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HISTORY OF THE CONCEPT OF VALUE

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DISCUSSION PAPER 14.06

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ABSTRACT

In this historical review we distinguish between two broad categories of value theories, objective and subjective, which focus respectively on the conditions of production and on the preferences of consumers. The objective approach to value theory is discussed with respect to classical political economy and the labour theory of value and the Sraffian revival of classical value theory in the twentieth century. The subjective approach to value theory is discussed with reference to neoclassical economics, with emphasis on marginal utility and equilibrium; marginal productivity and the distribution of product; and enhancements to utility analysis developed in the late nineteenth and early twentieth centuries. We conclude with a very brief and speculative reflection on the challenge of the digital age for value theory. The paper has been prepared as an entry for the forthcoming second edition of the *International Encyclopedia of the Social and Behavioural Sciences* (Elsevier).

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Introduction

We distinguish two broad categories of value theories, objective and subjective, which focus respectively on the conditions of production and on the preferences of consumers. Objective value theory was most influential in the era of classical political economy, especially in the work of David Ricardo and Karl Marx, and was revived after 1960 by the followers of Piero Sraffa. Subjective value theory became prominent after 1870 under the influence of William Stanley Jevons, Léon Walras and Carl Menger, and remains the approach to the theory of value that is taken by mainstream economists today.

The Objective Classical Theory of Value

The objective classical theory of value dates from the mid- to late seventeenth century, reflecting increased interest in the production of commodities and reduced emphasis on the circumstances of their exchange. It was the cornerstone of classical political economy (Dobb 1973; O'Brien 2004). In the two decades after 1670, Sir William Petty 'came remarkably close to the idea that the exchange value of a commodity is determined by the quantity of labour needed to produce it' (Meek 1973, p. 35). Half a century later, Richard Cantillon distinguished the market price of a commodity from its 'intrinsic value', the latter being proportional to the land and labour needed for its production.

In *The Wealth of Nations* (1776), Adam Smith took three distinct approaches to the problem of value. The first, following Petty, was a simple *labour embodied* theory, which Smith believed to apply without qualification to the 'early and rude state of society'. The second, which he thought more appropriate to contemporary capitalism, was an 'adding-up theory' that explained value as the sum of the costs of production, including land and capital in addition to labour. His third theory, which anticipated the later subjective value theory (but was not fully developed by Smith), saw value as being determined by the 'toil and trouble' experienced by the producers.

David Ricardo and the Labour Theory of Value

A much more systematic treatment of value was provided by David Ricardo. Ricardo's primary interest was in the distribution of the social product, and in particular the determinants of the rate of profit, since he regarded this as by far the most important influence on the growth prospects of the British economy. He needed a theory of value less for its own sake than to provide a reliable way of measuring these distributional variables. Ricardo seems originally to have hoped that he could evade the problem by formulating a 'corn model' of agricultural production in which both inputs and outputs consisted entirely of physical quantities of grain. Soon, however, he replaced corn with labour 'as the quantity in terms of which product, wages and surplus were alike expressed' (Dobb 1973, p. 74).

Ricardo was critical both of Adam Smith's 'adding-up theory' of value and of Jean-Baptiste Say's subjective approach to the problem. He began his own *Principles of Political Economy and Taxation* with an extended discussion of the labour theory of value, noting that air and water were much more useful than gold, but also much less valuable. 'Utility then is not the measure of exchangeable value', he concluded as a general principle, 'although it is absolutely essential to it' (Ricardo 1821, p. 11). For

the small minority of useful objects that could not be freely reproduced, such as rare statues and pictures, scarce books and coins, and vintage wines, value is indeed determined by their scarcity relative to the demand for them. But the great majority of commodities can be freely reproduced ‘almost without any assignable limit’ by the employment of human labour, and the labour theory of value does apply to all such commodities, ‘on the production of which competition operates without constraint’ (*ibid.*, p. 12). Fluctuations in supply and demand cause only ‘accidental and temporary deviations of the actual or market price of commodities’ from their ‘primary and natural price’, which is given by ‘the comparative quantity of labour which is necessary to their production’ (*ibid.*, p. 88).

