10. How are goods and services valued in economics?

Marco Veronese Passarella (University of Leeds)

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1. INTRODUCTION

The search for the cause and the measure of value of products of human activity – be they single basic commodities (e.g. corn), services (e.g. education), complex artefacts (e.g. large-scale infrastructures), or composite accounting entries (e.g. the annual gross domestic product) – was the key motive behind the inception of modern economic thought. Leaving aside Aristotle's pioneering thoughts and Thomas Aquinas' normative precepts, the first attempts to develop a positive theory of value date back to the Seventeenth and the Eighteenth centuries. They trace back in particular to the ground-breaking works of William Petty and Richard Cantillon. However, it was the Classical political economists, notably Adam Smith and David Ricardo, who engaged to formulate a complete theory of value of goods produced and traded within a capitalist society. The latter is characterised by a "free" labour market and the private ownership (or control) of means of production. According to Smith, Ricardo, and other Classical theorists, value is an intrinsic or objective feature of goods and it is best expressed by the cost or effort of production. Thus labour would be not only the cause of value, but also the natural measure of it – although some modifying circumstances should be taken into account in the definition of the value in exchange.

The Classical intrinsic theory of value dominated studies in political economy until the 1870s. It was then replaced by the subjective theory of value developed by the early Neoclassical economists in the last decades of the Nineteenth century. The new, utility-based, approach was so successful that the Classical theory was completely crowded out in the space of three decades or so. Nowadays the vast majority of the economists see value as arising from the subjective preferences of the individual consumer. These preferences are "revealed" by the individual's observable choices. Utility is no longer regarded as a "cardinal" (meaning measurable) magnitude and, methodologically, differential calculus has been replaced with an axiomatic approach. Nevertheless, the current theory still relies on the utilitarian philosophy that inspired the works of the pioneers of the Neoclassical approach. The influence of logical positivism on the new, "ordinal", formulation is also apparent. Building upon these premises, the key learning from this chapter is the different ways in which value has been understood in economics since the mid Eighteenth century. For this purpose, the rest of the chapter is organised as follows. Section 2 focuses on the preference-based theory of value, meaning the approach that dominates microeconomics journals, university modules, and textbooks today. Section 3 is made up of three subsections. It deals with the early Neoclassical (or Marginalist) subjective approach, the Classical intrinsic theory, and current heterodox approaches to value (notably the Marxian theory, the surplus approach, and energy-based theories), respectively. Some remarks are provided in Section 4.

2. CURRENT MAINSTREAM APPROACH TO VALUE

The current dominant view can be defined as a "preference" or "ordinal utility" theory of value. It states that value is defined by the utility of goods and services for the consumer. So value is not a barometer of the effort of production, let alone an intrinsic feature of a certain good or service. On the contrary, value is always individual (as it is something that shows up in the individual consumer's brain, not an inner feature of items "out there") and subjective (as it arises from an individual choice). This means also that interpersonal comparisons of utility are not allowed. However, all the economists need to look at, when analysing the consumer's behaviour, is her system of preferences. These preferences are "revealed" or "disclosed" by the consumer's actual, observable, choices. To understand this point, let us consider an economy where only two goods are available, X and Y, which are continuously divisible. If we assume also that the consumer can rank any two-good bundles by order of preferences, we can draw the map of her indifferences curve (see Figure 10.1[a]). These curves show different bundles of goods between which the consumer is indifferent, that is, from which she gets the same level of "utility". Clearly the consumer's utility increases as she moves off up- and right-wards (i.e. from I_1 to I_2, and from I_2 to I_3, in Figure 10.1[a]).

A "well-behaved" indifference curve between two goods possesses a number of features (see Box 10.1 for the geometrical derivation of such a curve). First, the indifference curve is defined only in the non-negative quadrant of Figure 10.1, meaning that negative quantities of goods are not taken into consideration. Second, it is negatively sloped, meaning that the consumer does never get satiated. In other words, a bundle with more goods is always preferred to a bundle with less of both. Finally, the curve is convex, meaning that if the consumer reduces her consumption of good X, larger quantities of good Y are required to keep her utility unchanged (and vice versa). In formal terms, properties above are guaranteed by completeness, transitivity, continuity, and strong monotonicity of the indifference curves.[1] The slope of the indifference curve in each point measures the so-called "marginal rate of substitution" (MRS), meaning the amount of good X the consumer is ready to give up in exchange for a unit of good Y while maintaining the same level of satisfaction. The MRS is usually different at each point along the indifference curve. Two extreme cases are worth mentioning. If goods X and Y are perfect substitutes (for example, cane sugar and beet sugar) then indifferences curves are parallel (negatively-sloped) straight lines and the MRS is constant (see Figure 10.3[a]). By contrast, if X and Y are perfect complements (for example, cane sugar and coffee) then indifference curves become L-shaped and the MRS is either zero or infinite (see Figure 10.3[b]). In principle, each type of indifference curves can be associated with a different type of utility functions.[2] The concept of utility is not strictly necessary to define consumption patterns for the individual consumer. As Lionel Robbins (1932) clearly stated, all is necessary is that the consumer's ends are classifiable in order of

[1] A detailed discussion of features above is out of purpose of this chapter. The interested reader can refer to a "standard" microeconomics textbook.

[2] Straight indifference curves can be associated with a linear utility function, that is: $U(x,y) = A + a \cdot x + b \cdot y$, where $A, a, b \geq 0$ are parameters. L-shaped curves can be associated with a Leontief function, that is: $U(x,y) = \min(a \cdot x, b \cdot y)$. Finally, a well-behaved indifference curve is usually associated with a Cobb-Douglas function, that is: $U(x,y) = A \cdot x^a \cdot y^b$, where $b = 1 - a$ and $0 \leq a \leq 1$.

importance. However, utility functions are still used by most textbooks to provide intuitive representation of the consumers' preferences.

The indifference curve is one of the two fundamental concepts which underpin current consumer theory. The other fundamental concept is the budget constraint. Taken together, these analytical tools allow deriving the demand curve for the consumer. The budget constraint can be represented in the indifference map as a negatively-sloped straight line. It shows all the two-good bundles that are affordable for the consumer. Intuitively, the point that maximises the consumer's satisfaction is the one at which the indifference curve is tangent to the budget constraint line (point E in Figure 10.1[b]). Notice that the slope of the budget line shows the relative price of good X in terms of good Y. In formal terms:

$$B = p_x \cdot x + p_y \cdot y$$

and hence:

$$y = \frac{B}{p_y} - \frac{p_x}{p_y} \cdot x$$

where B is the budget constraint for the individual consumer (say, her own disposable income), whereas p_x, p_y, x, and y are prices and quantities of goods X and Y, respectively.

Clearly, the higher the price of good X, given the price of good Y, the steeper will be the budget constraint line (i.e. the budget line rotates towards the origin, moving from E_2 to E_1, in Figure 10.2[a]).[3] This means that the quantity of good X chosen by the individual consumer falls as the price increases.[4] Individual demand is therefore a negative function of the unit price of goods (see Figure 10.2[b]). Given certain assumptions, a negatively-sloped aggregate demand curve can then be obtained by aggregating together individual consumers' demand curves. Similarly, a positively-sloped aggregate supply can be obtained by adding together individual firms' supply curves. Each firm combines together inputs (notably, labour and "capital") to maximise profit. Equilibrium price and output are determined by the interaction of aggregate demand and aggregate supply. Perfect competition conditions ensure that consumers' MRS eventually equal firms' "marginal rate of transformation" (MRT).[5] Under a competition equilibrium, consumers manage to maximise their own satisfaction, while goods are produced in the most efficient way. Prices are scarcity indexes.

