The *Economist* Dupuit on Theory, Institutions, and Policy: First of the Moderns?

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> Public utility is the principle, the basis, the foundation, not only for property, but for taxation, for law, because society makes stipulations that are in the public interest. The debate between justice and utility is of immense scientific importance.
> —*Jules Dupuit, "Du principe de propriété"*

> Whoever will take the trouble to look at the whole of the studies or even at the rapid sketches left by Mr. Dupuit will readily recognize that his total work reveals an intelligence whose scope surpasses many men whose names are more well known to the public than his own. . . . Mr. Dupuit's reputation, far from having to fear something from time, will probably owe it much.
> —*E. Lamé Fleury, "Economistes contemporains"*

Almost half a century ago the great ideational historian Joseph J. Spengler proclaimed, with good evidence (1954), Richard Cantillon (1680?–1734) the "first of the moderns." Cantillon was, for all intents and purposes, the forerunner of classical economics in spite of the fact that he lived firmly in the "mercantile" time line. In this article I advance the case that the engineer Jules Dupuit (1804–1866) was a neoclassical-

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contemporary economic thinker ensconced in the classical age.[1] Dupuit has long been characterized, correctly and along with the American A. T. Hadley, as one of the two most important transport economists of the nineteenth century. And beginning with F. Y. Edgeworth, he has, over the present century, been recognized for the discovery of seminal areas of pure economic analysis. These contributions, contained mainly in three essays ([1844] 1952, [1849] 1962, and 1849), include no less than the following: the discovery of marginal utility theory as the fundamental behavioral postulate of economics, demand theory, the concept of full price, welfare economics, monopoly theory, the theory of price discrimination, quality differentiation (and distortion), spatial pricing, the focal role of entrepreneurship, and a theory of the competitive adjustment mechanism. Such purely theoretical inventions, constituting nothing less than the essentials of microeconomic theory, have been and are being explored elsewhere.[2]

A more inclusive and contemporary side of Dupuit has been entirely neglected. Dupuit as the holistic scientist and integrator of theory, legal institutions, and policy has never come to light, owing to the total neglect of a brilliant series of essays and communications. These contributions on institutions and economic policy were published mainly in the *Journal*

1. Dupuit was born in 1804 in Fossano, Italy, which was then part of the French Empire. At age ten he returned to Paris with his parents and continued his education in the secondary schools of Versailles, Louis-le-Grand, and Saint-Louis, finishing with a physics prize. In 1822 he enrolled at the Ecole Polytechnique, and in 1824 he entered the Ecole des Ponts et Chaussées. Dupuit's economic interests flourished along with engineering studies on roads, floods, municipal water systems, and hydraulics. He was promoted steadily, becoming director, chief-engineer of Paris in 1850, and inspector-general of the Corps des Ponts et Chaussées in 1855. He received the Legion of Honor in 1843.

2. Beginning with a full-scale obituary in France (Fleury 1867), a citation by William Stanley Jevons, attacks by Léon Walras in his *Eléments* and correspondence, oblique references in Alfred Marshall's *Principles*, and substantial praise by F. Y. Edgeworth (1894, 1910, 1911–13) and Rudolph Auspitz and Richard Lieben (1914), the story of Dupuit's contributions to static microeconomic theory has (slowly) been told. Later in the twentieth century the assessments of Dmitriev ([1904] 1974), Bernardi (in Dupuit 1933), Guitton (1934), Knight (1935), Boutet, Roy, and Divisia (1945), Divisia (1950), and Stigler (1950) appeared, focusing on Dupuit's discovery of marginal utility and its implications in demand theory. The broader nature of Dupuit's inquiry has been analyzed more recently: see Beard and Ekelund 1991; Ekelund 1967, 1968, 1969, 1970, 1971, 1972, 1987; Ekelund and Gramm 1970; Ekelund and Hébert 1973, 1976, 1978, 1985, 1999a, 1999b; Ekelund and Shieh (1986, 1989); and Ekelund and Thornton (1991). His welfare triangle and notion of fixed cost have been placed as sources of analyzing the effects of economic growth and development (Romer 1994).

des économistes between 1850 and 1865, the year prior to his death.[3] In these papers and in his 1861 book *La liberté commerciale*, Dupuit focused solely on economic questions and became the "complete economist," portraying utility as not only the core of the economic universe but the unifying force behind policy and institutions as well as theory.[4] In short, he believed that pure economics was both a theoretical and an empirical science that should be accepted by all (1863a, 1863b, 1863c, 1863d), that economic institutions and policy questions are matters of economics as a "positive science" (1861c, 113), and that utility and its rationale in empirical investigation were the foundations of that science. Far more than simply a railway practitioner or a dabbler at the periphery of economics, Dupuit was one of the soundest scholars of the premodern period. These achievements have been obscured by the fact that Dupuit's writings, including those of his later years, were not then and have never been collected in book form.

Dupuit accomplished the integration of economic theory with institutions and policy in a context of empiricism, with several related innovations: (1) the creation of property rights assignments as the center of incentive-based economic outcomes; (2) the invention of central principles of public choice and interest group analysis as the source of all government interventions (e.g., regulations, taxes, tariffs); and (3) the placement of a utility maximand, demand revelation, and empirical study at the center of a theory of economic policy and institutional evolution. Since these achievements are inextricably intertwined with the pure economic theory he developed by 1849, I begin with an abbreviated treatment of Dupuit's theoretical inventions, which were less compact though no less scientific than Augustin Cournot's, with which he was apparently unacquainted.[5]

3. Of fifty-two publications between 1850 and 1865 listed in Bernardi's 1933 collection (which is an undercount in terms of total publications over this period), thirty-nine deal with economic subjects and only thirteen (just 20 percent) are concerned with engineering subjects.

4. I do not know of a single reference in the English or international literature to these several dozen institutional contributions to nontransport policy, except for brief mentions in Ekelund 1967. Dupuit's analysis of property rights is discussed briefly in Mosca 1998. References to several of these papers appear in Etner 1983, but without an analysis of their importance. These contributions are listed in an incomplete bibliography of Dupuit's works published in Italy in 1933 (Dupuit 1933, 219–24). At present, only two of Dupuit's works ([1844] 1952 and a portion of [1849] 1962) have been translated into English.

