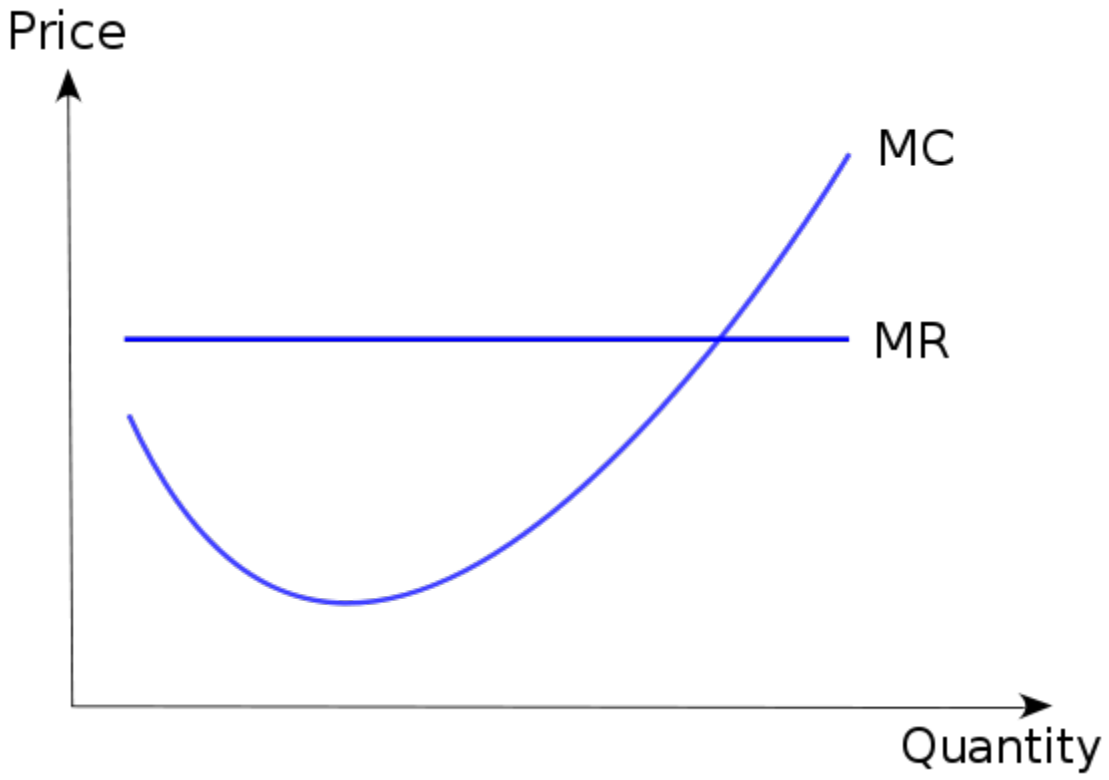
Chapter- 3

Marginal Cost



A typical marginal cost curve with marginal revenue overlaid

In economics and finance, **marginal cost** is the change in total cost that arises when the quantity produced changes by one unit. That is, it is the cost of producing one more unit of a good. Mathematically, the marginal cost (MC) function is expressed as the first (order) derivative of the total cost (TC) function with respect to quantity (Q). Note that the marginal cost will change with volume, as a non-linear and non-proportional cost function includes

- variable terms dependent to volume,

- constant terms independent to volume and occurring with the respective lot size,
- jump fix cost increase or decrease dependent to steps of volume increase.

So at each level of production, the marginal cost is the cost of the next unit produced referring to the basic volume.

$$MC = \frac{dTC}{dQ}$$

In general terms, marginal cost at each level of production includes any additional costs required to produce the next unit. If producing additional vehicles requires, for example, building a new factory, the marginal cost of those *extra* vehicles includes the cost of the new factory. In practice, the analysis is segregated into short and long-run cases, and over the longest run, all costs are marginal. At each level of production and time period being considered, marginal costs include all costs which vary with the level of production, and other costs are considered fixed costs.