The utility approach to value is not just a *positive* theory, meaning a theory that *explains* what the actual value of things "out there" is. It is also a *normative* theory of value, meaning a theory that *states* how things should be assessed. In fact, it is frequently used by the policy-makers to appraise projects and policy proposals. The problem is that if utility is individual

[3] If we assume that Y is the vector of all products of the economy except for good X, the budget line expresses the individual valuation of X relative to market valuation of X.
[4] By contrast, the demand for good Y increases. This happens for normal goods, for which the *substitution effect* (i.e. Y is now relatively cheaper, and the consumer demands more units of Y) dominates the *income effect* (i.e. the consumer's real income has been soaked up, so that she reduces her consumption of both X and Y).
[5] The MRT is the quantity of good X that must be sacrificed in order to produce an additional unit of good Y, assuming that both goods are produced by means of the same scarce inputs.

and subjective, it can be hardly observed or measured. As a result, interpersonal comparisons are arbitrary and "collective" (or "social") welfare can be hardly defined in general terms. Ironically, "welfare economics", which was developed by Arthur Cecil Pigou and other economists of the early Twentieth century to analyse wellbeing at the society-wide level, is grounded in the very utility theory of value (Pigou 1920). As welfare economics is invoked to justify most traditional government policies (think of egalitarian policies, redistributing income from the wealthy to the poor), these turn out to lack scientific rationale. How to get out of this impasse? Fortunately, there are some concepts through which the utility theory of value can still be made operational, notably, the individual willingness to pay, Pareto efficiency and optimality criteria, and the compensation test. In short, a certain policy is worth doing if the maximum amount that the gainers are willing to pay to the losers (to accept the policy) is greater than the minimum amount the losers are willing to accept. No cardinal measurement of utility is necessary to appraise social wellbeing and make decisions. This approach is an extension of Vilfredo Pareto's efficiency criterion (Pareto 1896, 1906) and was developed in the 1930s by Nicholas Kaldor (1939) and John Hicks (1939). When evaluating a certain change, there is a Pareto improvement when at least one individual is made better off and no one is made worse off. The Kaldor-Hicks efficiency criterion states that there is a rise in efficiency when a "Pareto-superior state" is reached by arranging sufficient money compensations from the individuals who are made better off to those who are made worse off, so that everyone ends up no worse off than before.[6] The standard example is the compensation for pollution paid by a factory: the latter should be allowed to pollute until it can compensate its neighbourhoods for the losses they suffer because of pollution (see Box 10.2 for a criticism of this view).

3. ALTERNATIVE APPROACHES

3.1 Early Neoclassicals and the cardinal utility approach

The utility theory of value traces back to the so-called "Marginalist revolution" which took place in the last three decades of the Nineteenth century and has established itself as the dominant approach in economics ever since. It was Stanley Jevons (1871), Léon Walras (1874), Carl Menger (1871), and especially Alfred Marshall (1890), who put marginal utility at the heart of a new way of doing economic theory that was then termed "Neoclassical economics".[7] As mentioned in the second section, Neoclassical economists advocated the

[6] Notice that, unlike a Pareto efficiency improvement, a Kaldor-Hicks improvement could in fact leave some individuals worse off (e.g. the set of Pareto improvements is a subset of Kaldor-Hicks improvements). In addition, such compensation has only to be potential. It is sufficient that the gain of individuals who are better off could theoretically outweigh the loss suffered by individuals who are worse off (so that the former could pay the latter to make them indifferent to the new state). All in all, the Kaldor-Hicks criterion is a useful way to measure how far a given state is from Pareto efficiency and whether a certain policy can make it more efficient.

[7] The adjective "Neoclassical" was coined by Thorstein Veblen to label Marshall's approach. Marshall himself saw his own work in continuity with the ideas of Classical political economists, notably Smith and Ricardo. For Marshall, prices are only determined by marginal utility in the short run, as supply cannot be augmented and market prices depend mainly on demand. By contrast, machines and buildings have to be replaced in the long run, so that prices are determined by replacement expenses and other "objective costs", as advocated by the

idea that things are valuable because the individual gets satisfaction from them. More precisely, the value of a certain good is defined by the utility the consumer gets from the last dose of it. Neoclassical authors built, in particular, upon the pioneering works of Jeremy Bentham, Hermann Heinrich Gossen, and other "outsiders", in a period that was dominated by the cost-based approach to value advocated by Classical political economists. From Bentham (1789), the Neoclassicals borrowed the reduction of individual behaviour to a maximising calculus of pleasure and pain deriving from consumption. From Gossen (1854), they got both the principle of decreasing marginal utility and the principle of equality of weighted marginal utilities. The former means that the satisfaction obtained from consumption decreases as the quantity consumed increases. In formal terms:

$$u_i' = \frac{du(q_i)}{dq_i} \geq 0, \text{ with } u_i'' = \frac{d^2u(q_i)}{dq_i^2} < 0$$

where u_i' stands for the marginal utility of the i-th good (say, either X or Y in the second section), $u(\cdot)$ is the utility function of the consumer, q_i is the quantity of the i-th good, and u_i'' is the second derivative of the utility function (e.g. the derivative of marginal utility).

Gossen's second principle means that the consumer maximises her wellbeing when she manages to balance her marginal satisfactions per unit of value across different goods. In formal terms, the equilibrium or maximum satisfaction condition is:

$$\frac{u'(x)}{p_x} = \frac{u'(y)}{p_y} = \cdots = \frac{u'(z)}{p_z}$$

where x, y and z are quantities of goods X, Y and Z, respectively, and p_x, p_y and p_z are their unit prices. Money can be now taken into consideration by assuming that z stands for the amount of gold (so that we can take its price as the *numeraire*, $p_z = 1$), be it either in form of coins or bars. If a constant marginal utility of gold-money is assumed, unit prices can be re-expressed as a direct function of marginal utility of goods. For instance, the unit price of X in terms of gold is:

$$p_x = \frac{u'(x)}{u'(z)} \cdot p_z = \frac{1}{\bar{u}_z} \cdot u'(x)$$

where $\bar{u}_z$ is the constant marginal utility of gold-money. This fundamental result was first obtained by Marshall in his *Principles of Economics* (1890). It allows bridging the gap between the utility theory of value and the determination of individual demand schedules, as it makes clear that the unit price of good X falls as the consumption of it increases (thereby reducing the marginal utility of X).[8] This is the original formulation of the Neoclassical

Classicals. However, other Marginalist economists, especially Stanley Jevons and Léon Walras, regarded their own approaches as opposed to the Classical one.

[8] Notice that Marshall, unlike other Neoclassical economists, takes the price as the dependent variable, while regarding quantity as the independent variable. Incidentally, Marshall was also the economist who popularised the standard demand and supply graph. This is the historical reason economists still put the price (which is usually regarded as the independent variable) on the vertical axis, while measuring quantity along the horizontal axis.

principle of decreasing individual demand we presented in the second section. It enabled Marshall to work out the "consumer surplus" (or "consumer rent"), meaning the psychological gain linked with the difference between the market price the individual consumer pays for a certain good and the price she would be willing to pay for intra-marginal doses of it (e.g. area ABC in figure 10.2, assuming that $p_{x,2}$ is the market price). When the cardinal utility theory of value gave way to the ordinal approach, Marshall's derivation of individual demand was replaced with the modern method based on indifference curves.

Despite its popularity, the utility theory of value suffers from many limitations. We have already mentioned that the impossibility of interpersonal comparisons of utility is one of the main issues with the cardinal approach to value advocated by the early Neoclassicals. The hypothesis of constant marginal utility of money has also been questioned, because money utility is very likely to be affected by income and wealth levels of individuals. On the other hand, the current (ordinal) approach is not free from criticism either. The main issue concerns the way individual preferences are defined. Preferences cannot always be inferred by choices. For instance, individuals cannot always choose what they prefer (think of health, beauty, etc.). In addition, individual preferences are not innate and context-free, but are affected by social interactions with other individuals and the environment. Furthermore, rationality of individuals is always bounded, as they make decisions in an uncertain world. As a result, their behaviour can hardly be described by a maximisation function under constraints.[9] Finally, both the ordinal approach and the cardinal approach to value regard prices, including input prices, as "indexes of scarcity". This is the fundamental assumption that lies behind the neoclassical theory of distribution. However, the scarcity-based theory of prices and distribution has been questioned by several economists since the 1960s. This point is discussed in subsection 3.3.