5. I neglect individual formal influences on Dupuit's thought in this essay. There is direct evidence from his many writings that he "kept up with the literature" over time, having read

The Theoretical Advances

Dupuit's basic theoretical advances are fairly well known. For many centuries economists had used the term *utility* loosely to describe the general welfare or individual satisfactions. Dupuit, however, was the first writer ([1844] 1952) to make utility maximization, which was the sum of *marginal* utilities in markets, the center of economics. That center was perfectly generalized to include all maximizing behavior. Demand for anything—potatoes, rail travel services, theater tickets, or a medal of the Legion of Honor—presupposed utility.[6] There was "no utility other than that for which people are willing to pay" ([1844] 1952, 83), and this principle applied to social as well as "economic" behavior. In an argument that may only be described as "Beckerian," Dupuit explained implicit markets for "social goods" such as marriage: "[Not all wealth has] an exchange value susceptible to market analysis, but it all has utility. Since utility is susceptible to a common measure, the general principles of science may be applied to [such goods]. . . . the beauty, the youth, wit, or good breeding of a woman takes the place of a dowry;

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the leading English economists of his day and the earlier classical period. Citations may be found to Smith, Ricardo, Malthus, McCulloch, Say, and others. Dupuit fully accepted Say's Law, the classical dichotomy, and the wages-fund theory, presenting a pristine discussion of the quantity theory of money (1861a, 19–62). His familiarity with his contemporaries and predecessors undoubtedly affected his choice of topics. The impact of Pelegrino Rossi, who in some sense stood midway between Say and Dupuit on the importance of utility in demand, has also been noted (Grall and Vatin 1997). There is no doubt that Dupuit shared the creed of many of his French liberal contemporaries. On the fundamental precepts of microeconomics and value theory, however, he was unique. Influences in this critical area include Say, Henri Navier, and, of course, Adam Smith's "paradox of value" (Ekelund and Hébert 1976). Without evidence that Dupuit knew of or was influenced by Augustin Cournot—and I know of none—Dupuit's fundamental theoretical inventions remain unique. Their importance has been very slowly realized, however.

6. In an 1853 essay "De l'utilité et de sa mesure: De l'utilité publique" [On utility and its measure: On public utility], an elaboration of the 1844 essay, Dupuit outlined the complete generality of economics and economic calculation, first demonstrating a *marginal* utility calculation of the demand for salt and creating a demand curve out of it. Said Dupuit, "The calculation that we have applied to salt could have been made for meat, bread, diamonds, and all other useful objects, for those which we produce painfully [with resource costs], as for those which nature accords gratis, for material wealth as for intellectual wealth. . . . If this calculation showed, for example, that to compensate all the members of the Legion of Honor for the last of their decorations, it would be necessary to allot them an income of a hundred million [francs], wouldn't we be justified in saying that the institution is equivalent for France to wealth [consisting] of an income of a hundred million. . . . Economic utility . . . is based on our desires whether or not they conform to reason; it considers men as they are, it is morality that teaches us how they should be" (1853, 17).

reciprocally, a fine dowry takes the place of what is missing in her" (1853, 13–14).

Dupuit used the theory of marginal utility to establish general demand theory ([1844] 1952, [1849] 1962, 1849) in graphical, verbal, and symbolic terms.[7] When added to theories of short- and long-term resource adjustment, production cost, and supply—all based entirely on the opportunity cost of resource use ([1844] 1952, 104–5)—he was able to develop the modern theory of markets (1861a, 134–35).[8] These fundamental theoretical insights, covering a great deal of what came to be known as static "neoclassical microeconomics," were the basis for numerous and important discoveries, including the efficiency and welfare implications of static monopoly theory; the theories of price discrimination, marginal cost pricing, excise taxation, and spatial economics; and the comparative price-allocative effects of competition. These contributions have been spotlighted in the past, but several critical aspects of his inquiry have remained in the shadows.

Dupuit staunchly defended economics as a discipline that had to use scientific methods—to the point of alienating a few liberal members of the Société d'Économie Politique.[9] These methods were applied to supply and demand and to market adjustment. But Dupuit understood that

7. Dupuit's establishment of utility as the foundation of economic "science" contrasts in many ways with later neoclassical figures such as Léon Walras. Utility, to Dupuit, was the single foundation of behavior (*all* behavior), with revealed demand being a result of utility valuations. (This explains his quest for clear and better measurement and empirical activity.) For Walras, at least according to Jaffé (1976, 513–15), marginal utility and subjective valuation were something of an afterthought—incidental to his theory of exchange and competitive markets. This view, along with the generality of Dupuit's conception, places him in contrast to Walras and to other "founding" neoclassical economists.

8. That Dupuit fully understood and created examples of the "Marshallian" theory of competitive market adjustments is established in Ekelund and Hébert 1999a.

9. He also thought that economists argued far too much over basic precepts, and that this unfortunate fact had two results: it caused the public to distrust economics as a science, and it shifted attention from the necessary and fertile field of application (1863c, 238–39, 247). The French liberals generally rejected "scientific economics" (certainly the scientific economics of Augustin Cournot) but did carry on a lively debate with Dupuit over the nature of political economy (see, e.g., 1861c, 1863c, 1863d). Arguments have been proffered for the liberals' distrust of "scientific economics." One suggested insight into Dupuit's scientific perspective is that engineers were, after the coup of December 1851 that restored the empire under Napoleon III, keenly aware of the dangers of being overtaken by politicians who, rightly or wrongly, might have believed that they had designs on government policy making. As political economists, moreover, the engineers did not want to be blamed for economic disturbances. In addition, the methodology of the French liberals was considerably different from that of either Cournot or Dupuit.

comparative statics were only a starting point—a generalized method of framing the analytics of particular markets. Careful empirical analysis of each market had to be undertaken with (as Alfred Marshall later claimed) one item at a time taken out of the pound of ceteris paribus.[10] Goods, moreover, were treated as combinations of utility-producing characteristics in markets, which worked to establish a full-price equilibrium wherein transaction costs were minimized within a competitive process.

