Production and Costs

See chapters 7-9 in Mansfield et al

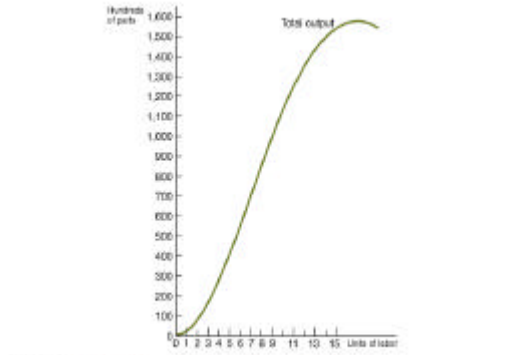

FIGURE 7.1 Relationship between Total Output and Amount of Labor Used on Five Machine Tools, Thomas Machine Company

Production

- Having considered demand have to move to cost and to do that try to understand production
- Useful general framework: production functions
- Simplest: one machine and one input producing an output. Consider maximum output by each combination.

Production

- Average product = $\frac{\text{total product (output)}}{\text{amount of input}}$
- Marginal product = addition to total product from one additional unit of input
- Derivative of output wrt input
- Can trace these

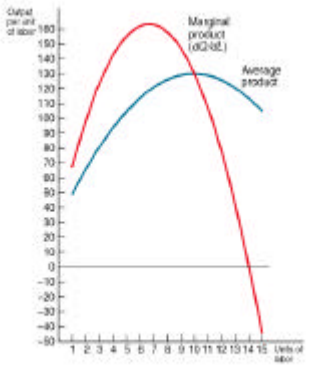

FIGURE 7.2 Average and Marginal Product Curves for Labor

Production

- Can generalise
- Consider two variable factors
- $Q = F(X_1, X_2)$

Production

- Law of diminishing returns: after some point the marginal product will decline
  - Generalisation
  - Assumes technology constant
  - Assumes one factor fixed
- Gives shape to functions

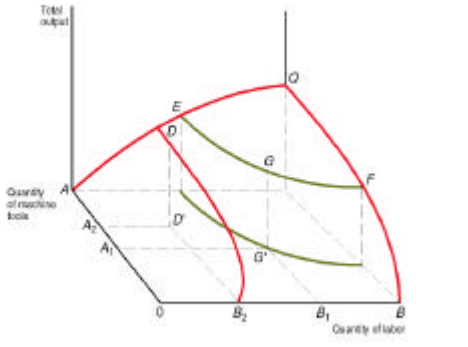

FIGURE 7.3 Production Function, Two Variable Inputs

Isoquants

- Can represent the surface in two dimensions using isoquants

- $MP_1 = \delta Q/\delta X_1$; $MP_2 = \delta Q/\delta X_2$
- MRTS = rate at which one input can be substituted for another with output constant
- $MRTS = -d X_2 / dX_1$ (minus slope of isoquant)
- Which can show is = $-MP_1/MP_2$
- If can only use fixed proportions then get:

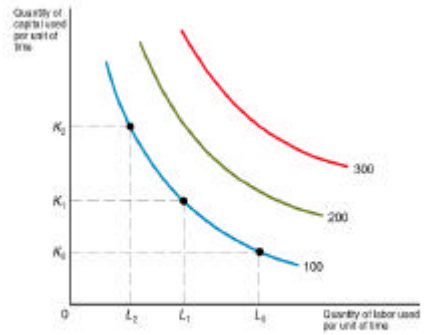

FIGURE 7.4 Isoquants

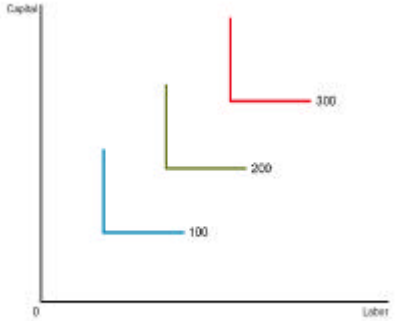

FIGURE 7.5 Isoquants in the Case of Fixed Proportions

Optimal Combinations

- Want to ask what combinations of factors should choose to maximise the output for a given cost: introduce a budget constraint
- Need to consider combinations capital and labour available

  P_L L+ P_K K = M
- Get Isocost curve

Production

- Can superimpose on isoquant diagram
- Maximisation of output for given cost will be where iscost curve is at a tangent to isoquant
- Minimisation of cost for given output