3.2 The Classical approach to value

Historians of economic ideas are still wondering whether Marginalism was a real revolution, meaning a radical change in the paradigm of economic science. While Jevons, Walras, and Menger, distanced themselves from Classical tradition, Marshall saw his own contribution as a development of Smith, Ricardo and Mill's works. After all, the new approach was to be labelled Neo… classical.[10] Most Marginalists, like most Classical economists before them, supported *laissez-faire* in economic policy. They also shared the view of the economy as a spontaneous equilibrium system ruled by natural-like laws. Yet differences are particularly apparent when focusing on the theory of value. In a sense, if Marginalism was a revolution, it was a revolution against the Classicals in the meaning of Karl Marx, that is, a rebellion against the Ricardian intrinsic approach to value. Notice that it was Marx to coin the definition "Classical Political Economy". He meant a theoretical system based on the analysis of interactions between (and within) social classes, a theory of surplus creation and distribution, and an intrinsic theory of value. For Marx the benchmark theory was the one developed by Ricardo, while Smith was sometimes criticised for his theoretical ambiguities.

[9] For a thorough critical review of standard unbounded-rationality microeconomics, see Lavoie (2014), ch. 3.
[10] See again footnote 7. See also Screpanti and Zamagni (2005), ch 5.1.1.

Yet Smith was the first author who provided a complete formulation of an intrinsic theory of value. In *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776), he clearly defined the "value in use" (or "use-value") and the "value in exchange" (or "exchange-value").[11] The former is associated with the want-satisfying power of a good, say X, and roughly corresponds to the early-Neoclassical concept of utility. The latter is the power of purchasing other goods which the possession of X conveys. We can also define it as the quantity of the good (or goods) Y which a unit of X can be exchanged for. In formal terms:

$$\varepsilon_{x,y} = \frac{p_x}{p_y}$$

A positive use-value is a necessary condition for a certain good to have a positive value in exchange. If no one is willing to consume it, the exchange value of X is null. However, for Smith utility is not a proper measure of the value in exchange, let alone a source of intrinsic value.[12] Rather a good possesses an intrinsic value because it is produced by means of human labour. More precisely, labour is the cause and the unit of measure of value. Yet the exchange value is defined by the ratio between prices within capitalism. The market price gravitates towards a natural equilibrium level, termed "natural price" by Smith. The natural price is the price that would prevail if workers, landowners and capitalists were all free to move where they get paid the most, thereby levelling their own respective remuneration rates across the economy. For the sake of simplicity, let us assume that capital is made up of wages only and lands are plentiful and free, so no rent is paid to use them. The unit natural price of the i-th good can be simply expressed as follows:

$$p_i = l_i \cdot w \cdot (1 + r_i)$$

where l_i is the labour coefficient (meaning the quantity of labour spent to produce a unit of the i-th good), w is the natural wage rate of workers, and r_i is the natural profit rate of capitalists in the i-th sector.[13]

It is now easy to show that if the rate of profit is positive, the quantity of labour "embodied" in the i-th good falls short the quantity of labour that the same good enables its possessor to "command" or "purchase". In formal terms:

$$\frac{p_i}{w} = l_i \cdot (1 + r_i) > l_i, \text{for } r_i > 0$$

[11] Notice that Classical political economists and Marx used to use the term "commodities" instead of "goods". For the sake of uniformity, we keep on referring to "goods" hereafter.

[12] Smith uses the well-known "diamond-water paradox" to support his point. In short, a pint of water is more useful than an ounce of diamonds, but the former is cheaper than the latter. Value in exchange has nothing to do with utility. The Marginalists would counter-argue that Smith should have looked at the marginal utility, meaning the relative scarcity of diamonds compared to water, to solve the paradox. However, the point is that for Smith the value in exchange must be traced back to production conditions.

[13] Unlike wage rates, natural profit rates are assumed to be uniform within sectors, but not across sectors (due to technological, institutional, or geographical barriers to entry). This hypothesis is not explicitly advocated by Smith. However, it allows explaining why, for Smith, the embodied labour-theory of value does not hold true (as a theory of relative prices) even within a simplified capitalist economy where labour is the only input.

It is clear that labour commanded is a relative price, as it is the price of goods in terms of the price of labour (i.e. the nominal wage rate paid to workers). An important corollary follows that natural price ratios must mirror labour commanded ratios, whereas, in general, they differ from embodied labour ratios. In formal terms:

$$\varepsilon_{x,y} = \frac{p_x}{p_y} = \frac{l_x \cdot (1 + r_x)}{l_y \cdot (1 + r_y)} \gtrless \frac{l_x}{l_y}, \text{ for } r_x \gtrless r_y$$

where x and y are quantities of good X and Y, respectively.

The (relative) quantity of labour which a certain good enables its possessor to command, not the labour embodied in that good, defines its exchange value. Notice that the goal of Smith was not just to show how value of products is set in. Looking at the economy as a whole, the concept of labour commanded allows Smith to achieve his real target, that is, to find a stable and reliable measure of the "wealth of nations". If the money wage rate of workers is assumed to be uniform across sectors and constant over time, it can be used as a deflator of the domestic product. The latter can be expressed in (commanded) labour units, which are independent of the ebb and flow of market prices. In addition, the higher the gap between the labour commanded by the net domestic product of a certain nation and the labour embodied in it, the higher the surplus available for accumulation. This is the reason Smith does not advocate a pure labour-theory of value. Such a theory can be applied to an "early and rude" state of society, where no accumulation takes place (so that $r_x = r_y = 0$), but it is not fit for a well-developed capitalist society. However, value is still an intrinsic property of goods. Although it is realised on the market, value is determined by production conditions.

At the beginning of the Nineteenth century, Smith's theory of value was recovered and developed by David Ricardo. In a sense, Ricardo engaged to clean up Smith's theory from a few logical inconsistencies. The starting point of Ricardo's theory can be best explained by taking into consideration an abstract society where workers' real wages are only made up of corn. For the sake of simplicity, let us assume also that corn is produced by means of labour only. In the corn sector, capital is advanced by capitalists in the form of a corn wage-bill paid to workers. Consequently, the rate of profit can be worked out in physical terms (meaning in corn terms, see Figure 10.4), regardless of the price system. If a decreasing fertility of lands is assumed, so that labour productivity in the corn sector falls as both the extension and the intensity of farming increases, the rate of profit of the corn sector eventually declines. Finally, since competition between capitalists leads to equalise profit rates across sectors, sooner or later the general rate of profit will fall as well (see Box 10.3 for a formal outline of the corn model). Ricardo can therefore argue that tariffs, quotas and other restrictions on imported agricultural products end up squeezing the profit rate of the manufacturing sector (while inflating rent of landowners), thereby discouraging capital accumulation.[14]

[14] It must be mentioned that Ricardo developed his theory with the aim of questioning the so-called "Corn Laws". These were restrictions and tariffs on imported grain, which were enforced in the United Kingdom between 1815 and 1846.

Ricardo's analysis of income distribution in terms of corn is fascinating and elegant. However, it can be hardly generalised. A different unit of measure of value is necessary to extend the properties of a corn-based economy to a society where workers afford to buy a composite bundle of wage goods. In the *Principles of Political Economy and Taxation* (1817, and subsequent editions) Ricardo committed to generalising his point by advocating an embodied labour theory of value. One of the main issues with Smith's theory of labour commanded is that it is affected by circularity, for Smith attempts to explain the natural price of goods by means of another price, namely, the price of labour.[15] By contrast, labour contents can be shown to determine natural prices (and exchange rates) also within a capitalist society. In a nutshell, if labour is the only primary input in production, and competition levels out profit rates across sectors, natural price ratios mirror embodied labour ratios. In formal terms:

$$\varepsilon_{x,y} = \frac{p_x}{p_y} = \frac{l_x \cdot (1 + r_x)}{l_y \cdot (1 + r_y)} = \frac{l_x}{l_y}, \text{ for } r_x = r_y = r$$

The quantity of direct labour spent in the production of a certain good is, therefore, the measure of both its intrinsic value and its exchange rate with other goods.

