Worksheet 7.2

Paper Chain Factory Simulation

The law of diminishing returns is a basic microeconomic concept that explains how a firm's costs of production change in the short-run as it varies the amount of labor employed. As workers are added to a fixed amount of capital, the productivity of additional workers decreases beyond a certain point due to the lack of available capital.

To test the law of diminishing returns, it is possible to create a factory floor right in your own classroom. Follow the instructions below to determine whether the law applies to your own imaginary firm.

Introduction: Your classroom is about to turn into a factory that manufactures paper chains (to hold paper anchors for paper boats, of course!). A paper chain is made by taking two long, narrow strips of paper, folding one into a ring and stapling the ends together, then folding the other into a ring and connecting it to the first ring to make a chain. Two loops of paper stapled together make a chain. The longer your chain, the more productive your factory and its workers are. The goal of your paper chain factory, of course, is to make the longest chain possible in a fixed amount of time using a fixed amount of land and capital, with labor as your only variable resource. This is therefore an experiment to test the short-run law of diminishing marginal returns.

Resources:

1. Land resources: You will need one table or a couple of desks pushed together. This is your factory floor. Additionally, you will need a box of paper, preferably recycled or used paper. These are your land resources.
2. Capital resources: Every factory needs tools. The tools you'll have for this activity are two pairs of scissors and two staplers. Since this is a short-run simulation, the amount of land and capital cannot be varied, therefore you may NOT use more scissors and staplers as more workers join the production process.
3. Labor resources: These will consist of the members of your class. The simulation will start with just one worker, and in each successive round one additonal worker will be added until at least eight members of your class have joined the factory floor.

TIME: The time for each round of production is limited to one minute. Your teacher or a member of your class should be designated as time keeper.

Data Collection: Each student in the class should record the following down in a data table. If you have access to laptops, the data can be collected in Microsoft Excel or in Google Spreadsheets. This way you can create graphs of the data to assist with your analysis later on. Each student should record the following data during the simulation.

Economics

# of Workers (QL)	Total Product (TP)	Marginal Product (=change in TP)	Average Product (TP/QL)

Conducting the simulation: When your land and capital resources are ready and your recorder and time keeper have been designated, you may begin the simulation.

1. In round one, only one student should come to the table. The timekeeper must start the clock and give the worker one minute to cut and staple as many links into one paper chain as he or she can. At the end of the minute the recorder must count the number of links in the chain, record it in the production table, and then take the chain and any links that were cut but not stapled aside in preparation for the next round.

2. In round two, a second worker should join the first and the two may work together for one minute to make as long a chain as they can. Again, the recorder will count the number of links in the chain at the end of one minute, record this under 'total product', then remove the chain and any unstapled links from the table.

3. In rounds three through eight, an additional worker is added in each round and the new production team is given exactly one minute to make as long a chain as they can. At the end of each round, the recorder must count the number of links and record this under 'total product'.

4. At the end of the eighth round the factory must close its doors and the simulation is over. Now the class as a whole should look at the total product data and together help the recorder calculate the marginal product and average product for each of the eight rounds.

Data analysis: With your productivity data tables complete, you may now plot your data for total, marginal and average product on a graph similar to those earlier in this chapter, with the quantity of labor on the x-axis and the firm's output on the y-axis. Using Microsoft Excel or Google Spreadsheets you can create a graph that should look something like the following

created using real data from Mr. Welker's class recorded in a Google Spreadsheet):