Actual estimates of demand and utility had to be made and, in common with many of the early engineers such as Charles Ellet, Dionysius Lardner, and Alphonse Belpaire, actual empirical calculations were also part of some of Dupuit's investigations. (Naturally, formal statistical and econometric analysis, pioneered by Francis Galton, F. Y. Edgeworth, Karl Pearson, and George Yule, was some decades away.) In this regard, for example, Dupuit's calculations of the regressive nature of the "tobacco tax" (1859b) and, most especially, his presentation of population and mortality statistics (1865b) are interesting, but even his earliest writings on economics contained instructions on linear estimations of demand curve segments ([1844] 1952, 103).

Dupuit unflinchingly claimed that the maximization of public utility in all markets was the only worthy maximand of policy and institutions. He fully understood that there were problems to be considered in the measurement of utility and, particularly, in the money measure of utility. Political economy, he argued, must utilize the money measure, but he added that

> political economy . . . is not, in the final analysis, a rigorous measure of the ability of things to satisfy mankind's needs; it would be difficult to say whose hunger was the greater—that of the rich man, who would be willing to pay a million for a kilogram of bread, or that of the beggar, who, having nothing to give, would risk his life for it. But

10. The ceteris paribus method was central to Dupuit's inquiry. His formal theory of demand is one case in point, but some of the most interesting examples concern hypothetical and actual markets. Dupuit supposes, for example, that the wine tax is completely removed and, astonishingly, nothing happens to price. Political economy has the answer according to Dupuit: "You are wrong to be astonished; the price of wine, as the price of all things depends only on supply and demand. The elimination of the tax does not immediately change either one or the other; thus the price remains the same. But consider: producers who will benefit plant new vines; and in five or six years, supply will be greater, the consumer will profit in turn from the reduction in the tax" (1861c, 114).

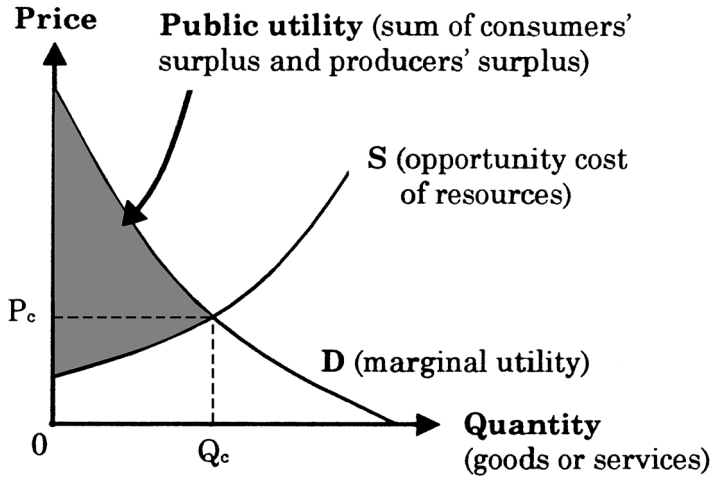

Figure 1 Public Utility

> political economy, confining itself to questions of wealth, can measure the intensity of a desire only by its monetary expression. It bakes bread only for those who can buy it, and leaves to social economy the trouble of supplying it to those who cannot afford to give anything in exchange. ([1844] 1952, 89)[11]

In very practical terms this was (as shown in figure 1) the maximization of the sum of producers' and consumers' surplus. If supply represents the real and full opportunity costs of using resources and demand represents the summed marginal utilities (in cardinal money terms) to be had from producing a good or service, competitive price (P_c) and quantity (Q_c) maximize the public utility for society from producing the good. For Dupuit, in the overwhelming majority of cases this happy result—the minimization of deadweight loss—was produced within an open, intertemporal process of competition unfettered by utility-

11. Measurement issues came to the fore after Marshall published his *Principles* in 1890, but economists in the lineage of Dupuit continued to argue that utility-based "investigations have no psychological, but exclusively an economic purpose." Though the rich and the poor may differ in the enjoyment of a shilling's worth of something, "neither the rich nor the poor man would have given the shilling for something that did not come up to the enjoyment or satisfaction involved in the possession of the shilling" (Lieben 1894, 717).

reducing property rights assignments (as we will see) or by artificial restrictions of any kind. It was proxied by the geometric definite integral of the difference between costs and demand, which Dupuit invented and used in economics (Roy in Boutet, Roy, and Divisia 1945, 11–12). In short, the basis for economic prosperity and progress was measured by public utility and the volume of exchange produced in its generation. But underlying all markets was some assignment of property rights and some set of incentives that the assignment provided.

Property Rights Assignment and Public Utility

Dupuit's mature investigations led him to the key to understanding all economic outcomes—the assignment of property rights. Dupuit shared Jeremy Bentham's contempt for any so-called natural rights-based laws, arguing that property is not a right anterior to law but that all kinds of property assignments are a consequence of law. Law defines and limits property rights, as he reveals in his two-part essay of 1861 (1861b). Property is a human institution that has advantages and disadvantages, and laws are simply contracts that are established and changed as the interests of the parties to the contract change. The justification for property is purely empirical. "Justice" or "natural right" is unreliable and even chimerical as a foundation for property, because justice depends on how parties in a dispute define it. The economic laws of supply and demand—based on utility and scarcity—are neutral. Supply and demand was the mortar that provided the foundation for establishing what would give the "greatest good for the greatest number." In this modern and modified Benthamite view, welfare maximization takes on a particular kind of empirical flavor. Maximizing output where price approximated the full cost of using resources is the end of property assignments. This criterion is positive, neutral, and empirical, giving a clear guide to law and legislation.

Land tenure was a case in point. Society's interests simply coincided with direct, personal, and perpetual assignment of rights in agriculture—empirically, output was not maximized under communal systems. As Dupuit noted, "It is essential for society that land be privately and personally cultivated, not only for those who cultivate with an interest in maximizing output, but also in order to maximize improvements that profit those which follow [particular owners]" (1861b, 339). This was

a principle, according to Dupuit, empirically derived from the effects and limits of inheritance. The English legislator was a bad agriculturist because, in England, land was transmitted in huge concentrated parcels to the eldest male inheritant. Here, natural rights were satisfied, but economic efficiency was not. Unfortunately, Dupuit does not consider or compare French and English systems of land tenure in the form of *métayage* and fixed-rent assignments. He implies, of course, that anything less than full ownership is inefficient—a view that supports the traditional Mill-Marshall view rather than more recent hypotheses (Cheung 1969). Furthermore, principles of justice, normative and relative, provide no guide to economic distribution.[12]

Dupuit stressed that the empirical-utilitarian approach to law had overwhelming advantages over natural rights as an approach to law and property. In the matters of agriculture, books, inventions, mining, wild game, fish, railroads, and water resources, "the partisans of natural rights are silent, uncertain or divided, and neither time nor experience improves their understanding because justice is not to be experienced" (1861b, 49). But simple experience could not have failed to inform Dupuit that some laws and legislation did not maximize public utility. As early as 1849, in fact, Dupuit had attacked the preposterous tax paid to postmasters to maintain horses on routes parallel to railroads and canals (1849). Such special interest legislation was an artifact of state subsidies prior to the opening of the railroad and improved means of transport and mail carriage.