A number of other factors can affect marginal cost and its applicability to real world problems. Some of these may be considered market failures. These may include information asymmetries, the presence of negative or positive externalities, transaction costs, price discrimination and others.

Cost functions and relationship to average cost

In the simplest case, the total cost function and its derivative are expressed as follows, where Q represents the production quantity, VC represents variable costs, FC represents fixed costs and TC represents total costs.

$$MC = \frac{dTC}{dQ} = \frac{d(FC + VC)}{dQ} = \frac{dVC}{dQ}$$

Since (by definition) fixed costs do not vary with production quantity, it drops out of the equation when it is differentiated. The important conclusion is that marginal cost *is not related to* fixed costs. This can be compared with average total cost or ATC, which is the total cost divided by the number of units produced and *does* include fixed costs.

$$ATC = \frac{FC + VC}{Q}$$

For discrete calculation without calculus, marginal cost equals the change in total (or variable) cost that comes with each additional unit produced. In contrast, incremental cost is the composition of total cost from the surrogate of contributions, where any increment is determined by the contribution of the cost factors, not necessarily by single units.

For instance, suppose the total cost of making 1 shoe is $30 and the total cost of making 2 shoes is $40. The marginal cost of producing the second shoe is $40 - $30 = $10.

Marginal cost is not the cost of producing the "next" or "last" unit. As Silberberg and Suen note the cost of the last unit is the same as the cost of the first unit and every other unit. In the short run increasing production requires using more of the variable input - conventionally assumed to be labor. Adding more labor to a fixed capital stock reduces the marginal product of labor because of the diminishing marginal returns. This reduction in productivity is not limited to the additional labor needed to produce the marginal unit - the productivity of every unit of labor is reduced. Thus the costs of producing the marginal unit of output has two components: the cost associated with producing the marginal unit and the increase in average costs for all units produced due to the "damage" to the entire productive process ($\partial AC/\partial q)q$. The first component is the per unit or average cost. The second unit is the small increase in costs due to the law of diminishing marginal returns which increases the costs of all units of sold. **Therefore, the precise formula is:**

$$MC = AC + (\partial AC/\partial q)q.$$

Marginal costs can also be expressed as the cost per unit of labor divided by the marginal product of labor.

$MC = \Delta VC/\Delta q;$
$\Delta VC = w\Delta L;$
$MC = w\Delta L;/\Delta q;$
$\Delta L/\Delta q$ the change in quantity of labor to affect a one unit change in output = $1/MPL$.
Therefore $MC = w/MPL$ SInce the wage rate is assumed constant marginal cost and marginal product of labor have an inverse relationship - if marginal cost is increasing (decreasing) the marginal product of labor is decreasing (increasing).

Economies of scale

Economies of scale is a concept that applies to the long run, a span of time in which all inputs can be varied by the firm so that there are no fixed inputs or fixed costs. Production may be subject to economies of scale (or diseconomies of scale). Economies of scale are said to exist if an additional unit of output can be produced for less than the average of all previous units— that is, if long-run marginal cost is below long-run average cost, so the latter is falling. Conversely, there may be levels of production where marginal cost is higher than average cost, and average cost is an increasing function of output. For this generic case, minimum average cost occurs at the point where average cost and marginal cost are equal (when plotted, the marginal cost curve intersects the average cost curve from below); this point will *not* be at the minimum for marginal cost if fixed costs are greater than zero.

Perfectly competitive supply curve

The portion of the marginal cost curve above its intersection with the average variable cost curve is the supply curve for a firm operating in a perfectly competitive market. (the portion of the MC curve below its intersection with the AVC curve is not part of the supply curve because a firm would not operate at price below the shut down point) This is not true for firms operating in other market structures. For example, while a monopoly "has" an MC curve it does not have a supply curve. In a perfectly competitive market, a supply curve shows the quantity a seller's willing and able to supply at each price - for each price there is a unique quantity that would be supplied. The one-to-one relationship simply is absent in the case of a monopoly. With a monopoly there could be an infinite number of prices associated with a given quantity. It all depends on the shape and position of the demand curve and its accompanying marginal revenue curve.