Integrated with his labour theory of value was Ricardo’s surplus theory of income distribution. Wages were determined by the consumption requirements of the labourers, and were the first charge on the net product (the difference between total output and the means of production – seed corn, for example – that were needed to produce it). The residual was the ‘surplus produce’, which Ricardo believed to be divided between capitalists and landlords in accordance with his theory of differential rent. His treatment of rent allowed Ricardo (unlike Cantillon) to eliminate land from the analysis of value, since the value of corn was determined by the quantity of labour needed to produce it on the least fertile land, where no rent was paid.

Capital, however, was altogether more troublesome. It posed four difficult problems, all related to the question of time (O’Brien 2004, p. 100). First, the ratio of capital to labour differed from industry to industry. Second, the durability of fixed capital – which Ricardo distinguished from circulating capital – was unequal between industries. Third and fourth, the period of production and the turnover rate of capital were also different in different industries. These four factors would cause prices to diverge from labour values, even in the long period when rates of profit tended towards equality, so that an increase in wages would lead to changes in natural prices even if the quantities of labour embodied in the various commodities was unaltered. But Ricardo convinced himself that these complications were relatively minor. ‘The greatest effects which could be produced on the relative prices of those goods from a rise in wages’, he claimed, could not exceed 6 or 7 per cent’ (Ricardo 1821, p. 36), leaving him with what the neoclassical economist George Stigler famously described as a 93% labour theory of value.

Ricardo continued to wrestle with these problems until the very end of his life, acknowledging just before he died that the labour theory of value was only an approximation to the truth (King 2013, pp. 79-80). But that did not lead him to embrace a subjective theory of value, or even to withdraw his objections to Adam Smith’s adding-up theory. A change in wages would not lead to a change in the prices of all commodities in the same direction, as Smith’s principle entailed. ‘On the contrary’, Ricardo noted, ‘if wages fell, those commodities only would fall in value, which had a less proportion of fixed capital employed upon them, than the medium in which price was estimated [that is, gold]; all those which had more, would positively rise in price’ as a consequence of the increased rate of profits (Ricardo 1821, p. 46).

Karl Marx and the Labour Theory of Value

Marx was a strong admirer of Ricardo, but also a severe critic. His most fundamental objection was that Ricardo had failed to distinguish different modes of production, instead regarding capitalism as in some way timeless and eternal. Where the theory of

value was concerned, Marx believed, the crucial distinction was between capitalism and the earlier, classless ‘simple’ or ‘petty commodity production’. In simple commodity production, commodities normally sold at prices equal to their labour values, but in capitalism matters were considerably more complicated.

He also criticised Ricardo for failing to make a second vital distinction, between constant and variable capital: the former was the value of the ‘dead’ or ‘stored-up’ labour in raw materials and machines, while the latter, the ‘living labour’, represented the value of the workers’ labour power, and was the sole source of surplus value, and hence of profit. This affected his analysis of the rate of profit, which for Marx (no less than for Ricardo) was the single most important economic variable. In Marx’s system, the rate of profit was positively related to the rate of exploitation (the ratio of surplus value to variable capital) and negatively related to the organic composition of capital (the ratio of constant to variable capital) (Marx 1867, chs. VIII-IX; Marx 1895, chs. III-IV; Howard and King 1985, ch. 6).

In a competitive capitalist economy, Marx argued – again like Ricardo – there would be strong forces tending to equalise both the rate of profit and the rate of exploitation in all industries. But there were inescapable technical conditions that gave rise to large differences in the organic composition of capital in different sectors. This meant that commodities would not, in general, sell at prices equal to their labour values. They would instead sell at what Marx termed ‘prices of production’, which would exceed labour values in industries with an above-average organic composition and fall below values if the organic composition was below the social average. In aggregate, however, the sum of prices would equal the sum of values; the sum of profits would be equal to the sum of surplus value; and the rate of profit would be the same, whether it was calculated in terms of values or prices of production.