Joseph Garnier, the liberal editor of the *Journal des économistes*, raised substantive arguments against Dupuit's utilitarian principle. Garnier argued that the principle "legitimized violations of property and rights to work, feudal rights, corporate privileges, artificial monopolies, abuse, slavery, expropriations, debt forgiveness, confiscations, etc., etc." (in Dupuit 1861b, 49). Dupuit concurred with Garnier, arguing that such bad laws—laws that did not conform to the maximization of

12. Each individual has an incentive to overestimate his own contribution in the matter of distribution. But natural laws and supply and demand *do* give an answer: Distribution is "neither just nor unjust: it is, an accepted fact. The economic laws of supply and demand, which reward the dancer and singer a hundred times more than the judge, the general, or the laborer, are neither just nor unjust: they are an accepted fact" (1861b, 338). It is the economist's role to understand and demonstrate what the natural law produces. Invocation of natural rights gives no guide whatsoever to wealth ownership or distribution. Natural forces, finding expression in terms of supply and demand, do. Once more, Dupuit's view on the subjective nature of justice contrasts with early neoclassical economists such as Walras.

public utility—contradicted the utilitarian principle of property. However, the greatest defense of the principle (according to Dupuit) was that it was the only way to provide convincing evidence to get rid of bad laws. If one could show empirically and in repeated challenges of bad laws that welfare was being suppressed, bad laws would at least tend to be changed. (This argument is identical to some contemporary views in law and economics, e.g., Rubin 1977; Priest 1977). On the other hand, natural rights "principles" were no guide to legal change. For example, society cannot maintain natural rights in agriculture (first come, first served), as in open commons, in the face of the superior efficiency of personal appropriation of the soil (Dupuit 1861b, 50). In fine, any principle suggesting that rights are anterior to law cannot effectively be used to attack abuses that exist in law and legislation. The principle of public utility maximization with limits (discussed below) and supported with empirical evidence is far more persuasive.[13]

Property Assignments to Increase Public Utility

Dupuit recognized that economic outcomes and the public utility they produced were a clear function of *how* property rights were arranged. A prime aspect of his uniqueness, moreover, was the recognition that all kinds of "property," including services of a social or moral nature, provided utility. His fundamental premise was the same in all cases: Assign property rights so as to maximize the utility value of output to society. When in doubt, study the facts of particular cases, develop empirical argument and appeal to higher-yielding outcomes under alternative institutional structures.

Dupuit's essay (1861b) provided many illustrations dealing with tangible and intangible property. Fully half of his lengthy essay was devoted to intellectual property—rights to plays, books, artistic creations, and

13. Dupuit answered other objections to the utilitarian principle applied to property, one of which was that it was "materialistic" in contrast to the "spiritual" natural rights approach. This argument, so often heard in the history of thought, is that property should be raised above "matter." "What," Dupuit argues, "do the partisans of justice demand for authors and inventors? Is it glory? No, it is only a question of their uplifting." But, he continues, "the theory of utility, far from diminishing the author's or the inventor's glory, increases, instead, the outpouring of intellectual products for the masses" (1861b, 51). Thus property rights assignments can increase incentives to produce, and such incentives have positive effects on societal welfare.

so on. Such property, argued Dupuit (1861b, 38–43), was no different than any other kind. He focused on all sides of the question of literary property, including that pertaining to artists, editors, and scientists, and argued against extremes—communal on the one hand and perpetual rights for authors and inventors on the other. Rather, both literary and patent rights to inventions should be granted to stimulate output and to cover the risk for writer-publishers and inventor-entrepreneurs. The public's and the author-inventors' interests would then both be protected. (How to achieve this goal remains a matter of debate ([Hansmann and Santilli 1997]). Private property rights provide incentives for productive activity—in society's interest—and ultimate communal rights to literary, scientific, and technological advances would put them in the public domain.[14]

Dupuit advocated fully assigned property rights in perpetuity for fully reproducible goods. Such assignments in the case of agricultural land (and other uses) maximized production and conserved property intertemporally. But his basic understanding went even further. He suggested that agricultural rights could be assigned to maximize the joint value of output (à la Ronald Coase). Under the natural rights approach, game belonged to the one who appropriated (killed) it, not to the owner of the land the game was killed on. Such assignment did not, however, take account of the *reciprocal externality*, when game ate crops planted by the farmer. As Dupuit argued, the end of assigning rights to the landowner is "to see that the market value of the game and the crop is maximized" (1861b, 37). The farmer could receive compensation for the game (through a "tagging system") or, failing that, take possession of all game killed on her property.

Assignments dealing with nonreproducible goods such as the mining of minerals were and are particularly thorny. In such properties, three parties generally had interests in the assignment of rights—landowners (whose land contained the minerals), inventors of extraction methods, and the state. Partisans of "justice" gave no guide as to where rights

14. Dupuit believed the French patent law (instituted in 1791) far too vague as to intent and suggested replacing it with the maximand of public wealth and utility and with language that included incentives for inventors and constraints on exclusivity (1861b, 46). These limits (the number of years could be debated) had huge societal payoffs. According to Dupuit, "From our own day we have seen the invention of the daguerreotype, after being put in the public domain, became the object of huge improvements which have transformed it in only a few years" (46).

should be placed. Under such principles, rights assignment was capricious and depended on the particular interests to which one was economically linked. "But," said Dupuit, "if you demand that the mine belong to whosoever produces the most coal, iron, or lead, then you go right to the true solution" (1861b, 48).

