Long Run Product and Costs
Econ 201/Haworth

Recall that in the long run, a firm can choose to enter a market, exit a market, expand or contract. Let's focus on this final pair of choices.

When a firm expands or contracts, we talk about how that firm has changed its scale of operations. In the long run, all factors are variable, and so as the firm hires more (or less) factors of production, the firm will clearly change its output over this period of time. We refer to that output as scale. You can think of scale as another way of referring to output in the long run.

What happens when a firm expands, hiring more factors and increasing their scale of operations? Below, we have three production functions that describe how the output of three different firms is affected by expansion (note that K = capital, L = labor, and q = firm's output in the long run). Assume that each firm is hiring 1 unit of both K and L (i.e. K = 1, L = 1). Over time, these firms decide to increase hiring of both K and L, increasing both K and L to 2 units (i.e. K = 2, L = 2).

		if K = 1, L = 1:	**if K = 2, L = 2:**
Firm 1:	$q = 10\left(\sqrt{K^3 \cdot L^3}\right)$	$q = 10\left(\sqrt{(1)^3 \cdot (1)^3}\right) = 10$	$q = 10\left(\sqrt{(2)^3 \cdot (2)^3}\right) = 80$
Firm 2:	$q = 50\left(\sqrt{K \cdot L}\right)$	$q = 50\left(\sqrt{(1) \cdot (1)}\right) = 50$	$q = 50\left(\sqrt{(2) \cdot (2)}\right) = 100$
Firm 3:	$q = 4\left(\sqrt[3]{K \cdot L}\right)$	$q = 4\left(\sqrt[3]{(1) \cdot (1)}\right) = 4$	$q = 4\left(\sqrt[3]{(2) \cdot (2)}\right) = 6.35$

Here's what we observe within this example. When each firm doubles the number of factors they hire, their output always goes up, but does not necessarily double.

Firm 1 doubles the number of factors hired, and their output increases by more than double
Firm 2 doubles the number of factors hired and their output also doubles
Firm 3 doubles the number of factors hired and their output increases by less than double

These 3 firms are an example of the 3 different types of product curves we observe in the long run. Firm 1 reveals what we call increasing returns to scale. Firm 2 illustrates the concept of constant returns to scale, and Firm 3 reveals what we call decreasing returns to scale. Here is a more complete (but still simple) definition of these terms:

Increasing returns to scale: if you double the number of factors, then output more than doubles
Constant returns to scale: if you double the number of factors, then output also doubles
Decreasing returns to scale: if you double the number of factors, then output less than doubles

Examples of increasing returns to scale can often be found in financial services markets, or more generally in any market where greater size allows a firm to reduce unit cost (more on this later). Constant returns to scale is often characterized by firms in a more mature industry, and decreasing returns to scale is typically thought to occur within agriculture markets.
When moving from product to cost, we want to recall the relationship between these two concepts. Recall from an earlier discussion that product curves are inverse mirror images of cost curves. I.e., if we find a product curve increasing, then the corresponding cost curve will be decreasing. In other words, increasing product implies decreasing cost (and vice versa).

As a firm expands, if the firm's long run average cost is decreasing, then the firm experiences decreasing costs. If expansion has no effect on long run average cost (i.e. long run average cost is unchanged), then the firm experiences constant costs. If the firm expands and the firm's long run average cost increases, then we have a firm experiencing increasing costs.

Therefore:
Increasing returns to scale $\Rightarrow$ Decreasing costs
Constant returns to scale $\Rightarrow$ Constant costs
Decreasing returns to scale $\Rightarrow$ Increasing costs

A term we may apply to decreasing cost is economies of scale. When a firm has economies of scale, the firm's average cost will decrease as the firm expands. Economies of scale is a characteristic that firms will try to create if it's possible to do so. E.g., Best Buy will shift to a system where a store employee will direct customers to a cash register, rather than let customers choose their own register. This is thought to speed up the sale of goods, and if the firm can do this without changing their total cost, higher output/sales will lower the firm's average cost during this high demand period. This is a type of economies of scale. Note that the opposite of economies of scale is diseconomies of scale.