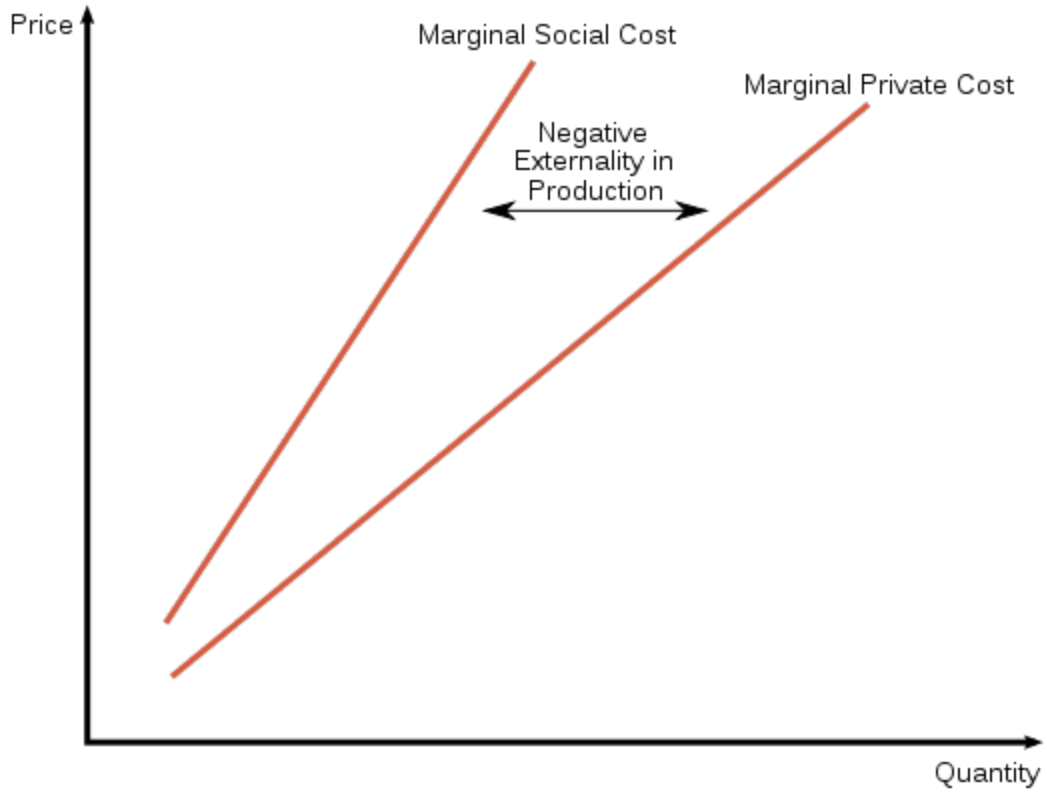
Relationship to fixed costs

Marginal Costs are not affected by changes in fixed cost. Marginal costs can be expressed as $\Delta C(q)/\Delta Q$. Since fixed costs do not vary with (depend on) changes in quantity, MC is $\Delta VC/\Delta Q$. Thus if fixed cost were to double MC would not be affected and consequently the profit maximizing quantity and price would not change. this can be ilustrated by graphing the short run total cost curve and the short run variable cost curve. The shape of the curves are identical. Each curve initially increases at a decreasing rate reaches and inflection point then increases at a decreasing rate. the only difference between the curves is that the SRVC curve begins from the origin while the SRTC curve originates on the y-axis. The distance of the origin of the SRTC above the origin represents the fixed cost - the vertical distance between the curves. This distant remains constant as the quantity produced Q increases. MC is the slope of the SRVC curve. A change in fixed cost would be reflected by a change in the vertical distance between the SRTC and SRVC curve. Any such change would have no effect on the shape of the SRVC curve and therefore its slope at any point - MC.

Externalities

Externalities are costs (or benefits) that are not borne by the parties to the economic transaction. A producer may, for example, pollute the environment, and others may bear those costs. A consumer may consume a good which produces benefits for society, such as education; because the individual does not receive all of the benefits, he may consume less than efficiency would suggest. Alternatively, an individual may be a smoker or alcoholic and impose costs on others. In these cases, production or consumption of the good in question may differ from the optimum level.