In the numerical example in volume III of *Capital*, published in 1895, twelve years after Marx’s death, there are five industries, with an organic composition of capital ranging from 1.5 in industry III to 19.0 in industry V, and also significant differences between industries in the durability of constant capital. After transformation, the ratio of price of production to labour value ranges from 1.85 in industry III to 0.86 in industry V (Marx 1895, ch. IX). This analysis, to repeat, did not appear in Marx’s lifetime, and before its publication Friedrich Engels amused himself by announcing a ‘prize essay competition’ in which he invited the readers of volume II of *Capital* to supply the solution to the so-called ‘transformation problem’. No-one succeeded, though several entrants came very close (Howard and King 1985, part III; Howard and King 1989, ch. 2).

Criticism of Marx’s procedure for transforming labour values into prices of production began almost immediately after it was revealed in 1895. The neoclassical Austrian economist Eugen von Böhm Bawerk rejected the entire theoretical apparatus, including the distinction between constant and variable capital and the theory of exploitation in addition to the labour theory of value itself, while his former student Rudolf Hilferding came to Marx’s defence. Ladislaus von Bortkiewicz, himself sympathetic to the classical tradition in political economy, took issue with the details of Marx’s analysis, criticising him for failing to transform input values and pointing out that the aggregate equalities on which Marx had insisted would hold only under special circumstances (all three essays are reprinted in Sweezy 1975). Other significant contributors to the pre-1914 debate included Wolfgang Mühlport and V.K. Dmitriev (Howard and King 1989, ch. 3).

In the 1920s some Marxists began to ask whether these quantitative aspects of the labour theory of value had not been given too much attention, at the expense of the deeper and more interesting qualitative questions. The best known of these Hegelian Marxists was the Russian Menshevik, Isaak Illich Rabin (1975), whose thinking has stimulated a large and continuing literature on the ‘form of value’ in Marx. Some Western Marxists began to ponder the implications of the decline in competition associated with the rise of cartels, trusts and giant corporations at the end of the nineteenth century. If competition was no longer strong enough to equalise the rate of profit across industries, what relevance did the (quantitative) labour theory of value have in the new stage of ‘monopoly’ or ‘state monopoly capitalism’? Paul Sweezy (1942) borrowed extensively from neoclassical analyses of oligopoly pricing, while continuing to endorse the qualitative labour theory of value. Discussion of the (quantitative) transformation problem also continued after 1945, with a range of alternative solutions being proposed (Howard and King 1992, part IV).

Piero Sraffa and the Revival of the Classical Theory of Value

Meanwhile, a young Italian scholar was working in Cambridge on the definitive edition of Ricardo’s collected works, and also attempting to reinterpret the entire classical tradition in value theory. The eventual outcome was a slim volume entitled *Production of Commodities by Means of Commodities*, with the modest sub-title ‘Prelude to a critique of economic theory’ (Sraffa 1960). Piero Sraffa took as given the outputs of the various commodities, the inputs of those commodities and of labour that were needed to produce them, and one distributive variable. This could be either the real wage (as in Ricardo), or the wage share in net output, or – Sraffa’s own preference – the rate of profit, itself possibly determined by the rate of interest. He demonstrated that, on the assumption of an equal rate of profit in all industries, these parameters were sufficient to determine all prices and the other distributive variables, without any reference to demand conditions or to marginal utilities.

In fact Sraffa shared the classical emphasis on ‘physical real cost’ (Kurz 2003, p. 169), and had no time whatever for subjective value theory. His analysis pointed to fundamental weaknesses in the neoclassical theory of capital, since the capital stock could not be defined independently of the rate of profit, still less inserted into an aggregate production function that could then be differentiated with respect to ‘capital’ in order to determine the rate of profit. Sraffa also exposed a ‘monotonic fallacy’ in neoclassical theory: a rise in the profit rate, he demonstrated, might *reduce* the value of capital (the phenomenon of ‘capital reversal’) and might also induce capitalists to adopt productive techniques with a *higher* capital-labour ratio (‘reswitching’). Sraffa’s work encouraged the search for alternatives to the marginal productivity theory of distribution and gave rise to the celebrated Cambridge controversies in the theory of capital (Harcourt 1973).