The public utility principle was not only compatible with *changes* in legislation, it was adaptable to underlying determinants of supply and demand—yielding different solutions for the different circumstances in which the mineral wealth was found. Where minerals or other nonreproducible goods were in great abundance, for example, rights could be parceled out by the state to a coalition of investors. But that solution would not produce maximum utility elsewhere, depending on "the division of the surface rights, the scarcity of the mineral, the lack of capital, the [transaction] cost of dealing with owners, or on how onerous monopoly would be for the consumer" (1861b, 48). Thus, many circumstances peculiar to particular nonreproducible goods had to be considered before property rights could be assigned for maximum welfare.[15]

Fact gathering and empirical analysis also underscored proper assignments for resources that were reproducible but which were characterized as "common property." Dupuit considered fishery in this context. In France the state owned the rights to the fish in the rivers; in other countries fish were owned by property owners alongside the river. Which system was better? According to Dupuit, the best system was the one that simultaneously put the most fish on the market, subject to the constraints of conserving the total harvest over time and being compatible with river navigation of other types of vessels (1861b, 49). Multiple goals had to be balanced. That required experience and experimentation, a method much like the "comparative institutions" approach of Demsetz (1969).[16]

His view of forest resources was even more insightful and prescient. "The belief that private interests would seek to clear all forests and that

15. Dupuit reiterates this position in a debate on property rights in mining that took place in October 1863 (1863b). Without scientific knowledge and deep and clear empirical study, virtually nothing can be said about the "optimal" (welfare maximizing) assignment of property rights to subterranean wealth. As always the object of the assignment is to render the produce most abundant at the lowest price (taking other relevant constraints into account). Nowhere, it should be noted, does Dupuit speak of conservation of nonreproducible resources. The price system, or so he intimates, is sufficient to optimally allocate use through time.

16. I am struck by the similarity between A. T. Hadley's "Coasian" speculations and Dupuit's earlier analysis of externalities (see Hadley 1896, 127–30).

we would have neither wood for fuel nor for construction is a chimerical belief" (Dupuit 1863b, 500). Rapid deforestation would increase the price of wood, and soon there would be no more interest in "slash and burn." He concludes that under free exploitation and property rights assignment, "each parcel of soil is devoted to the culture which conforms with the public interest, and [private undertaking] makes no exception in favor of forests. I also believe that the minister of finance would, because of this, do no better than to sell those [forests] which belong to the state" (500) to private interests. In fine, private exploitation of forest resources, with fully defined and assigned property rights and an operative price mechanism, was sufficient to conserve and husband forest resources, as any other exploitation pertaining to the products of the soil. Careful empiricism and experience with different systems would guide the adoption of a particular system of property rights. Assignments that would work in one time and place would not in another when production, technology, and other conditions changed.[17]

Public Utility and the Theory of Economic Policy

Another critical aspect of Dupuit's later writings was his development of a theory of economic policy. Although he did not express his views in such terms, his advance may be expressed as two interrelated principles: (1) the concern that particular pieces of legislation maximized public utility (the sum of consumers' and producers' surplus); and (2) the integration of demand, supply, elasticity, and other "neoclassical" considerations into policy analysis. The polemics of his period, not unlike the polemics of our own, provided the subjects for analysis. Consider, briefly, three examples—policies related to agriculture, transportation, and trade and technology.

Agricultural Problems

Dupuit's interest in agricultural markets was stimulated by periodic "food crises" in France and elsewhere. The French agricultural crisis of

17. Several interesting contemporary empirical studies in fact take Dupuit's approach to property rights assignment and assessment to "underground property" such as oil and gas (Libecap and Wiggins 1984) and the "common pool" problem of the fisheries (Johnson and Libecap 1982).

1855, in particular, led him to address periodic "crises" driven by particular elements of agricultural markets (1859a, 1859b). As a firm believer in the Malthusian population argument, Dupuit envisioned a close relationship between agricultural production, population, and technology.[18] In the case of agriculture and grains, on which a large part of world consumers relied, production was subject to the vagaries of nature. Not only was the total quantity of grain at risk at any given time, the variability of agricultural production posed particular dangers to populations that rose in response to growing food supplies. Larger numbers of people were at risk. Unlike the rich, who could substitute other goods when bread prices rose, the poor, with fewer options, spent a higher proportion of their total budget on bread (1859a, 163). During an agricultural crisis the poor faced starvation while the rich got a "deal" in the form of lower prices on other commodities given up by the poor (fuel, clothing, and so on).

The central economic problem, however, was bound up with elasticities. In particular, the high price of bread is the result of reduced supply when crops are insufficient, and "there is a necessary, inevitable result that consumption cannot exceed the quantity of wheat that exists" (1859a, 164–65). Within an excellent practical explanation of supply and demand (which Dupuit had understood for at least fifteen years by 1859), the unique market characteristics of wheat and other agricultural commodities were explained: "There is between price and quantity produced a relationship that cannot be modified at will. [The relationship] is different for each kind of good, but for wheat and for those commodities essential to existence, [it] is of a particular character, that a slight reduction in production causes a great rise in price. This result thus can bring about a shortfall that creates great suffering" (165).

The problem of demand inelasticity (in the neighborhood of the prevailing price) was twofold: "A bumper crop creates an enormous reduction in the price of cereals," and no one goes hungry. These wide price swings for wheat mean that the interests of producers and consumers are totally different. "In years of abundance, the price falls so low that, for the farmer, the crop is insufficient to pay the costs of farming and the land rent; in years of scarcity, the price rises so high that not

18. Dupuit's (1865a) empirical excursion into the Malthusian theory as applied to the thirty-nine departments of France yielded several insights, including the necessity of discussing technology.

only is he compensated for the reduction in quantity but the farmer obtains an enormous windfall" (165–66).

Dupuit's analysis of the "farm question" in theoretical terms could be placed into a modern "principles" textbook. But he goes beyond this to analyze, in the remainder of his lengthy essay (168–76, 346–65), how people and governments deal with the problem. Under the headings of individual, collective, and municipal charity on the one hand, and municipal and governmental measures or decrees on the other, Dupuit took on a complete analysis of attempts to lessen the volatility of and subsidize agricultural markets by "voluntarism" or "regulations." Given his classical liberal orientation, it is unsurprising that no method save nonintervention came off very well. As much might have been expected of English classical writers. However, Dupuit's perspicacity in relating an advanced economic theory to agricultural policy is highly innovative.