Negative externalities of production



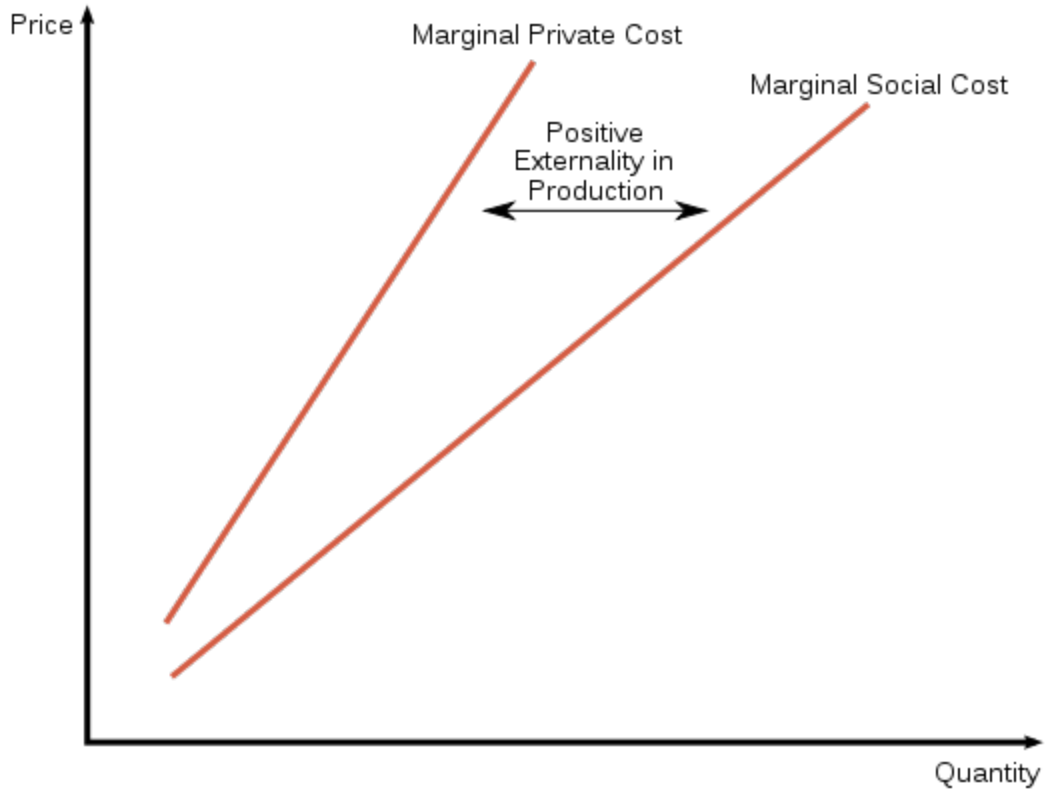
Negative Externalities of Production

Much of the time, private and social costs do not diverge from one another, but at times social costs may be either greater or less than private costs. When marginal social costs of production are greater than that of the private cost function, we see the occurrence of a negative externality of production. Productive processes that result in pollution are a textbook example of production that creates negative externalities.

Such externalities are a result of firms externalising their costs onto a third party in order to reduce their own total cost. As a result of externalising such costs we see that members of society will be negatively affected by such behavior of the firm. In this case, we see that an increased cost of production on society creates a social cost curve that depicts a greater cost than the private cost curve.

In an equilibrium state we see that markets creating negative externalities of production will overproduce that good. As a result, the socially optimal production level would be lower than that observed.

Positive externalities of production



Positive Externalities of Production

When marginal social costs of production are less than that of the private cost function, we see the occurrence of a positive externality of production. Production of public goods are a textbook example of production that create positive externalities. An example of such a public good, which creates a divergence in social and private costs, includes the production of education. It is often seen that education is a positive for any whole society, as well as a positive for those directly involved in the market.