There were also important implications for the Marxian labour theory of value. Sraffa’s intention seems to have been to rehabilitate Ricardo’s value theory (‘seems’, because he published almost nothing after 1960 and never responded to the substantial critical literature that his book soon generated). But Meek (1973, pp. xxviii-xliv) soon recognised that Sraffa’s analysis could also be used to solve the transformation problem. Sraffa had devised a ‘Standard Commodity’ in which the ratio of outputs to inputs was identical for all commodities. This Standard Commodity, Meek suggested, could be used as the *numéraire* in transforming values into prices of production, overcoming the difficulties that Bortkiewicz and others had identified with Marx’s

solution, so that (as in the one-commodity Ricardian corn model) the maximum rate of profit depended solely on the technical conditions of production and did not vary with prices or with the actual rate of profit.

This procedure might be sufficient to rescue the labour theory of value. Whether it was also necessary was another matter. Neoclassical critics like Paul Samuelson maintained that the entire process of transformation was an ‘unnecessary detour’, since prices of production could be derived directly from knowledge of conditions of production and income distribution, without any need to calculate labour values. Samuelson was supported by the former Marxist Ian Steedman, who also drew on Sraffa to identify serious additional problems with the labour theory. The existence of joint production and alternative techniques of production could produce paradoxical results, including negative labour values and negative surplus value, even while prices and the rate of profit remained positive (Steedman 1977). It was soon recognised that these perverse outcomes posed a significant challenge not just to Marxian value theory but also to any Sraffian rehabilitation of classical theory (Howard 1987).

As already noted, Sraffa’s own intentions were never made clear. The fundamental question that he left unanswered was whether *Production of Commodities* should be regarded as a brick or a broom, that is to say, as the basis for a modernised version of classical value theory or only as a critique – certainly, a profound and damaging critique – of the subjective, neoclassical theory of value and distribution. Thus his work remains open to a variety of different, if not entirely inconsistent, interpretations (Roncaglia 2009).

One final question concerns the ethical dimension of objective value theory, and in particular the use of labour values as instruments for the purposes of socialist planning. It is unclear what Marx’s own position was on this issue (compare Meek 1973, pp. 256-63 and Robinson 1942, pp. 23-4). Several serious problems have been identified, including the environmental damage caused by neglecting the costs of land, water and other natural resources; the excessive capital-intensity induced by ignoring differences in the durability of capital goods; and the failure to relate prices to use values when there is no genuine market for consumer goods (Nove 1983). Arguably, efficient planning requires a synthesis of objective and subjective value theory, as proposed (unsuccessfully) in the former Communist countries by would-be reformers like Viktor Novozhilov and Ota Šik.

The Subjective Neoclassical Theory of Value

In the years following the publication of William Stanley Jevons’s *Theory of Political Economy* (1871), Carl Menger’s *Grundsätze der Volkswirtschaftslehre* (1871) and Léon Walras’s *Éléments d’Économie Politique Pure* (1874), the concept of ‘marginal utility’ gravitated to the very centre of economic theory. While there were many important classical precursors to significant elements of ‘neoclassical’ theory (Ekelund and Hébert, 2002), the 1870s marked a turning point because the entire body of theory started to be systematically reformulated around the proposition that the value of economic goods is fundamentally a consequence of subjective assessment by individuals.

Marginal Utility and Equilibrium

The utility that an individual derives from the consumption of a quantity of a particular good is determined by his or her subjective assessment of the pleasure, or satisfaction, derived from consumption. ‘Marginal utility’ refers to the satisfaction that an individual gains from the consumption of an additional unit of a particular good in a given context. For example, the context for the marginal utility derived from the consumption of the 10th unit of a good is given by the individual having already consumed 9 units of that good, and so on.

While H. H. Gossen and Jules Dupuit had already posited that marginal utility diminishes with additional consumption, the early neoclassical economists reflected on the implications of that proposition for the relationships between demand and price, and supply and price. To varying degrees of generality, Jevons and Walras identified an equilibrium state within a competitive environment on the assumption that individuals choose to maximise their utility. The central pillar to their theory is the proposition that a maximising individual will attain equilibrium through exchange when the relative prices for goods possessed are equal to his or her subjective assessment of their relative marginal utilities. If the relative price of a good is less than an individual’s assessment of its marginal utility relative to other goods, a maximising individual will wish to acquire more of that good in exchange for other goods he or she possess with relative prices that are higher than his or her assessment of their relative marginal utility.