In addition to Dupuit's use of elasticity, I find two details of particular interest. The first is the employment of a full-price analysis, one including time and transaction costs with nominal price, in interpreting the effect of the introduction of cooperatives as a palliative to food shortages. Dupuit argued that food cooperatives—if they eliminated middlemen or specialized retailers—could increase the full price and reduce the utility provided through distribution systems. He was, to the best of my knowledge, the first economist to argue that vertical disintegration might lower economic efficiency and public utility.[19] Consider Dupuit's own words concerning the possible economic inefficiencies of vertical disintegration:

> [The belief that intermediaries are unnecessary] is, for economists, a subject of contention against such [cooperative] societies, inasmuch as the spontaneous establishment of these intermediaries, [and] their prosperity without the subvention of the state are, to the contrary, a proof of their utility: society will only freely pay for services which provide them actual utility. When a new intermediary is seen to impose itself between the producer and the consumer, it is in order to render a new service, without which the consumer would not exist.

19. One much-debated modern view of exclusive dealing, resale price maintenance, and territorial restraints, voluntarily imposed by manufacturers on downstream agents, suggests that such practices are utility maximizing (see Bork 1966; Blair and Kaserman 1978). Dupuit's argument concerning "middlemen" provides a precise foundation for this view.

> You say: The grocer on the street corner sold for 20 centimes the fish which is sold at the marketplace for 10; but it is sold to the small consumer who gets up too late in the morning to get to the market; if the latter loses 10 centimes on the price of fish, he gains on the other side two hours of his time, which to him represents as much as money. The proof that the grocer renders services and that he is not paid too much is that you shop from him when alternatives are available. (1859a, 169–70)

Second, armed with the first clear technical understanding of supply and demand, Dupuit was able to make short shrift of the whole concept of price controls. One need only compare key entries such as "supply and demand," "competition," or "monopoly" in the liberally sponsored *Dictionnaire de l'économie politique* to Dupuit's conceptions to see that his participation in the volume (on subjects nominally related to engineering such as "voies de communication" or actually related such as "poids et mesures") and in the Société d'Économie Politique was "polite" but that his analysis was unabsorbed. These entries, written by Joseph Garnier, A. Clément, and Charles Coquelin, respectively, are basically "English classical" renditions with citations to other prominent liberals (such as Pelegrino Rossi). Legal or forced price reductions in the face of shortages would create excess demand. As Dupuit put it, "All artificial lowering of price creates a corresponding increase in consumption and increases scarcity as it [the legal price] diminished" (1859a, 351). Price policies would exacerbate the crises and provide no incentives to augment future production.[20] These clearly articulated and theoretically supported views were obviously at odds with those of Dupuit's liberal contemporaries.

The solution to agricultural problems caused by variable yields was to eliminate all agricultural tariffs. Open trade meant that there was less chance of starvation with the same level of domestic production variability. Since variability in French wheat production was the problem,

20. One novel policy was to manipulate the quantity of wheat sold for bread making by "prohibiting" the use of wheat in making liquor and animal foods, among others. This was counterproductive, according to Dupuit, because such a policy would require special information concerning relative quantities used; even more important, it would drive the crisis into future years. Using an intertemporal approach to economic policy, he argued that redirecting wheat to bread making would, by lowering the price of wheat, mean a lower quantity of wheat supplied in the future.

Dupuit appealed to the commonsense notion that free trade within France created enormous benefits from region to region. According to Dupuit, "It must be recognized that the question of free trade in grains is only a consequence of the question of generalized free exchange, and it is not possible to provide arguments in favor of the one without serving the other" (1859a, 363). The gradual elimination of mercantile customs and tariffs within France produced great prosperity. And, despite the effects on land rents and the amount of land cultivated for grains, English tariff reform had (even by 1859) huge benefits.[21] The Peel reforms "have supported coal mining, foundries, manufactures, and [England] has obtained from [international] exchange of these a greater quantity of wheat than its own agriculture would have produced under the protectionist system" (365). In short, after examining all the possible expedients that governments might use to avoid food crises, Dupuit arrives at the most efficacious principles: "*Laissez faire! laissez passer!* . . . The question of grains, sugars, irons, butcher shops, bakeries, etc., etc., all resolve themselves in the same manner. In these questions the task of economists is to find a solution that refers to these four sacred words that we come to repeat" (365).

Dupuit and French Transport Regulation

This maxim, *laissez faire, laissez passer*, was Dupuit's policy guide from 1844, the beginning (in publication at least) of his economic interests. Throughout his career he turned a critical eye on the institutional role of government and its economic effects in establishing and supporting a transportation system. A "Colbertian" tradition of government involvement in French industry continued as the highway and transport system proceeded in Dupuit's day. Dupuit was highly critical of particular poli-

21. Dupuit was in fact forced to confront the critics of free trade, some of them "liberals," when they argued that the effects of free trade on land rents had been neutralized by the effects of drainage, agricultural technology, and machinery in England. Rents, as Dupuit acknowledged, had actually risen after trade. But, as Dupuit pointed out, "if this increase is real, it has been produced not only in spite of the introduction of foreign wheat, but in spite of the drainage, in spite of machines and the other agricultural technology that the English have introduced" (1860b, 516). His analysis was that free trade, which greatly increased English importation, had lowered price, but it also increased demand through a marked population increase. He also explains that, ceteris paribus, alternative regimes of free trade and protection could produce a "cobweb" effect on population in England.

cies, most particularly the regulatory policy of establishing rates proportional to mileage for all roads.[22] In fact, Dupuit's attack on regulatory policies relating to highways preceded his first economic essays ([1844] 1952, [1849] 1962, 1849).[23] His policy analysis of the transportation system, and particularly the emerging railroads in France, naturally accompanied and was commingled with his theoretical inventions. It has also been suggested that Dupuit's economic analysis was stimulated by technical studies of the railroad and his obvious knowledge of mechanics.[24] But it is less well known that his theoretical essays were accompanied and followed by a stream of policy papers on institutional aspects of the French transportation system, again with special emphasis on the railways.