Unfortunately, the wage bill is not the only sum advanced by the capitalists. Other means of production, say machines, are also bought and employed as inputs besides labour. Techniques of production, meaning both the number of machines per employee and production times, vary across sectors. This affects the relative value of products. As a result, price ratios no longer reflect labour content ratios, except for the very special case in which everything is produced by the same technique. Clearly this never occurs, and if it does so, it is only by chance (see Box 10.4). Ricardo was well aware of this issue, but he thought that labour contents could still provide a decent empirical measure of value.[16] However, this analytical flaw, along with other "external" factors, paved the way for the replacement of the labour theory of value with the utility-based approach advocated by the early Neoclassicals.

3.3 Alternative approaches to value: Marx' and Sraffa's "critiques"

While dropped by Neoclassical economists and the academia, the baton of Classical theory of value was picked up by socialist thinkers of the Nineteenth century, particularly by Karl Marx and his co-writer Friedrich Engels. For Marx, Classical economists were guilty of

[15] In fact, there are four issues with Smith's approach. First, while Smith claimed that labour is the primary source of value, he ended up developing also an "adding-up theory of value", where the natural price is determined by (not just expressed as) the summation of natural income rates. Second, Smith failed to recognise that the rent is not a cost of production (as, in contrast, it arises from differences in fertility of lands) and it does not affect the natural price (because the latter is worked out in the least fertile plot of land). This is the reason the rent has been dropped by natural price equation above. Third, Smith did not realise that a commanded theory of labour can be advocated if and only if profit is regarded as a residue, meaning the residual income that remains after wages have been deducted from net product. Finally, the hypothesis of constancy of the (nominal) wage rate (which is necessary to compare commanded labour figures over time and across countries) is hardly tenable.

[16] It seems that Ricardo was not that wrong after all. It has been recently shown that labour contents interpreted as "underlying regulators of prices, turn out to have strong empirical backing" (Shaikh 1998, p. 226).

taking for granted the system of capitalism. They had failed to identify and explain its historical specificity. The analysis of capitalism's "laws of motion" and "internal contradictions" had to be at the heart of the critique of political economy, meaning both the criticism and the refinement of Classical analytical toolkit. Focusing on the theory of value, there are three main innovations made by Marx: first, the replacement of Ricardo's "microeconomic" theory with a social (or "macroeconomic") approach to value; second, the clear recognition of the monetary form of value; third, the use of the labour theory of value to show that the "surplus value" earned by the capitalists arises from the exploitation of workers in the "production sphere".[17] The labour market is the fundamental institution of capitalism. Within a capitalist society, workers are free before the law.[18] To provide for themselves, they sell the only "commodity" they possess, their own "labour force", to industrial capitalists in exchange for a money wage. In the factory, workers spend labour to produce heterogeneous goods marked by different use values. Accordingly, this labour takes many different concrete forms. Each concrete labour time is a fraction of the society-wide labour time. It becomes socially necessary abstract labour, and hence social value, to the extent that products are sold on the market in exchange for money. In other words, value is created *in potentia* within the production sphere, but must be then socially validated (or realised) within the circulation sphere. While circulation may well "destroy" value (when a "realisation crisis" occurs, due to overproduction), it cannot add value to products at the economy-wide level.

The point is that inter-capitalist (or inter-firm) trade is a zero-sum game for the capitalist class taken as a whole. The profit made by one capitalist is here offset by the loss suffered by another capitalist. Consequently, the origin of surplus value, meaning the difference between the amount of money "advanced" by the capitalists at the beginning of the economic process and the amount they realise at the end, must be searched for in the production sphere. For Marx, this surplus value can only come from the *excess* of the working day over the time *necessary* to reproduce the labour force. The latter is the time it takes to produce the bundle of consumption goods workers purchase back by spending their own wage on the market. In other words, capitalists' surplus value (or profit) arises from unpaid labour, for workers are paid a wage that allows them to consume just a share of the entire (net) product. The rate of exploitation of the working class is, therefore, defined by the rate of surplus labour, meaning the ratio of the surplus labour time to the necessary labour time. Having clarified this, Marx goes on and shows that the general rate of profit of the economy is a linear, positive, function of the rate of surplus labour. The former is the uniform rate which is charged over production costs if capitalists are free to move their capitals across sectors. When fixed capital (say, machines) and non-wage circulating capital (for instance, row materials) are taken into account as inputs,[19] competition and other market forces are likely to drive relative output prices away from relative labour contents. This is the problem faced by Ricardo indeed. However, at the economy-wide level the summation of prices is always proportional to the

[17] The Classicals and the so-called "Ricardian socialists" understood that the surplus must arise from "unpaid" labour, but they attributed it to the prevailing conditions in the circulation sphere.
[18] Meaning that they are no longer serfs, as in a feudal society, or slaves, as in a slave society.
[19] Marx terms the value of this capital component the "constant capital", while the component that is turned into wages is named the "variable capital".

summation of labour contents, and total profit (determined by the general rate of profit) is always proportional to total surplus labour (determined by the exploitation rate). Prices and profit are nothing but transformed forms of labour contents and surplus labour, respectively (see Box 10.5 for a more detailed presentation). For Marx, Ricardo's conundrum had been eventually solved, while his critique of classical political economy had turned into a critique of capitalism and its exploitative nature.

Marx's rendition of the labour theory of value gave rise to one of the most long-lasting controversies in the history of economic (and philosophical) thought. The point is that Marx's explanation about how to "transform" labour contents (or labour-values) into competition prices (or reproduction prices) was incomplete.[20] None of the repeated attempts to develop or amend it made by the Marxist theorists between the end of the Nineteenth century and the beginning of the Twentieth century were entirely convincing. In addition, the socialist turn of the Classical approach was regarded as politically unseemly in major Western universities. As a result, the Classical approach to value was discredited and marginalised until the 1960s, when it was revamped by Piero Sraffa's major work, *Production of commodities by means of commodities. Prelude to a critique of economic theory*. Two are the main points made by Sraffa: first, the Marginalist-Neoclassical theory of value and distribution is affected by a fatal flaw;[21] second, relative (reproduction) prices can be worked out without any reference to utility functions or individual preferences. For this purpose, capitalism must be regarded as a circular production process generating a physical surplus. All is necessary to define relative prices is the knowledge of the economy-wide technique of production. In the case of an economy with single-product industries, the set of techniques is given by the vector of labour coefficients and the matrix of interindustry coefficients. For example, in a two-industry (and two-good) economy the price system would be:

$$p_x = \left(l_x \cdot w + p_x \cdot a_{xx} + p_y \cdot a_{xy}\right) \cdot (1 + r)$$

$$p_y = \left(l_y \cdot w + p_x \cdot a_{yx} + p_y \cdot a_{yy}\right) \cdot (1 + r)$$

where a_{xx} is the quantity of good x (say, quarters of corn seeds) used as an input to produce one unit of the same good (for example, one ton of corn), a_{xy} is the quantity of good y (say, tons of iron) used as an input to produce one unit of good x (one ton of corn in our example), and so on. Notice that, unlike Sraffa, we stick to the Classical assumption that workers are paid in advance, so that profit accrues on the total capital advanced, including wages.

When $n > 2$ industries are taken into consideration, the price system can be generalised and defined in matrix terms as:

[20] The analysis of value and exploitation is provided by Marx in the first volume of *Capital* (1867), whereas the "transformation" procedure is described in the third volume. The latter was outlined by Marx between 1863 and 1883. However, the manuscript was completed and published in 1894 by Engels, eleven years after the death of Marx .