From this three key principles emerged: quantity demanded for a particular good decreases with respect to the price of that good; quantity supplied for a particular good increases with respect to the price of that good; and, when one equilibrium price prevails for each particular good (the ‘law of one price’) in a competitive environment, quantities of goods are exchanged up to the point where each individual’s assessment of relative marginal utilities reflects relative equilibrium prices, at which point the value of all goods supplied is equal to the value of all goods demanded for both individuals and markets. Some early neoclassical economists used these relationships to re-interpret Adam Smith’s discussion of the distinction between use value and exchange value to suggest that water has a low exchange value because its relative abundance suggests low marginal utility, whereas diamonds have a high exchange value because their relatively scarcity suggests high marginal utility. Conversely, the high total utility of water is equated with high use value; whereas the low total utility of diamonds is equated with low use value.

The general conception of equilibrium was formulated by Léon Walras by treating utility for each individual as ‘separable’, so the utility from consuming a good depends on the quantity of that good alone, and ‘additive’ in the sense that total utility from consuming a number of goods is derived by summing of utility for each good. If $a, b \dots m$ indicate quantities of economic goods $A, B \dots M$ held by individual i following voluntary exchange, individual i ’s total utility U is:

$$U_i = f(a_i) + g(b_i) + \dots + h(m_i) \quad (1)$$

The marginal utilities of each good are given by the first derivative of the respective separable elements of relation (1), so that relative prices under competitive equilibrium reflect the various ratios of these first derivatives. However, in general equilibrium the quantity demanded of any one good is not just related to the price of that good; rather, it is related to the equilibrium price for each and every consumer

good, with each equilibrium price expressed as the rate at which it exchanges for a common *numéraire* (good A). But the relationship between the price of each particular good and the quantity demanded of each good remains negative; it is just that the demand relationship is conditioned by the relative prices of other consumer goods.

Walrasian equilibration extends beyond exchange to encompass production and capital formulation. Walras also argued that a ‘groping’ process of price adjustments, which he called *tâtonnement*, would lead to a system of equilibrium prices, to which quantities would adjust until markets fully clear. From the perspective of value theory, the key point to Walras was that marginal utility, or *rareté* as he called it, was the cause of value due to the general interdependence deriving from the utility-maximising behaviour of each individual entrepreneur, capitalist, landlord and worker. An entrepreneur making decisions about the formation of a particular capital good has regard to the demand for the productive services provided by that good, as well as the costs of accessing capitalists’ savings, just as an entrepreneur purchasing productive services has regard to the demand for consumer goods derived from the theory of exchange, as well as the price of productive services. The direction of causation for all values originates from the relative prices of consumer goods, which reflect relative marginal utilities.

Edgeworth (1889) was the first to point out a consistency problem with Walras’s equilibrating notion of *tâtonnement*, as a static theory does not demonstrate a path to from disequilibrium to equilibrium, which is significant when dynamic adjustments to disequilibrium prices take time to complete. For example, disequilibrium decisions concerning the formation of heterogeneous capital goods having flow-on effects for the supply of productive services and the availability of consumer goods. Late in life Walras removed disequilibrium trading from his theory, with an auctioneer crying prices but transactions themselves not settled until equilibrium prices had been attained. In contrast, Pareto, Walras’s successor in Lausanne, distinguished between complete and incomplete equilibrium, and provided for the owners of particular capital goods, among others, to acquire positive or negative rents under incomplete equilibrium.

Alfred Marshall, a second generation neoclassical economist, created an alternative approach to Walras’s that has become known as partial equilibrium. By invoking an “other things being equal” assumption, Marshall developed a theory of the relationship between price and quantity demanded, and quantity supplied, for a particular good in isolation from other goods. For the individual, and the market for a particular good in aggregate, a rise in price leads to a decrease in the quantity demanded and equilibrium within a market is given at the point where the demand and supply intersect.

