Input Substitution in Production

   A key idea in economics is that business firms typically can produce their products/svcs. using a variety of different methods and/or a variety of different combinations of inputs. A firm's choice of production method and of inputs is likely to depend on the prices of various inputs it might use.

Examples of input substitution:

1) Labor (L) & Capital (K) Substitution
   For example, banking services can be provided by human tellers, by ATM machines, or some combination of the two.

2) Materials Substitution

     For example, a bakery can make cakes using either cane sugar (S), or high-fructose corn syrup (HFCS), or a combination of the two. The cakes taste the same regardless of which is used. The downward-sloping (blue) line is the production isoquant for 7 cakes; this shows the different bundles of inputs of materials that could be used to produce 7 cakes.

Ounces of HFCS

25

7 cakes

20   Ounces of sugar
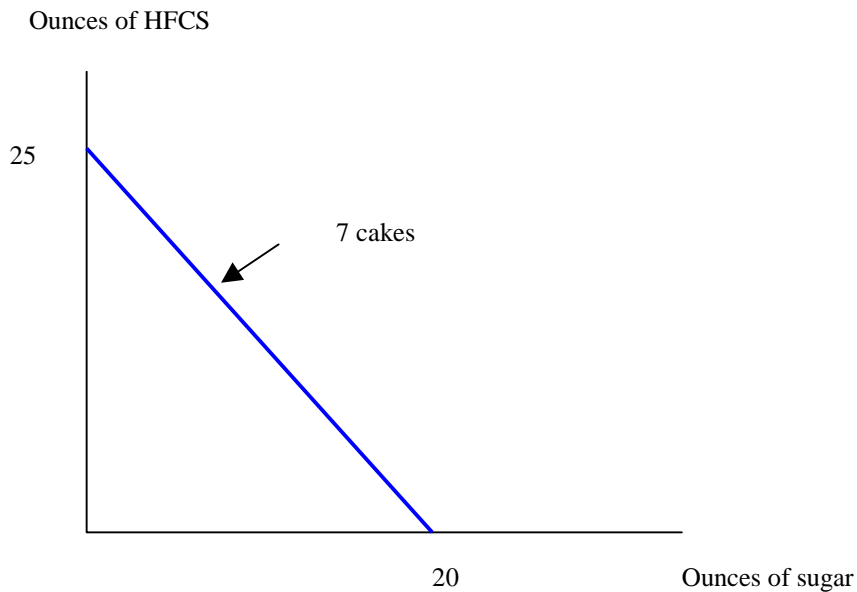
3) Capital (K) and Energy (E) Substitution

For example, pipelines are used to transport water, oil & gasoline (not all in the same pipe!). It turns out there is a tradeoff between the size (diameter) of the pipeline and the amount of pumping energy required to move a given volume of fluid through the line. A smaller diameter pipeline does not require as much energy as a larger diameter pipeline.