Examining the relevant diagram we see that such production creates a social cost curve that is less than that of the private curve. In an equilibrium state we see that markets creating positive externalities of production will under produce that good. As a result, the socially optimal production level would be greater than that observed.

Social costs

Of great importance in the theory of marginal cost is the distinction between the marginal *private* and *social* costs. The marginal private cost shows the cost associated to the firm in question. It is the marginal private cost that is used by business decision makers in their profit maximization goals, and by individuals in their purchasing and consumption choices. Marginal social cost is similar to private cost in that it includes the cost functions of private enterprise but *also* that of society as a whole, including parties that have no

direct association with the private costs of production. It incorporates all negative and positive externalities, of both production and consumption.

Hence, when deciding whether or how much to buy, buyers take account of the cost to society of their actions *if* private and social marginal cost coincide. The equality of price with social marginal cost, by aligning the interest of the buyer with the interest of the community as a whole is a necessary condition for economically efficient resource allocation.

Social cost, in economics, is generally defined in opposition to "private cost". In economics, theorists model individual decision-making as measurement of costs and benefits. Rational choice theory often assumes that individuals consider only the costs they themselves bear when making decisions, not the costs that may be borne by others.

With pure private goods, the costs carried by the individuals involved are the only economically meaningful costs. The choice to purchase a glass of lemonade at a lemonade stand has little consequence for anyone other than the seller or the buyer. The costs involved in this economic activity are the costs of the lemons and the sugar and the water that are ingredients to the lemonade, the opportunity cost of the labour to combine them into lemonade, as well as any transaction costs, such as walking to the stand.

Implications

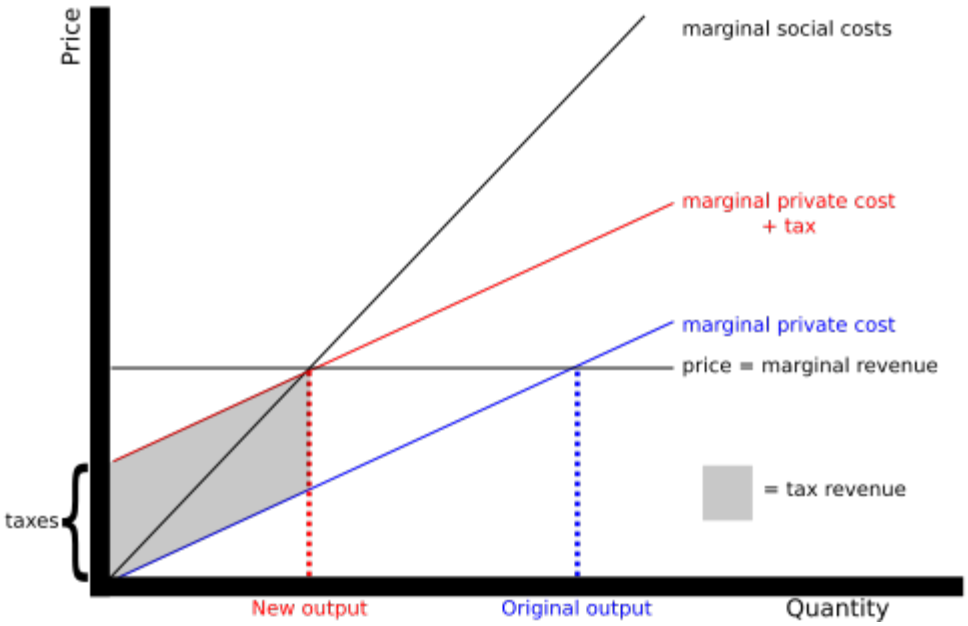
If there is a negative externality, then social costs will be greater than private costs. Environmental pollution is an example of a social cost that is seldom borne completely by the polluter, thereby creating a negative externality. If there is a positive externality, then one will have higher social *benefits* than private *benefits*. For example, when a supplier of educational services indirectly benefits society as a whole but only receives payment for the direct benefit received by the recipient of the education: the benefit to society of an educated populace is a positive externality. In either case, economists refer to this as market failure because resources will be allocated inefficiently. In the case of negative externalities, private agents will engage in too much of the activity; in the case of positive externalites, they will engage in too little. (The marginal rate of transformation in production will not be equal to the marginal rate of substitution in consumption due to the effect of the externality and as a result Pareto optimality will not occur.)