In Marshall’s analysis, the ‘marginal demand price’ is a point on the demand curve and represents the amount of money that an individual forgoes to acquire one additional unit of the good. Consequently, the marginal demand price is a monetary representation of marginal utility, provided that the marginal utility of money is constant. Pareto objected that that it is an unnecessary assumption, and derived the equation for a negatively sloped demand curve when permitting the marginal utility of the money (Walras’s *numéraire*) to vary (Pareto 1893-94). Eugen Slutsky (1915) then used Pareto’s demand equation to isolate the income effect of a price change (the change in the purchasing power of a consumer’s budget resulting solely from a

change in the price of a good) from the substitution effect (the substitution of one good for another attributable solely to the change in the relative price of the good). J.R. Hicks and R.G.D. Allen (1934) independently developed an alternative formulation of the income and substitution effects, with Hicks, in *Value and Capital* (1939), subsequently pointing out that the ‘Marshallian’ demand curve shows the combined influence of the income and substitution effects, whereas a study of the pure effect of changes in relative prices would derive the demand curve based only on the substitution effect by compensating the consumer for any income effect associated with a change in the price of a good. In doing so, Hicks provided a succinct mechanism to reconcile the fundamental difference in the demand theories of Walras-Pareto and Marshall.

Marginal Productivity and the Distribution of Product

The implication of the theories of production and capital formation for the distribution of product were not fully articulated in the 1870s. For example, Walras’s theory of production was initially predicated on ‘fixed’ coefficients of production. It was not until the technique of production was subject to change that questions related to the substitution of different services of production, and to the relationship between such substitution and variations in wages rates and rentals on capital and land, that analysis of the distribution of product, in the form of income, took centre stage in the 1890s. Major studies in that regard include J. B. Clark’s article on ‘Distribution as determined by a law of rent’ (1891); Phillip Wicksteed’s influential book *An Essay on the Co-ordination of the Laws of Distribution* (1894) and A W Flux’s review of that book (1894), which simplified and crystallised the meaning of Wicksteed’s work by famously invoking Euler’s theorem. J.B. Clark’s 1889 book, the *Distribution of Wealth*, is also important for bring the complete story together.

To maximize profit, entrepreneurs reflect on the productivity of each productive service when offering a price for that service, just as the owners of each productive service have regard for the best price they can obtain for providing that service. In the same way that consumers maximize utility by focusing on comparative marginal utilities under competitive conditions, so too would entrepreneurs maximise profits, and the owners of productive services maximise incomes, when the price of productive services in reflects their comparative ‘marginal product’ (the increase in output from adding one final unit of that particular productive service while holding the quantity of all other services unchanged), provided of course that those services are used to produce goods that are the most highly valued by consumers. In such circumstances, Euler’s theorem confirms that total product is completely allocated to the owners of productive services in direct proportion to the product of their productive service’s marginal product and quantity.

But the limit within which the ‘marginal productivity theory of distribution’ is valid has been the subject of much discussion, even among early neoclassical economics (Pullen 2010). Pareto used first-order homogenous production functions in 1894 to consider the substitution of productive services by changing the coefficients of production, but when he subsequently treated the issue of marginal productivity at length he raised concerns about the limits of substitutability (as some factors are necessarily fixed) and noted that productive services are not independent of output (when there are economies or diseconomies of scale). He also convinced Barone and Wicksteed of the importance of these limitations, with Wicksteed

subsequently abandoning much of the marginal theory of distribution. Walras, in contrast, quickly adopted the marginal productivity theory of distribution.

Extended Dimensions to Utility Analysis

The utility relation (1) referred to earlier is only additive because it is separable and expressed as a cardinal quantity. Second-generation neoclassical theorists, however, soon questioned both these requirements, with separability in particular seen as an unnecessary restriction that constrained the scope of utility analysis. Rudolf Auspitz and Richard Lieben (1889) presented the utility of one commodity as depending on the quantities of all commodities, so that separable and additive utility for individual i given by relation (1) is effectively replaced by a general non-separable and non-additive relation, such as relation (2) below.

$$U_i = f(a_i, b_i, \dots, m_i) \quad (2)$$

This allowed Auspitz and Lieben to undertake pioneering theoretical work on the complementary or substitutable relationship between different goods, which was later adopted and extended by Edgeworth, Pareto and others.