[21] In short, the point is that there is no simple monotonic relationship between the kind of the techniques of production used and the rate of profit. It may well be the case that more capital-intensive techniques are associated with higher profit rates. Remuneration rates of inputs do not mirror inputs' marginal productivities and prices are not indexes of scarcity. The Marginalist-Neoclassical theory of production, value and distribution lacks foundation.

$$\mathbf{p}^T = (\mathbf{l}^T w + \mathbf{p}^T \mathbf{A}) \cdot (1 + r)$$

where $\mathbf{p}^T = [p_j]$ is the $1 \times n$ row vector of reproduction prices,[22] $\mathbf{l}^T = [l_j]$ is the $1 \times n$ row vector of direct labour coefficients, and finally $\mathbf{A} = [a_{ij}]$ is the $n \times n$ matrix of technical coefficients.[23]

We have n price equations and $n + 2$ unknowns (namely, n prices plus the wage rate and the profit rate). The system can be solved by taking the price of a certain good or the net product of the economy as the *numeraire* and by setting exogenously either w or r. As a result, prices are determined by conditions of production, as claimed by the Classicals and Marx. In addition, income distribution does no longer reflect marginal productivities of labour and capital, respectively. On the contrary, it must be defined "from outside the system", as it depends on a number of institutional factors, including class struggle and the monetary policy stance. Finally, while Sraffa's system does not rely on the labour theory of value, and in fact has been regarded by many theorists as a rejection of it, the two approaches are not necessarily at odds. If the monetary value added of the economy is assumed to be proportional to the total direct labour, the surplus value (or profit) earned by the capitalists is proportional to the surplus labour spent by the workers in the production sphere.[24]

3.4 Alternative approaches to value: energy-theories of value

The publication of *Production of commodities* went along with a renaissance of Classical political economy in the 1960s-70s. Interestingly, Sraffa's approach shares a number of features with an earlier contribution of the Hungarian-American mathematician and physicist John Von Neumann (1937).[25] It is also very akin to the input-output analysis developed by Wassily Leontief (1941, 1986). The latter may well be regarded as a pioneering empirical application of Sraffa's later theoretical work. The Von Neumann-Sraffa-Leontief approach, or surplus approach, is suitable for the empirical analysis of structural interdependencies between industries.[26] However, its popularity has been falling in North-American and European economics divisions since the early 1980s. Predictably, the shelving of the surplus approach has gone along with a reduction in the interest of the economists in theories of value. If value is defined by individual preferences, all the economist is interested in is either the good's price within a competitive market or (if markets are absent or imperfect) individual willingness to pay for it.

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[22] Notice that the superscript "T" is a mathematical convention and stands for "transpose of matrix". In the equation above it means the transpose of a column vector, which of course is a row vector.

[23] Each technique of production is therefore defined by $\mathbf{l}^T$ and $\mathbf{a^j} = [a_i^j]$, where each element a_i^j is the quantity of good i used as an input to produce a unit of good j. Notice that matrix $\mathbf{A}$ is assumed to be viable, meaning that it has a maximum eigenvalue $\lambda_m < 1$. Given the $n \times 1$ column vector of outputs, $\mathbf{q} = [q_j] \in \mathbb{R}_n^+$, it follows that $\mathbf{q} > \mathbf{Aq}$. Finally, notice that if wages were to be paid "*post factum*, as a share of the annual product", the price system should be redefined as: $\mathbf{p}^T = \mathbf{l}^T w + \mathbf{p}^T \mathbf{A} \cdot (1 + r)$. This is the formulation proposed by Sraffa (1960, p. 11) to highlight the class conflict over the distribution of net product.

[24] In formal terms, the "price of production" of net product is defined as: $\mathbf{p}^T[\mathbf{I} - \mathbf{A}]\mathbf{q}$. The Marxian theory of value can be then traced back to the assumption that: $\mathbf{p}^T[\mathbf{I} - \mathbf{A}]\mathbf{q} = m\,\mathbf{l}^T\mathbf{q}$, where m is usually defined as the "monetary expression of (social) labour time". This is the assumption that underpins the so-called "single-system interpretation" of the labour-theory of value (see Duménil and Foley 2008).

[25] See Kurz and Salvadori (2001).

[26] Surplus theorists are sometimes labelled "Neo-Ricardians", because of the resemblance with Ricardo's theory.

While being set aside by most economists, the inquiry into the nature and causes of (intrinsic) value has revamped within the field of ecological economics since the late 1970s. Environmental scientists and ecological economists usually distinguish the "instrumental value" from the "intrinsic value" of things. The instrumental value is defined as the value reflecting the difference that a good makes to satisfaction of individual wants. It roughly corresponds to the "marginal utility". The intrinsic value is the value of "maintaining the health and the integrity of an ecosystem or species, per se, irrespective of human satisfaction" (Farber *et al*. 2002, p. 376). Building upon this view, many scientists have proposed an (embodied) energy-theory of value, aiming either to complement or replace utility-based theories of value. Solar energy is usually regarded as the only primary (scarce) input, meaning the only source and measure of intrinsic value, whereas labour and capital are just intermediate goods or inputs.[27] The main strength of energy theories of value is that, while anchoring value to thermodynamic laws and energy consumption, they provide a method of valuation which does not depend on consumers' preferences. In this sense, they show a clear similarity with the Classical theory and the surplus approach.[28] A second strength of energy-theories of value is that they are rather intuitive, as all goods and services require a certain amount of available energy to be produced. A third strength is that, like both the Classical and the surplus approaches, the energy-based one provides a method of valuation that does not rely on utility-functions, demand and supply schedules, or individual preferences. Since the measure of value is independent of income distribution and prices, the energy-based approach is also unaffected by the logical flaw that marks the Neoclassical theory of price and distribution. While the energy-based approach is not free of criticisms either (see Box 10.6), it seems highly palatable for environmental scientists and policy-makers,[29] and it could lead to a new renaissance of the Classical approach.

4. CONCLUSION

"What the cause and the measure of value of products are" was the fundamental question that marked the inception of modern economic thought (see Table 10.1 for an overview). Current mainstream approach regards value as arising from the individual's preferences. The latter are revealed either by the individual's observable choices or by her own willingness to pay. This approach is grounded in the utility-theory of value developed by the early Neoclassicals since the end of the Nineteenth century. In fact, current preference-based approach may well be regarded as an "ordinalist" rendition of the idea that value is defined by the subjective utility the individual derives from the consumption of the last (or marginal) unit of a certain

[27] Like the surplus approach, energy-theories of value are usually modelled through a system of simultaneous linear equations (e.g. Costanza and Hannon 1989). More precisely, the price system can be expressed as follows: $\mathbf{p}^T = \mathbf{e}^T[\mathbf{O} - \mathbf{A}]^{-1}$, where $\mathbf{e}^T = [e_j]$ is the $1 \times n$ row vector of net inputs of solar energy, $\mathbf{O} = [o_{ij}]$ is the $n \times n$ output matrix, $\mathbf{A} = [a_{ij}]$ is redefined as the $n \times n$ input matrix, and $\mathbf{p}^T = [p_j]$ is redefined as the $1 \times n$ row vector of energy prices. The system of relative energy prices is solved by assuming that solar energy is the *numeraire*.

[28] In fact, energy-theories of value show an even closer resemblance with pre-Classical theories developed by William Petty and Richard Cantillon in the seventeenth century.

[29] The net value of a certain public project, say a wind farm, can be measured by the quantity of energy that can be produced, net of building and maintenance energy costs. Similarly, the net value of a road, a bridge, or a railway, can be calculated as the algebraic difference between energy benefits and energy costs.

good. This is the usual story told by intermediate microeconomics textbooks. Yet the utility- or preference-based theory was not the dominant approach when political economy arose as an independent discipline from the moral philosophy. On the contrary, for Smith, Ricardo, and other Classical theorists, value was an intrinsic (or objective) feature of goods and it was best expressed by their labour content. While it was being progressively abandoned by academic economists, the labour-theory of value was used by Marx to found his critique of both the then-dominant view in economics, that is, the Classical political economy, and its subject, capitalism. This heretical line of research sat on the side-lines of the academic debate until the early 1960s when it was revamped by Sraffa. Sraffa provided both a harsh criticism of the new dominant approach, the Neoclassical one, and a logically sound rendition of Classical (and Marx's) intrinsic theory of relative prices, termed the surplus approach. The latter enjoyed great popularity in the 1960s-70s but it was gradually neglected by most economists since the 1980s. Interestingly, the early pioneering energy-based theories of value were developed in the same years. These theories show a noteworthy resemblance with the Classical and surplus approaches. Nowadays the debate around how goods and services are, or should be, valued is still very open (despite microeconomics textbooks and modules being dominated by the preference-based view) and encompasses a plurality of disciplines.