Theory

The ideas of social cost, externalities, and market failure are often used as an argument for government intervention in the form of regulations. Libertarians who believe in a free market respond that the existence of market failure should not lead to government intervention. They prefer to rely on tradition, community pressure, and dollar voting.

Negative externalities (external costs) lead to an over-production of those goods that have a high social cost. For example, the logging of trees for timber may result in society

losing a recreation area, shade, beauty, good quality soil to grow crops on, and air quality but this loss is usually not quantified and included in the price of the timber that is made from the trees. As a result, individual entities in the marketplace have no incentive to factor in these externalities. More of this activity is performed than would be if its cost had a true accounting.



This can be illustrated with a diagram. Profit-maximizing organizations will set output at $\mathbf{Q_p}$ where marginal private costs (**MPC**) is equal to marginal revenue (**MR**). (This diagram assumes perfect competition, under which price (**P**) equals **MR**.) This will yield a profit shown by the triangular area **0**,**C**,**F**.

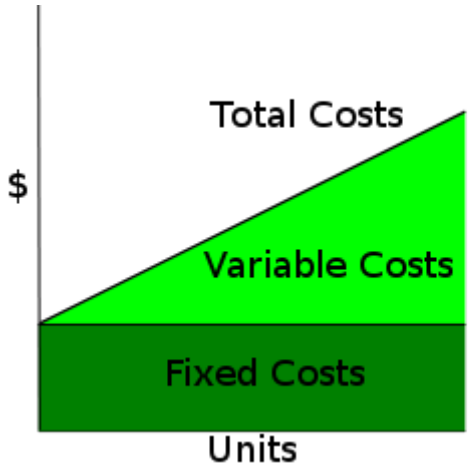
But if externalities are present, the attainment of social optimality requires that the full social costs must be considered. The socially optimum level of output is $\mathbf{Q_s}$ where marginal social costs (**MSC**) is equal to marginal revenue (**MR**). The amount of output, $\mathbf{Q_p}$ minus $\mathbf{Q_s}$, indicates the excess output due to the externality. Profits will decrease also, from **0**,**C**,**F** to **0**,**A**,**F**. It is clearly profitable for the firm to pollute, since "internalizing the externality" hurts profits. The amount of the externality will decrease from **C**,**D** to **B**,**A**.

Because the marginal social cost curve (**MSC**) is *above* the marginal private cost curve (**MPC**), this diagram illustrates the case of a negative externality. If the marginal social cost curve was below the marginal private cost curve, it would be a positive externality and social optimality would require a greater output than $\mathbf{Q_p}$ rather than a reduction of output.