Railroads were established as yet another transport means within the overall road and canal transportation network of the nation that, historically, was the product of mercantilist regulations of all types.[25] In an essay on transport legislation (1849), written in the same year as his "On Tolls and Transport Charges," Dupuit outlined some "strange contradictions" in the laws respecting transportation: "Here, under the form of diverse taxation, laws of the policy, hindrances of all kinds to arrest movement; there, under the form of subsidies given or taken, interest guarantees, from [transport] works executed gratuitously, or from extraordinary efforts to excite the public for further measures, one

22. This means that the "long- and short-haul discrimination" is really a form of competitive pricing. Other railway engineers (Charles Ellet and Dionysius Lardner) joined Dupuit in the opinion that rates proportional to mileage reduced the utility of railroads.

23. Dupuit had, from the beginning, been interested in the economics of transport policy, sometimes connected to his purely scientific studies. Dupuit's studies (1837, 1842) of the source of maintenance costs on the highways and his report on the same subject fifteen years later (1852) demonstrated an early confidence that the market rather than government would "regulate" aspects of road transportation to maximize public utility.

24. Dupuit's transition from critiques of benefits on the basis of cost differences to calculating benefits on the basis of psychological calculations of utility has been attributed to an application of the engineering principle of substitution (Grall 1997) and from mechanics generally (Ekelund and Thornton 1991; Grall and Vatin 1997). It is certainly within the realm of possibility that Dupuit's familiarity with the mechanical engineering principle of substitution helped condition his thinking on substitution and internal calculations in consumption. In this sense, empiricism initially gave rise to theory, and theory was later used as a basis for empirical investigations. It was, in short, a clear use of the scientific method as that method is commonly understood.

25. English railroads were provided, as were some highways and bridges, privately through joint-stock companies (accompanied by acts of Parliament). Following the revolution of 1830 and partly in imitation of the English, the French government began to focus on the

completely forgets that though certain transport means have utility, others do not serve anyone" (217). Dupuit criticized the French transport structure not only because the system relied on government provisions and subventions but also because the system was driven by "politics" rather than rational calculation. Production that does not take place within a market structure loses the reciprocal signals necessary to equate supply with demand. But "there are soon franchises that the state makes to producers that are arranged in a manner that covers the losses of private industry by special financial measures. Then there is no indication of when production should stop. After one canal, we see another canal, after one railroad, another railroad. Why this one rather than that one and why either one?" (218). Government did not use economic analysis—cost-benefit analysis—in order to get "rational results."

Dupuit used this observation to condemn all kinds of antique Colbertian rules and regulations regarding transportation. For example, in planning and establishing roads, the government did not take traffic demand into account. At the same time, postal interests got a special subsidy for their horses and operation that was independent of the amount of traffic. This noneconomic establishment of "postal roads" created a clearly non-cost-effective system of road transportation.[26] The attempts to maintain and restore all parts of the road system, including the "royal road system" of Louis XV, were also unsound from an economic perspective. Other rules and regulations simply ignored

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state transport system, and in 1837 a commission was directed to prepare laws on a national rail system. The French initially sought to make the main lines a purely public good, but self-interested members of the Chamber of Deputies saw the profit potential in a "mixed" system—which basically characterized rail exploitation throughout the nineteenth century. That mixed system comprised a "partnership" between governments and business that differed with each road. Although early leases were given for ninety-nine years, the government found that they could obtain shorter leases on more profitable roads. Policing the roads, limiting tariffs, supervising in general were the prerogatives of government, which, in most cases, appointed the administrative boards of each road (with salaries paid by the private companies). These conditions, replicated in many industries in France, led to very difficult problems. For example, funerals were supplied by the Service des Pompes Funébres, a franchising body designed to obtain "competitive" results for all classes of patrons. Though it was described by Edwin Chadwick (1843, 1859), the famed utilitarian practitioner, as having had this result, his data appear to indicate that the municipal government of Paris used the funeral industry as a "cash cow" (see Ekelund and Ford 1997).

26. Two years later Dupuit elaborated his criticism of the granting of privileges by the state. In "Concerning the Tax Paid to Postmasters by Owners of Public Vehicles" (1851),

the "best evidence" concerning costs. It was thought that the weight of vehicles created the most severe repair and maintenance problems on the roads. Thus vehicular traffic was taxed in proportion to the size of the carriage wheels. Dupuit challenged this notion on the basis of empirical evidence (1837) and on the grounds that taxes on traffic arbitrarily taxed consumers and producers, that is, without a rational assessment of costs and benefits (1842; 1849, 219).

The same irrational system of "internal mercantilism" was the underpinning of the French railway system from the beginning. French roads were established with the government's huge finger in the pie.[27] Willy-nilly, based on political pressures from "entrepreneurs" and sectional interests, the government provided capital and guaranteed loans to ventures that had no hope of paying their own way. Private-interest motivations for subsidies were supported by attempts to match the commercial prosperity of the English, without any attention to real world demand for rail (or canal or road) transportation.[28] This process of government support of railroads, moreover, was fanned by the "drumbeat of the periodical press" [*timbales de la presse périodique*]. Such support engendered rampant charlatanism in entrepreneurs who could use the subsidies as come-ons to investors. In sum, the incentive structure created by government involvement in transportation in general, and railroad building in particular, was all geared to productions that did not maximize public utility. Private investment, which admittedly

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Dupuit attacked an ancient institution that had economic effects on the direction and establishment of railroad traffic. Postmasters, because of their grant of state privilege, demanded an "indemnity" of twenty-five centimes on railroad travel where railroad routes were parallel. Horses, of course, had to be kept up whether they were used or not. Dupuit noted that it was ridiculous for the state to "preserve these relays on routes parallel to the railroads," adding that the state "should let die those who cannot live with their receipts" (151). The subsidy was discontinued later in the decade.

27. Lardner ([1850] 1968, 376) reports that by 1850, 1,722 miles of track were under traffic in France, another 1,274 were in progress, and 577 miles were projected but not yet begun, for a total of 3,573 miles. This compared with 1847 estimates of 6,565 miles of actual track in the United States (200 in progress) and 5,000 in the United Kingdom (with 4,500 in progress). France, however, was by this time ahead of all European states except the Germanic states (which included Denmark and Holland) (see Lardner [1850] 1968, 416–20). The particular marriage of government and private speculation in German roads is outlined in Bongaerts 1985.