But the extension of the analysis to encompass demand derived from multi-good utility functions also posed serious questions regarding the stability of the utility relation. When utility at a particular point in the utility system alters, depending on the path taken to attain that point, demand relationships will fluctuate. Utility is no longer completely exogenous – some elements of individual's subjective valuation of utility, and the associated demand relationships, are influenced by the economic process itself. Stable demand equations depend on each individual's assessment of utility being 'path independent', so that utility at a particular point is the same irrespective of the path to that point. In mathematical terms, path independence is contingent upon establishing the 'integrability' of the utility function; sometimes referred to as the 'integrability problem'. The formal conditions that establish integrability for economic analysis were first devised in Italian by G. B. Antonelli in 1886, but their importance was not appreciated at the time. Nicolas Georgescu-Roegen, Herman Wald and Paul Samuelson subsequently provided formally correct solutions.

The second significant change to utility theory was the move away from specifying utility as a quantity (cardinal utility) towards preferences over particular combinations of goods (ordinal utility). After Irving Fisher (1892) conjectured that the measurement of utility may not be strictly required for equilibrium theory, Pareto (1900, 2006-09) demonstrated analytically that: the shape of Edgeworth's indifference curves is unchanged for an individual irrespective of whether utility is considered cardinally or ordinally, and that the point of economic equilibrium is identical in both cases. He then suggested that experimental data on choice between pairs of goods could be collected in two ways: by direct observation of actual market decisions to derive what Hicks and Allen (1934) would call the marginal rates of substitution (which play the same role as relative marginal utilities in early neoclassical theory), or by conducting a series of binary choice experiments to notionally derive indifference curves after establishing whether respondents reject or accept proposed transactions. The subsequent and definitive specification of choice theory replaced the indifference curve framework with axiomatic formalism when Paul Samuelson (1938) and Hendrik Houthakker (1950) respectively introduced the 'weak' and 'strong' axioms of 'revealed preference'. One feature of the 'strong axiom' is that it establishes

conditions for preference revelation that are consistent with integrability having been established for demand relationships and utility.

Utility and Welfare

While Marshall and Edgeworth took important tentative steps in the direction of analysing the relationship between individual utility and collective welfare, it was Pareto who argued that any suggestion that individual maximisation necessarily implies collective economic maximisation is a proposition that needs to be demonstrated analytically. In demonstrating that relationship with the aid of his famous welfare criterion (that an unequivocal gain in collective economic welfare requires at least one person to gain and no one to be made worse off), Pareto (1906-09) also underlined his view that interpersonal comparability of utility must be excluded from economic theory generally, and from the analysis of collective economic welfare in particular. However, Pareto (1913) also introduced a formal analysis of social welfare by including arguments pertaining to the welfare of other members of the collective within each individual's utility function. This necessarily presumed that each individual person in society makes interpersonal comparison of utility and, as such, opened the possibility for analysis of redistribution in particular and social welfare more generally. But in extending the scope of the utility function in such a way, Pareto himself abandoned both his own welfare criterion and the use of ordered preferences (relying instead on quantities of utility). Ever since then, however, the economic approach to social welfare has been subject to repeated attempts to reinsert both the Pareto criteria and Paretian preference ordering back into the analysis of social welfare. The works of Bergson (1938) and Arrow (1950) are two of the more prominent examples.

Value in a Digital Age

One final problem is specific to the digital age. How does objective value theory apply in cyberspace? What, exactly, does Twitter produce? Which of its employees are productive labourers, which are unproductive, and why? Given that the marginal quantity of labour embodied in the 'product', whatever that might be, is very close to zero, while the average quantity of labour is very much larger, what is the relevant quantity for the purposes of defining value? Given the importance of intellectual property and hence of 'intangible' or 'fictitious capital' (Marx's phrase) in the digital economy, is there any tendency for the rate of profit to be equalised across the economy? How would Marx – or for that matter Ricardo – have reacted to a world of temporary monopolies, protected by intellectual property laws but subject to constant erosion by new technologies of production and consumption? The difficulties posed by these questions seem rather less damaging to the subjective than to the objective theory of value.

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