5. SEMINAR ACTIVITIES/DISCUSSION QUESTIONS

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FIGURES, TABLES AND BOXES

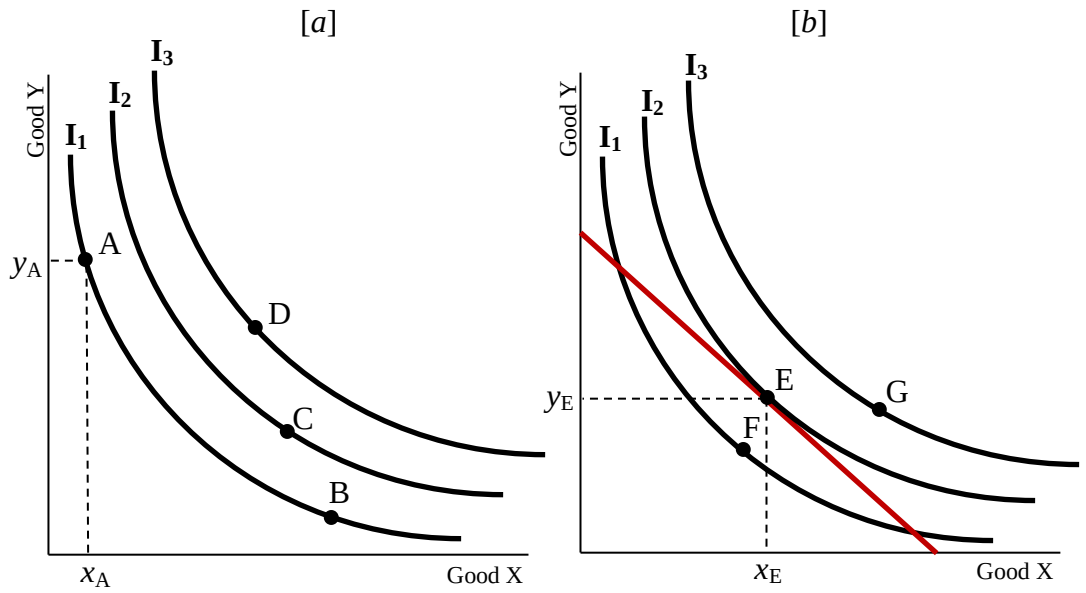


Figure 10.1 A map of indifference curves. Looking at chart [*a*], bundle A is made up of y_A units of good Y and x_A units of good Y. The consumer is indifferent between bundle A and bundle B, but prefers bundle C to bundle A (and bundle B), and prefers bundle D to bundle C. In chart [*b*] the consumer's budget is taken into account. The equilibrium point is E, where the "highest" indifference curve is tangent to the budget constraint line. Point F is affordable but does not maximise the consumer's satisfaction, whereas point G is preferred to E but it is not affordable by the consumer.

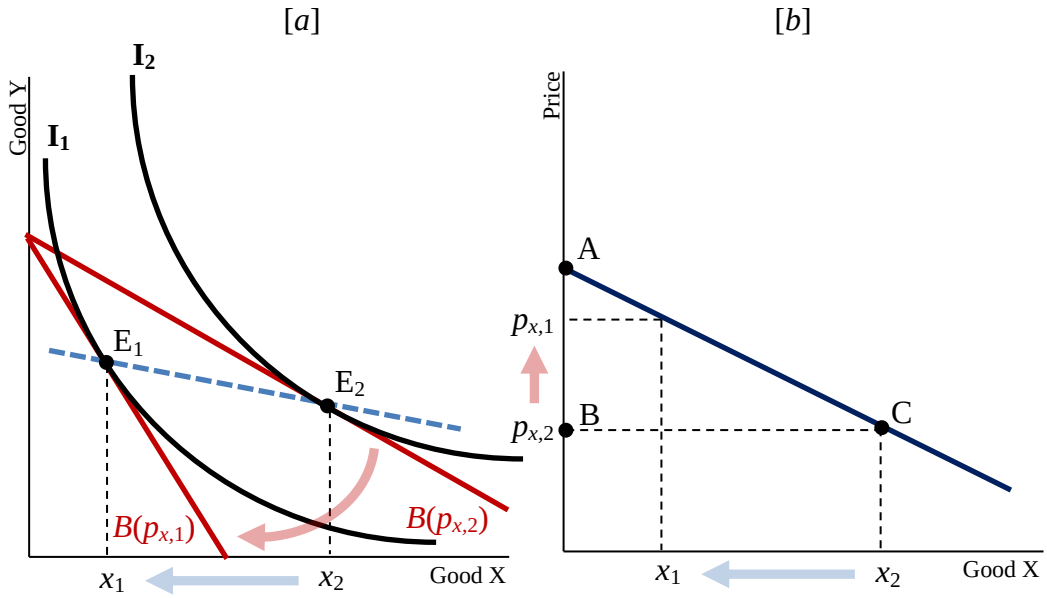


Figure 10.2 Given the price of good Y, the budget constraint line gets steeper and steeper as the price of good X increases (chart [*a*]). As a result, the consumer's demand falls as the price goes up (chart [*b*]). If the market price is $p_{x,2}$ the consumer surplus is measured by the area ABC. Clearly, the surplus reduces as the price increases.

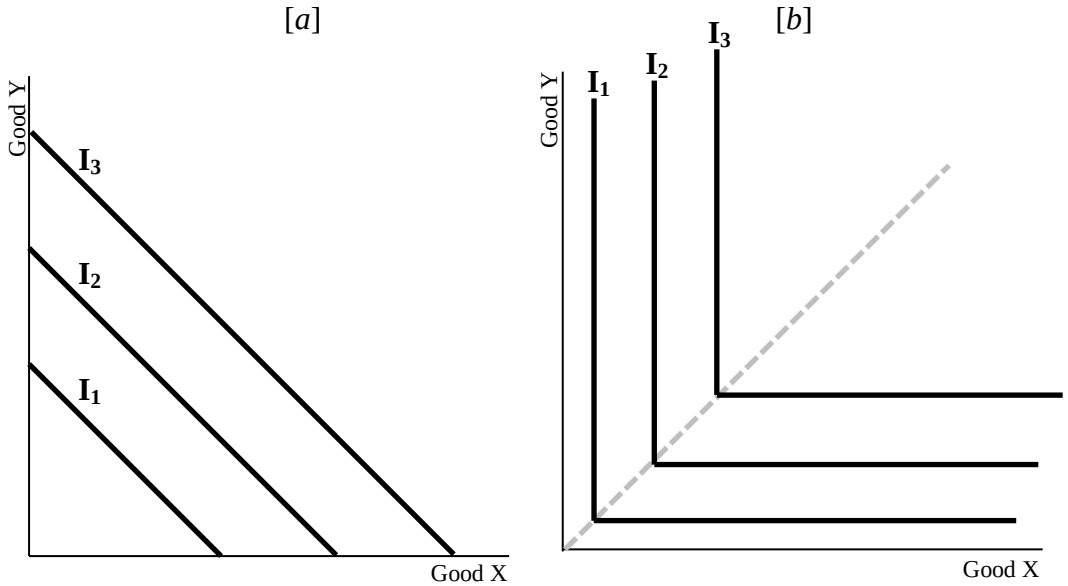


Figure 10.3 If X and Y are perfect substitutes then indifferences curves are parallel straight lines and the MRS is constant (chart[a]). By contrast, if X and Y are perfect complements then indifference curves become L-shaped and the MRS is either zero or infinite (chart [b]).