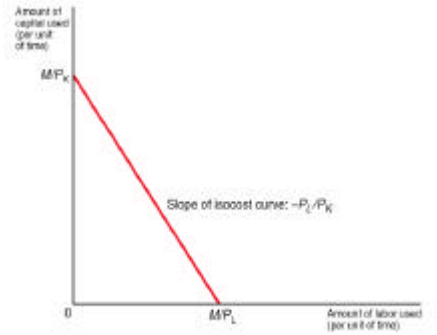

FIGURE 7.7 Isocost Curve

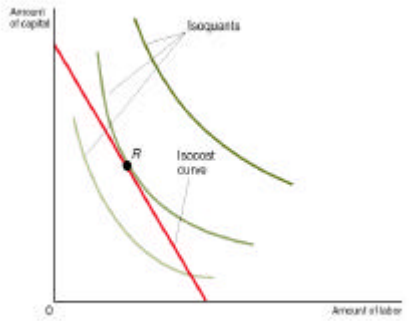

FIGURE 7.8 Maximization of Output for a Given Cost

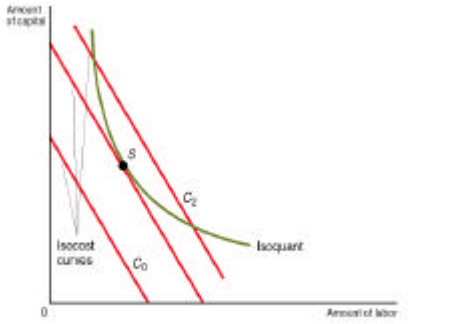

FIGURE 7.9 Minimization of Cost for a Given Output

Technological Change

- Clearly important to companies and economies
  - New methods
  - New products
  - New organisation
  - New management
- Within simple framework we have isoquant shifts out

Production functions

- What we are describing is a production technology and a budget constraint that is very general.
  - Underlying assumptions such as fixed costs
- Returns to a factor vs returns to scale
- Competitive benchmarking and regression/statistical analysis often used

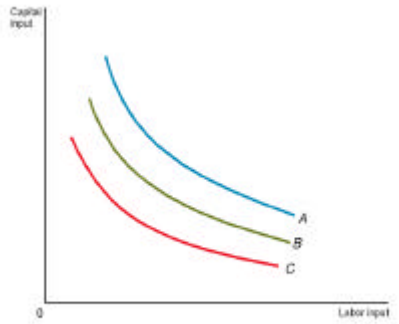

FIGURE 8.1 Change over a Period of Time in the Position of an Isoquant

Factor Productivity

- Increase labour productivity would change the shape of the isoquants
- Labour productivity is often used to measure productivity but it is only a partial
- Better to use Total Factor productivity

Total Factor Productivity

- Consider Q = a (bL + cK)
- Then TFP = a = Q / (bL + cK)
- Changes in total factor producivity measure changes in efficiency
- Can generalise to more factors
- Measures changes over time of firms efficiency (eg introduce flexible production methods)

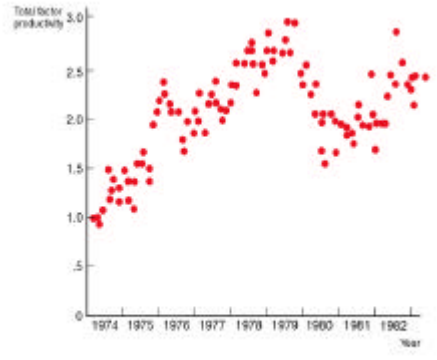

FIGURE 8.3 Total Factor Productivity, Actual Manufacturing Plant

Research and Development

- R&D is work of many kinds: dep on ind
- Product vs process
- Risk and chance: can use probability analysis to work out expected costs
- Ability to make R&D pay off differs
  - Probability of technical success
  - Probability of commercialisation
  - Probability of economic success
- Managerial economists can help in project selection

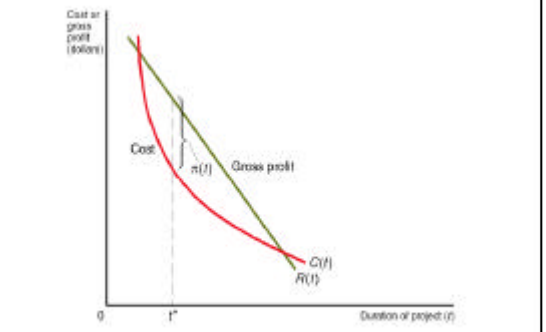

FIGURE 8.4 Time-Cost Trade-off Function and Optimal Duration of the Project

Learning

- Learning-by-doing important
- Holding output rate constant costs decline with total amount made
- Some firms have priced in expectation of lower future costs so beating competition (TI) also aerospace
- Can estimate learning curves

Technology

- Inventions versus innovations
- Reduced costs/improvement in inputs: machine tools
- Difficult distinction eg computers
- Time cost trade offs on projects
  - Present value of profit
  - Speed of development and introduction

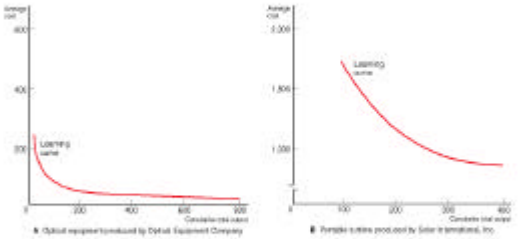

FIGURE 8.5 Learning Curves

Diffusion

- Need to be aware that it takes time for new products and innovations to spread
- Learning process early on
- Growth in proportion of firms using innovation tends to be sigmoid curve, influenced by profitability and size of investment.
- This tends to model the process well: can estimate

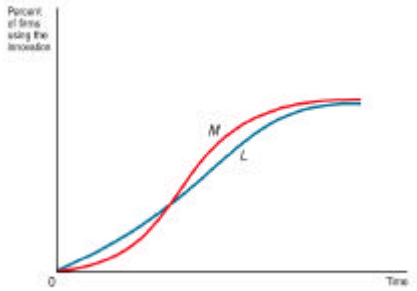

FIGURE 8.8 Growth over a Period of Time in the Proportion of Firms Using the Innovation