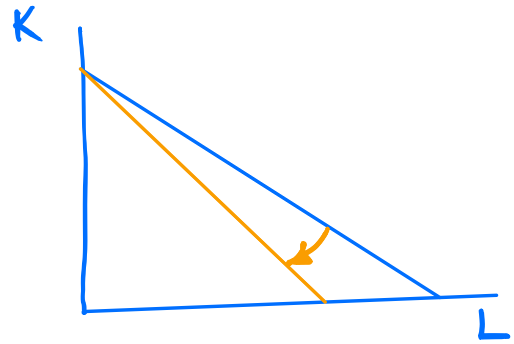
$wL + rK = C_0$
$K=0$, $L = C_0/w$
$L=0$, $K = C_0/r$
slope of isocost $= -\frac{w}{r}$

Change in Isocost.

1) C_0 increases to C_1



2) w increases.



Isoquant. - A curve whose every point is L & K that produce the same output Q.

Properties of Isoquant.

1) Each point of (L, K), there is exactly 1 Isoquant passing through it $\Rightarrow$ There are infinite number of isoquants.

2) Isoquants cannot intersect or be tangent to each other

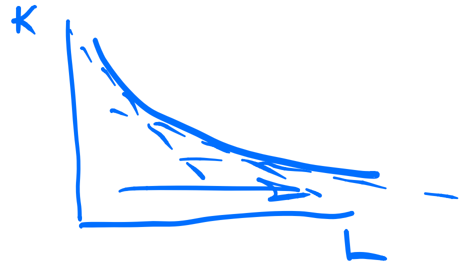
3) Higher Isoquant means higher output.

4) Isoquant always has negative slopes.

$$\text{Slope of Isoquant} = -\frac{MP_L}{MP_K}$$

= Marginal Rate of Technical Substitution (MRTS)

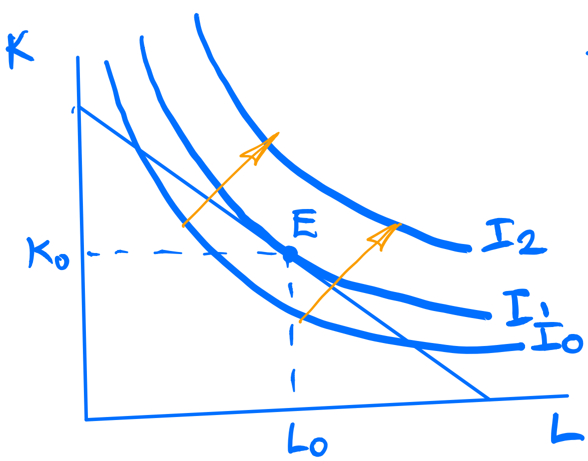
5) Diminishing MRTS as we increase L



Production Equilibrium.

1) Maximize Q

$$\max\ Q = f(L,K)$$
$$\text{s.t.}\quad \omega L + rK = C_0$$



The equilibrium is at $E = (L_0, K_0)$ because

1) E is on Isocost given $\omega L_0 + r K_0 = C_0$

2) I_1 is the highest Isoquant attainable given C_0 and we have I_1 tangent Isocost.

$$-\frac{MP_L}{MP_K} = -\frac{\omega}{r}$$

Equilibrium conditions at $E = (L_0, K_0)$

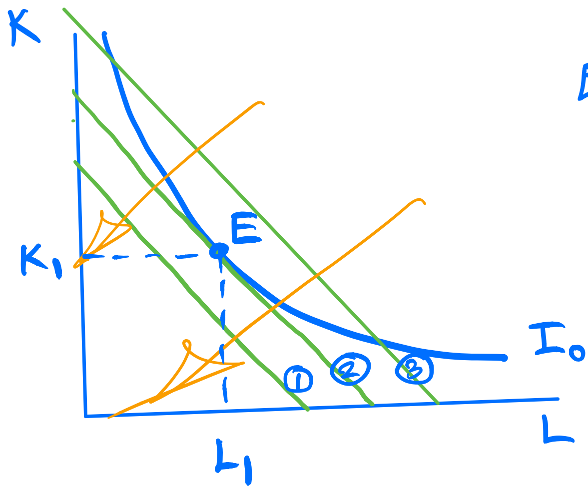
1) $\omega L_0 + r K_0 = C_0$ — on Isocost.

2) $\left.\left(\dfrac{MP_L}{MP_K}\right)\right|_{\text{at } E} = \dfrac{\omega}{r}.\ \Longleftrightarrow \left\{ \dfrac{MP_L}{\omega} = \dfrac{MP_K}{r} \right\}$

The last \$ spent of L gives the same output as the last \$ spent on K.