Labor Productivity in the Short-run
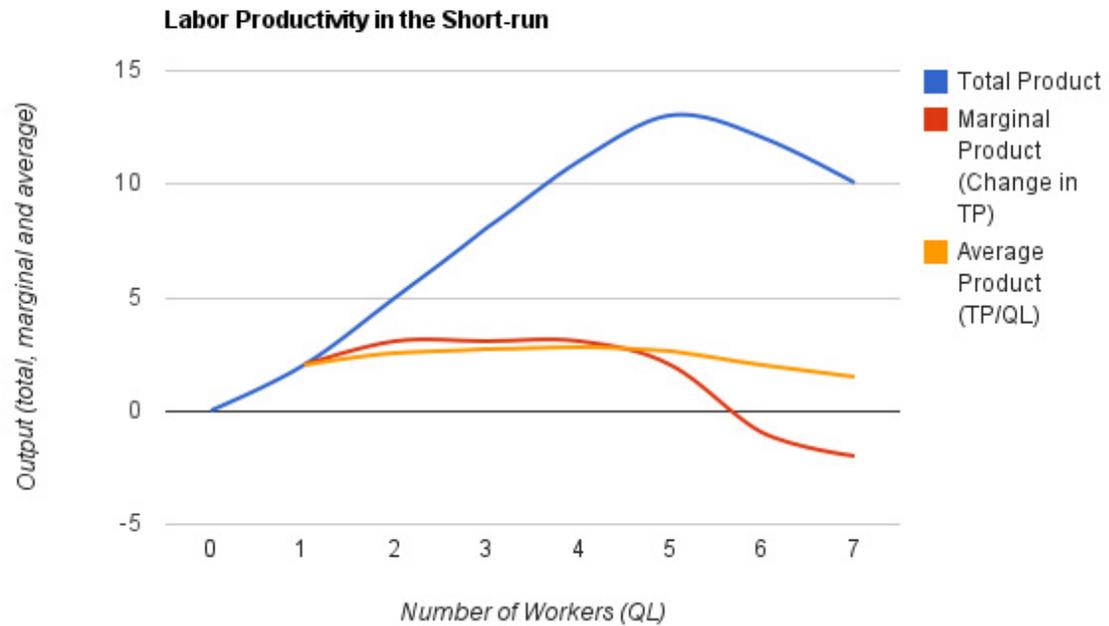
- As a class, analyze the relationships between total and marginal product.
- Determine whether your paper chain factory ever experienced increasing returns and whether it ever experienced diminishing returns.
- Discuss the reasons for the changes in total product during each round of production.

Marginal and Average Product in the Short-run
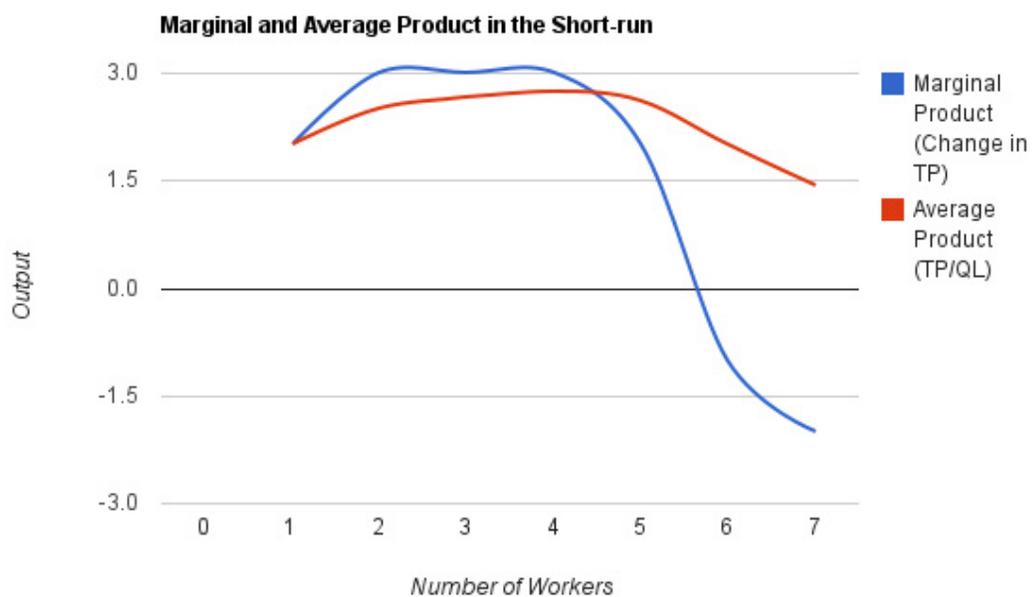
- The graph above illustrates just marginal and average products. Discuss the meanings of marginal product and average product and determine how they changed as workers were added to your factory floor.

- What is the relationship between marginal product and average product?

- Decide whether the law of diminishing marginal returns applied to your factory. If so, why? If not, why not?