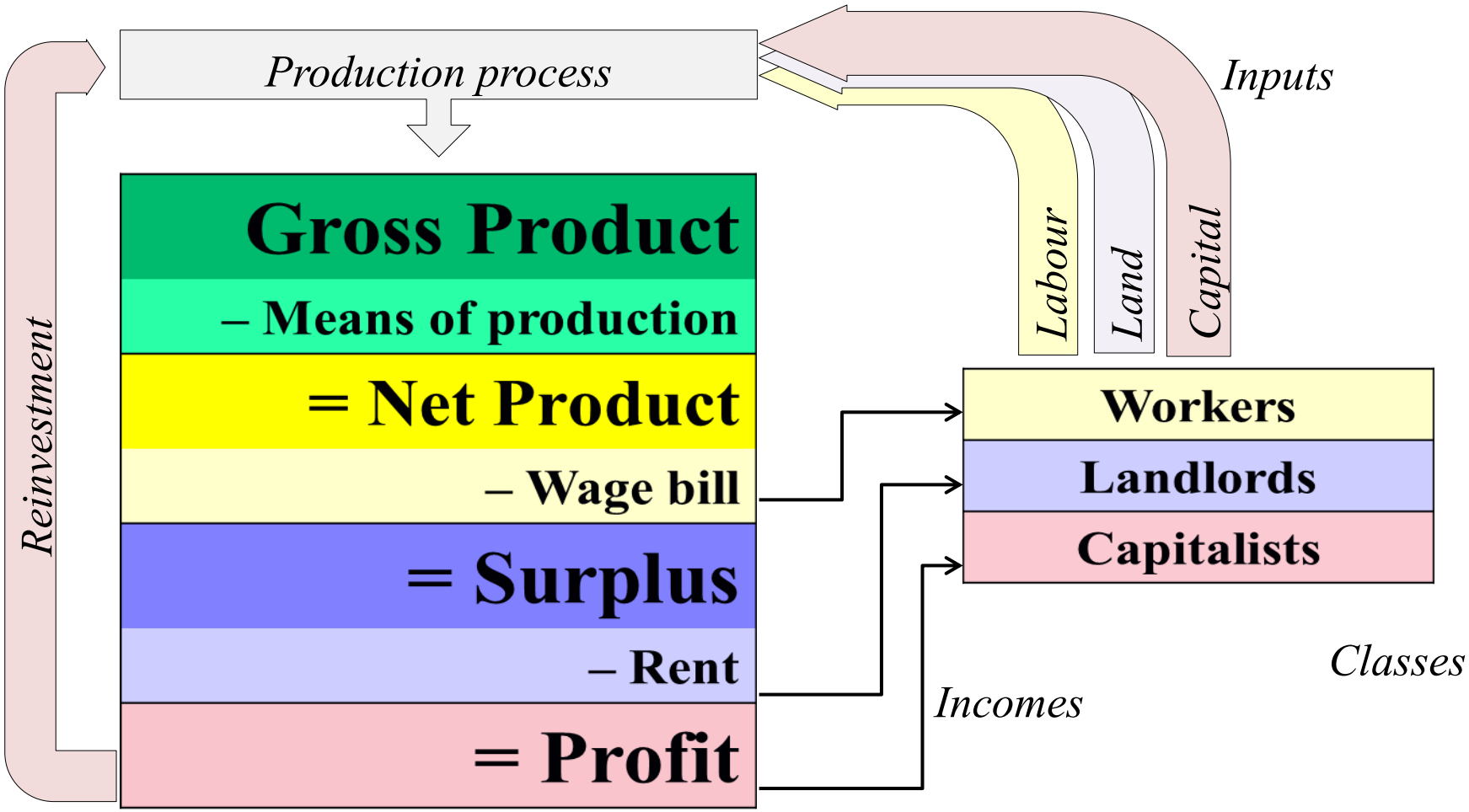


Figure 10.4 Net product is the difference between gross product and means of production (that is, corn output net of seeds in the corn industry). Surplus is what remains after wages are deducted from net product. Surplus is made up of non-labour incomes, including rent and profit.

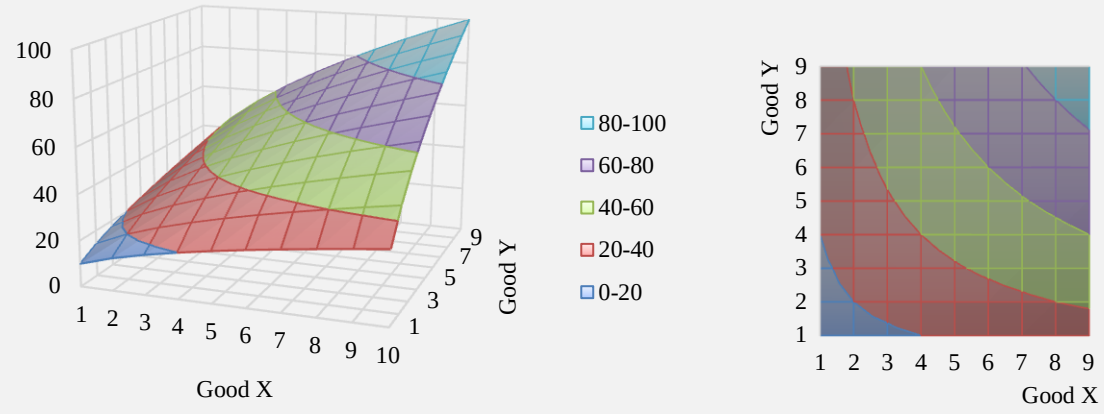
Table 10.1 Approaches to value from the mid Eighteenth century up until today.

Schools of thought	**Unit of value**	**Nature of value**	**Analysis level**	**Economic sphere**	**Political philosophy**	**Some of main theorists**[***]	**Period**
Utilitarians	Total utility	Intrinsic	Micro	Exchange	Mainly egalitarian	Bastiat, Beccaria, Bentham, Cournot, Galiani, Gossen, Say, Senior	1750-1880
Classicals	Production cost, individual labour	Intrinsic	Micro, Macro	Production, Exchange	Mainly conservative	J.S. Mill, Ricardo, Smith, Torrens	1770-1880
Marxists	Social labour	Intrinsic	Meso[**], Macro	Production	Egalitarian	[Marx] Bortkiewicz, Dobb, Luxemburg, Rubin, Sweezy	Since 1860s
Marginalists (or Early Neoclassicals)	Marginal utility	Subjective	Micro	Exchange	Heterogeneous	Jevons, Menger, Marshall, Walras	1880-1930
Neoclassicals[*]	Preference, willingness to pay	Subjective	Micro	Exchange	Mainly conservative	Allen, Hicks, Pareto, Slutsky	Since 1890s
Surplus Theorists	Reproduction cost	Intrinsic	Meso[**]	Production	Egalitarian	[Sraffa] Garegnani, Pasinetti, Steedman	Since 1960s
Ecological Economists	Energy cost	Intrinsic	Meso[**]	Ecosystem	Mainly egalitarian	-	Since 1970s

Notes: [*] today's dominant approach; [**] industry level; [***] excluding living scholars.

BOX 10.1 DERIVATION OF INDIFFERENCE CURVES

Consumer's "utility" is usually represented by means of a Cobb-Douglas function, $U(x, y) = A \cdot x^a \cdot y^b$, with $b = 1 - a$. The left-hand side of the chart below shows the plot of a Cobb-Douglas utility function for $x, y = 1,2, \ldots ,9$ (it is assumed that $a = 0.5$ and $A = 10$). We obtain a 3D chart, where individual utility is measured along the vertical axis, whereas good X and good Y quantities are measured by length and depth of the solid, respectively.



3D charts are nice but not intuitive, let alone easy to manipulate. The right-hand chart shows the 2D view from above of the solid. Each coloured area represents a different range of "utility" the consumer derives from different combinations of the two goods. Going even more in detail, each border curve marks a different indifference curve for the consumer. That is how we worked out indifference curves portrayed in Figure 10.1 and Figure 10.2.

BOX 10.2 IS THE KALDOR-HICKS EFFICIENCY CRITERION REALLY "VALUE-FREE"?

Despite its popularity, the Kaldor-Hicks criterion is not neutral. Supporting a certain government policy only when it is coupled with a corrective redistribution of income across social groups might seem a way out of the problem of the interpersonal comparisons of utilities. However, this criterion is not independent of value judgements about alternate income distributions, as it implicitly implies a preference of the policy makers for the *status quo*. Unfortunately, this means also that standard methods of assessment of government projects and policies, including the well-known "cost-benefits analysis" (where benefits are inferred from the "willingness to pay" of the individuals), are not value-free. On the contrary, the are grounded in a well-defined subjective, utilitarian, philosophy.