2) Minimizing Cost C

$$\min \; C = wL + rK$$
$$\text{st. } f(L, K) = Q_0$$



Equilibrium is at $E = (L_1, K_1)$ because

1) L_1 and K_1 can produce Q_0 because E is on I_0 that gives Q_0.

2) Isocost 2 is the lowest isocost we can stay on and still produce Q_0.

Equilibrium conditions at $E = (L_1, K_1)$

1) $f(L_1, K_1) = Q_0$ - (L_1, K_1) is on the given Isoquant.

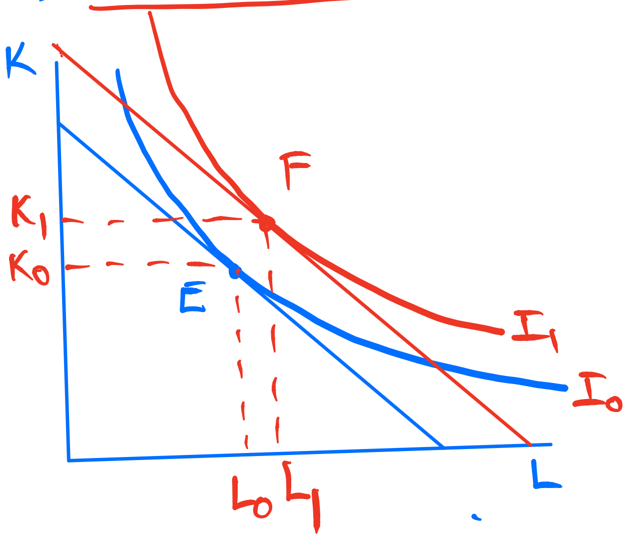
2) $$\left(\frac{MP_L}{MP_K}\right)_{\text{at } E} = \frac{w}{r}.$$

Change in Equilibrium

. max $Q = f(L, K)$

st. $wL + rK = C_0$

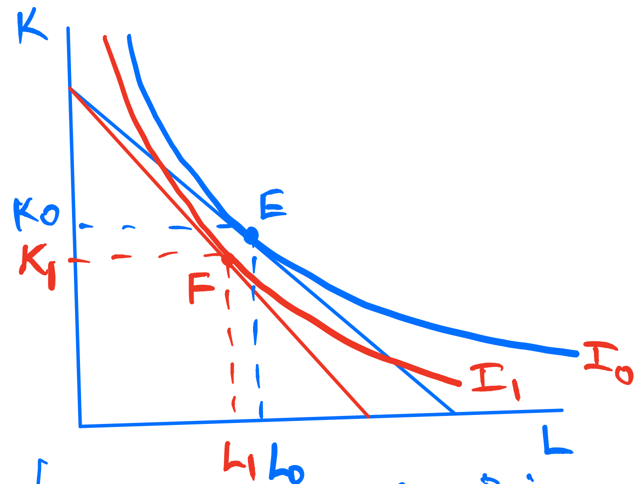
1). C_0 increases to C_1



Exactly the same as in higher income in consumption

- but no discussion of necessary/luxury goods.

2) Higher wage.



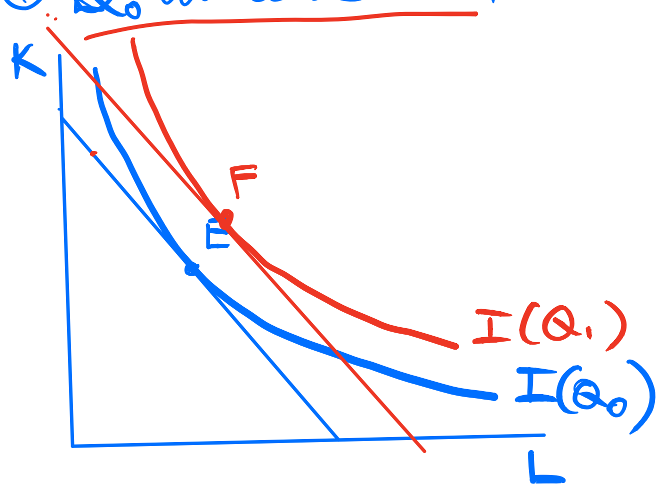
same as when P_x increases in consumption but no discussion of Subs & Income Effects.

Change in Equilibrium

min Cost $= wL + rK$,

st $f(L, K) = Q_0$

① Q_0 increases to Q_1



② higher wage