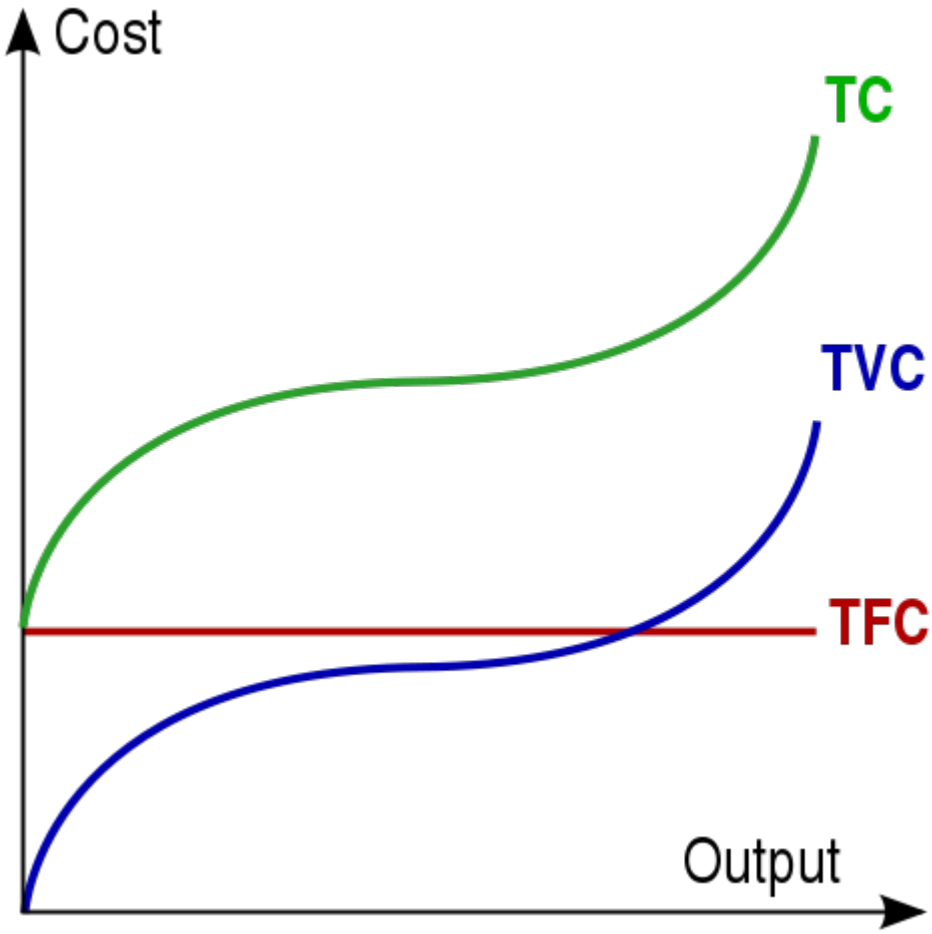
Institutional ecological economists in the tradition of Karl William Kapp provide a different definition of social costs, i.e. that share of the total costs of production that is not born by producers but is shifted to 3rd parties, future generations or society at large. Kapp, hence, rejected Pigou's confusing terminology of externalities and provides several

hundred pages of empirical data to support his argument that social costs are systemic, i.e. rooted in profit maximizing behavior of businesses, and an enormous problem of modern civilization. In the real world, they are usually not or cannot be internalized and must not be considered as accidental minor aberration from the "optimal norm" that can be fixed with ad hoc measures.

Total Cost



One can decompose total costs as the sum of fixed costs and variable costs. In the Cost-Volume-Profit Analysis model, total costs are linear in volume.



The total cost curve, if non-linear, can represent increasing and diminishing marginal returns.

In economics, and cost accounting, **total cost** (TC) describes the total economic cost of production and is made up of variable costs, which vary according to the quantity of a good produced and include inputs such as labor and raw materials, plus fixed costs, which are independent of the quantity of a good produced and include inputs (capital) that cannot be varied in the short term, such as buildings and machinery. Total cost in economics includes the total opportunity cost of each factor of production as part of its fixed or variable costs.

The rate at which total cost changes as the amount produced changes is called marginal cost. This is also known as the marginal unit variable cost.

If one assumes that the unit variable cost is constant, as in cost-volume-profit analysis developed and used in cost accounting by the accountants, then total cost is linear in volume, and given by: total cost = fixed costs + unit variable cost * amount.

The total cost of producing a specific level of output is the cost of all the factors of input used. Conventionally economist use models with two inputs capital, K. and labor, L. Capital is assumed to be the fixed input meaning that the amount of capital used does not vary with the level of production. The rental price per unit of capital is denoted r. Thus the total fixed costs equal Kr. Labor is the variable input meaning that the amount of labor used varies with the level of output. In fact in the short run the only way to vary output is by varying the amount of the variable input. Labor is denoted L and the per unit cost or wage rate is denoted w so the total variable costs is Lw. Consequently total cost is fixed costs (FC) plus variable cost (VC) or TC = FC + VC = Kr +wL.

Other economic models have the total variable cost curve (and therefore total cost curve) illustrate the concepts of increasing, and later diminishing, marginal returns.