BOX 10.3 RICARDO'S CORN MODEL

Let us consider a marginal land, where a certain quantity of corn, call it x, is produced. The (net) production of corn can be defined as:

$$x = \pi_x \cdot L_x$$

where π_x is the product per worker and L_x is the number of workers employed in the corn sector. The profit rate in the corn sector is therefore:

$$r_x = \frac{x - w_r \cdot L_x}{w_r \cdot L_x} = \frac{\pi_x}{w_r} - 1, \text{with } \frac{d\pi_x(L_x)}{dL_x} < 0$$

where w_r is the real wage of workers, meaning the wage rate expressed in terms of corn. An inverse relationship between the profit rate and the real wage rate shows up: the former reduces as the latter increases. In addition, the profit rate falls as labour productivity falls. Finally, total profit and total rent of a generic intra-marginal land are, respectively:

$$P'_x = r_x \cdot w_r \cdot L'_x = \left(\frac{\pi_x}{w_r} - 1\right) \cdot w_r \cdot L'_x = (\pi_x - w_r) \cdot L'_x$$

and

$$R_x = \pi'_x \cdot L'_x - w_r \cdot L'_x - P'_x = (\pi'_x - \pi_x) \cdot L'_x$$

where the superscript $'$ stands for "marginal land". The equation above shoes that rent is a residual income, arising from differences in fertility of lands and falling labour productivity in the corn sector.

BOX 10.4 HOW MACHINES AND PRODUCTION TIME AFFECT RICARDO'S THEORY

If machines (or other fixed capital components) and heterogeneous production times are taken into consideration, the natural price of the i-th good must be redefined as:

$$p_i = (l_i \cdot \mathrm{w} + a_{im} \cdot p_m) \cdot (1 + r)^{t_i}$$

where a_{im} is the number of machines (m) per unit of i-th product, p_m is the unit price of machines, and t_i is the production time. For the sake of simplicity, let us assume that machines are produced by labour only. As a result, their unit price is:

$$p_m = l_m \cdot w \cdot (1 + r)^{t_m}$$

Finally, the relative price of two consumption goods, X and Y, is:

$$\frac{p_x}{p_y} = \frac{[l_x \cdot w + a_{xm} \cdot l_m \cdot w \cdot (1+\mathrm{r})^{t_m}] \cdot (1+r)^{t_x}}{[l_y \cdot w + a_{ym} \cdot l_m \cdot w \cdot (1+r)^{t_m}] \cdot (1+r)^{t_y}}$$
$$= \frac{l_x + a_{xm} \cdot l_m \cdot (1+r)^{t_m}}{l_y + a_{ym} \cdot l_m \cdot (1+r)^{t_m}} \cdot (1+r)^{t_x - t_y}$$

If we assume that labour times are uniform ($t_x = t_y$), the price ratio above equals the labour ratio (l_1/l_2) *if and only if* the same technique is used across consumption sectors (meaning that: $l_x/a_{xm} = l_y/a_{ym}$). If labour times are not uniform, the equality between labour content ratios and price ratios is even less likely to occur.

BOX 10.5 MARX'S EXPLOITATION-THEORY OF PROFIT

For Marx, the unit value of output of the i-th industry (expressed in monetary terms) is:

$$\lambda_i = m \cdot (lk_i + l_i) = m \cdot [lk_i + (ln_i + ls_i)]$$

where m can be defined as the "monetary expression of labour time" (meaning the amount of money per unit of labour time, which Marx sets equal to one), lk_i is the coefficient of "indirect" or "dead" labour embodied in means of production, and l_i is the coefficient of "direct" or "living" labour spent by the workers in the production sphere. The latter is made up of two components: the necessary labour time, ln_i, meaning the period of the working day in which the workers produce "for themselves"; and the "surplus labour time", ls_i which is the time in which they produce for the capitalists. Considering n industries, the economy-wide rate of surplus labour, or rate of exploitation of the working class, is therefore:

$$e = \frac{\sum_{i=1}^{n}(ls_i \cdot x_i)}{\sum_{i=1}^{n}(ln_i \cdot x_i)} = \frac{(1-v) \cdot \sum_{i=1}^{n}(l_i \cdot x_i)}{v \cdot \sum_{i=1}^{n}(l_i \cdot x_i)} = \frac{1}{v} - 1$$

where x_i is the quantity of the i-th good and v is the unit value of labour-power (i.e. the ratio of necessary labour time to total labour time). If v and hence e are uniform across sectors, the value of goods produced in the i-th industry becomes:

$$\lambda_i = m \cdot [lk_i + ln_i \cdot (1+e)]$$

The value of products is defined by the indirect labour, the necessary labour time, and the rate of exploitation. This is the capitalist *law of value*. However, goods are traded at prices of production which are defined by the profit rate. This is the capitalist *law of exchange*. The unit price of goods produced is:

$$p_i = m \cdot (lk_i + ln_i) \cdot (1+r)$$

where r is the uniform or general rate of profit. Like Ricardo, Marx assumes that competition levels out profit rates across sectors. As a result, the price of each good is likely to diverge from the corresponding value. However, the deviations of prices from values must offset one

another. So, looking at the system as a whole, two aggregate equalities must hold: first, total profit equals total surplus-value (and hence total profit is proportional to total surplus labour); second, total price of output equals total value of output (and hence the monetary value of gross product is proportional to total direct and indirect labour, that is, $\sum_{i=1}^{n}(p_i \cdot x_i) = m \cdot \sum_{i=1}^{n}[(lk_i + l_i) \cdot x_i]$). The expression of the general rate of profit can be then defined as:

$$r = \frac{m \cdot \sum_{i=1}^{n}(ls_i \cdot x_i)}{m \cdot \sum_{i=1}^{n}[(lk_i + ln_i) \cdot x_i]} = \frac{e}{q+1}$$

where $q = \sum_{i=1}^{n}[(lk_i \cdot x_i)/(ln_i \cdot x_i)]$ is termed the "organic composition" of capital. The higher the rate of exploitation and the lower the organic composition of capital, the higher will be the general rate of profit for the capitalist class. The equation of the unit price of production becomes:

$$p_i = m \cdot (lk_i + ln_i) \cdot \left(1 + \frac{e}{q+1}\right)$$

Prices of production are entirely defined by labour contents. They are nothing but transformed forms of values. Similarly, profit is the monetary form of social surplus labour, stemming from the exploitation of workers within the production sphere.

BOX 10.6 OPEN ISSUES WITH ENERGY-THEORIES OF VALUE

From a biophysical viewpoint, three are three main issues with energy-theories of value. First, they typically consider only energy inputs and outputs, neglecting mass. Second, there are other inputs of energy in the biosphere (think of gravitational pull) in addition to solar energy. Third, when a pure solar energy flow theory of value is advocated, "there are issues with spatial and time scales" (Patterson 1998, p. 118). From an economic viewpoint, there are two additional criticisms. First, energy-based theories of value turn out to be "undetermined" both socially and historically. They assume that social value is independent of the specific dominant mode of production and exchange and of the underlying social relations. Here energy-based theories share one of the weaknesses of utility-based theories of value. Second, it has been argued that the exchangeability of goods and services in definite proportions is linked to the presence of a "third thing" that makes it possible. Yet, "any candidate for the status of the third thing, value, must be an intrinsic property *solely* of the commodity". By contrast, "all natural material things [and not just human products within capitalism] are formed through processes that require available energy and so the input of such natural energy *per se* cannot be the third thing generating exchange ratios that are characteristic solely of commodities" (Brown 2008, pp. 135-136). In other words, the point is not *how* value of things can be measured *en general*, but *what* the value of a product *is* within a capitalist economy. In principle, relative values could be measured by taking any product as the unit of account. This is the reason even a peanut-theory of value, in which all commodities are denominated in direct and indirect "peanut units" (Gintis and Bowles 1981,

p. 7) was provocatively proposed. The point is that gold, corn, salt, peanuts, and solar energy, can all act as "money" if the latter is intended as simple *monnaie* (French), *münze* (German) or *moneta* (Italian), as opposed to *argent*, *geld* or *denaro*. In the first case money acts as a pure means of exchange and unit of account. In the second case, it acts as capital. The latter is what distinguishes a capitalist society from an ideal "cooperative" or "primitive" one. Defining a *numeraire* is not sufficient. In formal terms, relative prices are not affected by the unit of measure chosen. In fact, this choice *per se* says nothing about the source or cause of intrinsic value of products. In other words, the choice of the *numeraire* should not be confused with the selection of the theory of value.