capital

900 B

500 B

energy
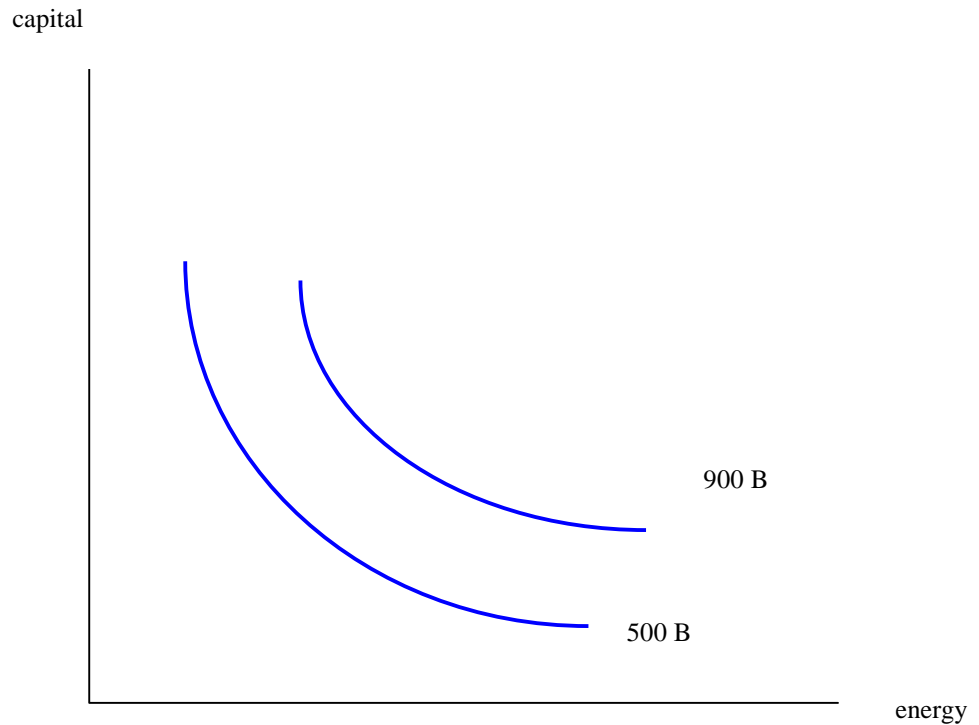
4) No substitution (fixed proportions)
    For a few types of production, inputs must be used in fixed proportions, or else some amounts of inputs are wasted. Aluminum production can be approximated by a fixed proportions relationship.
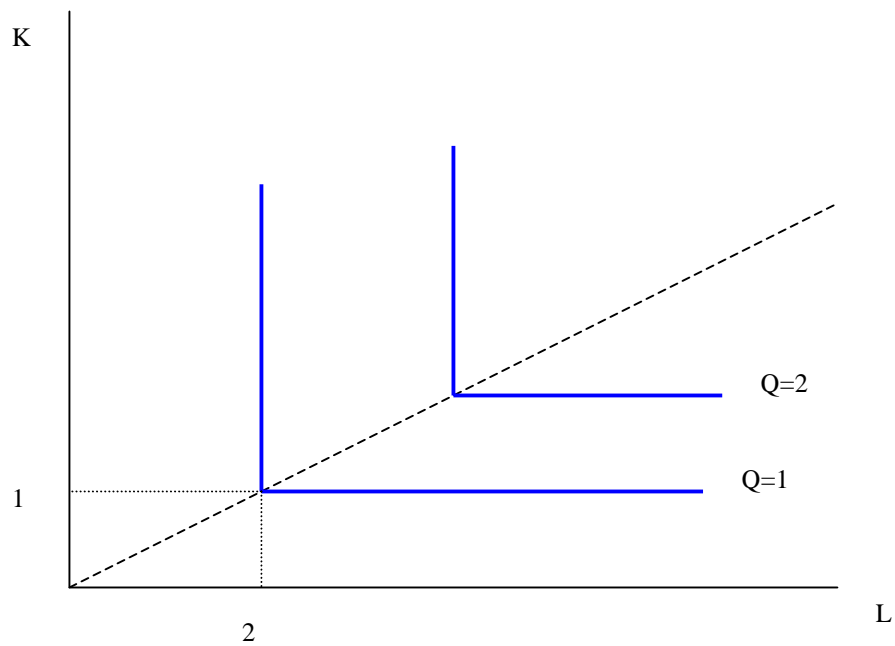
Marginal Rate of Technical Substitution (*MRTS*)

The *MRTS* captures the rate at which substitution between inputs is possible. The idea is essentially identical to the *MRS* in consumer theory. The *MRTS* captures the amount of one input a firm could give up when it increases another input, while keeping the amount of production the same. The *MRTS* can be measured as the (absolute value of) slope of a production isoquant.

For example, $MRTS_{LK}$, the *MRTS* between labor and capital, measures the amount of capital that a firm could give up when it adds one more unit of labor.

$$MRTS_{LK} = \frac{-\Delta K}{\Delta L}$$

Note that $\Delta Q = \Delta L \cdot MP_L$ and $\Delta Q = \Delta K \cdot MP_K$.
So if K is decreased and L is increased so as to keep Q the same, we have,

$$\Delta L \cdot MP_L = -\Delta K \cdot MP_K$$

So,

$$\frac{MP_L}{MP_K} = \frac{-\Delta K}{\Delta L} = MRTS_{LK}$$

That is, the ratios of the marginal products is equal to the *MRTS*.