28. Dupuit noted that some Frenchmen believed that the cause of English prosperity was the size of its shipping fleet. As a result, the French built more vessels, but to no avail, since they were not demanded (1849, 225).

depended on estimates of demand (and cost), was the only solution to the problem of welfare maximization. Full costs must be covered or apportioned as closely as possible with benefits in order to rationally allocate resources in all markets, including transportation. Dupuit drove the point home in paper after paper. As he pointed out in "Voies de communication" (1852–53c, 854), "every transport means that is controlled by the state and every transport means accessible to competition must be developed by private industry."

Trade and Technology

Unsurprisingly, Dupuit was a passionate advocate of free trade. His essay (1860a) and book (1861a) on free trade (*La liberté commerciale*) contained the most sophisticated discussion of market adjustments up to Marshall. But some of Dupuit's particular insights into the causes and effects of tariff reductions are of extreme interest.

Dupuit was the first to understand the welfare effects of tariffs on internationally traded goods. His "taxation theorem" that the loss in utility is proportional to the square of the tax is the key to understanding the unity of the effects of all impediments to trade. Taxes that raised price above costs, such as excise taxes, monopoly tolls, and tariffs, all caused lost utility. Reduction of any of these would increase welfare. Technological improvements such as the introduction of new machines lowered costs and increased welfare, but with a difference. New machines could only be had at a cost of resources—"the benefits of free trade could be had with the stroke of a pen" (1861a, 169).

But his understanding of the effects of free exchange went further. Running through his book is the explicit recognition that free international trade is simply an application of the effects of all free exchange—the total volume of trade increases with the diminution or elimination of restrictions—a central theme that connects all his work on economics.[29] Analogies are given from the deregulation of industry and from the elimination of territorial impediments to trade in France, where citizens, who traditionally had to endure onerous internal restrictions, should plainly understand the benefits of free international trade.

Dupuit understood and analyzed the pains and economic effects of

29. As he argued, "The productive forces of a country are not determined and fixed, they are given to man to increase and multiply by private and public works" (1861a, 97).

the transition to free trade (1861a, 107–14), but considered worker displacements from trade the same as technological displacements of workers by machines or inventions. In a particularly revealing passage, Dupuit makes an analogy between the effects of free trade and the invention of the railroad:

> This generation has already seen the effects of an analogous transformation created by the railroads. Carriage and steamboat enterprises ruined! Inns formerly crowded with houses, carriages, animals, today are deserted! Does one claim that the horsemen, the post-boys, the innkeepers, and the valets are mechanics and station chefs? Evidently, a new workforce takes place of the old, who, with much suffering, have found a place in some industry where access is easier, depending on age, aptitude, and training.
>
> The great objection by which one opposes free trade is thus the same as that which is made with [the introduction] of machinery. The response is, consequently, the same. (111)

Dupuit thus considered a new free trade regime for France as totally analogous in effects to new technology, which was the ceaseless force behind changes in markets and institutions. As demands were created for French products, displaced laborers, after temporary unemployment, would find work in areas where such demands were newly created or expanded. Neither trade nor technology was to be feared. Both were the source of market progress and economic growth.

Public Choice, Interest Groups, and the Economic Functions of Government

The missing link in a holistic, positive view of economic theory and policy, unfilled until the latter half of the twentieth century, was an integration of the role of self-interested groups working through coercive governmental powers with economic analysis. The most interesting and unique area of Dupuit's discussion of the benefits of free exchange is his "public choice" and "neo-institutionalist" discussion of how restrictions are demanded, supplied, and then eliminated in evolutionary fashion. Why, in effect, do we observe laws, institutions, and regulations that do not appear to produce a maximum of public utility or that produce deleterious effects? Free international trade is only one

species of a very large genus of cases. For example, the reasons why popular arguments against slavery in the southern United States were (up to 1860 at least) unsuccessful had much in common with why the free traders in France were meeting with so little success. Ideas without interests to back them up were useless in a system that both supplied and demanded regulations, prohibitions, and restrictions.

The doctrines of free traders were listened to depending "on the importance of the interests they protect[ed]" and on "the manner in which they [i.e., the interests] [were] grouped." Some interests are concentrated and particularized and others are not. As Dupuit notes:

> That which makes weak politics of free trade is the almost infinite divisions of the interests it supports. It [free trade] profits almost all; protection profits a small number, but gives much to each.
>
> Suppose that a badly established and abusive tax injures all Frenchmen by 1 franc (that is to say by 36 million). The tax profits a thousand persons, and they get only 10 million [francs] in revenue, which is an average of 10,000 francs each, but [the returns] provide some with 100 thousand, others with 40 or 50 thousand, and some whose share is reduced to 4 or 5,000 francs. You attempt to destroy and eradicate this abuse, crying that it is absurd to take 36 million from the entire nation to produce only 10, and you strain to hear any response from those who stand to gain from your reforms because there is a penalty [net cost] if the profit that they can obtain [1 franc] is counterbalanced by the cost of reading your study. (1861a, 177–78)

Although those whose per-capita tax is a small portion of their budget have no rational interest (are "rationally ignorant") in the tax, others are very much interested. The opponents of free trade, whose fortunes are intimately connected to the tax, will incur enormous costs to maintain protection, using their "trade associations, their writers, their journalists, their publications [to oppose change], and your weak voice is not heard until one fine day when another combination of interests triumphs on the side of justice [i.e., utility and economic efficiency]" (178).

All restrictions, including taxes, tariffs, grants of monopolies, subsidies, and government subventions of any kind, have their origins in interest-group pressures on the political process to obtain benefits for some while imposing costs on others. According to Dupuit, "It is the

history of all abuse and protection." The belief that interest-group analysis is critical to understanding and evaluating policy is essentially a modern view of the interplay between the political system and economic exchange. The suggestion that legislation is supplied and demanded along with the economic underpinning of why restrictions can emerge and flourish for a time under representative government is the essence of the contemporary theory of regulation (Stigler 1971; Peltzman 1976) and public choice.[30]

The solution, in Dupuit's view, was to continue to argue for free trade and against the protectionists. England, which faced similar opposition before Peel's reforms (Dupuit 1861a, 221–25), was able to engender enough public sentiment (with the help of manufacturing interests) to overcome the entrenched interest of landlords. But Dupuit recognized that France's traditions were different. An entrenched Colbertism permeated French thinking, which gave a convenient cover for purely interest-group legislation. Infant industries still existed after two hundred years (1861a, 222), and anglophobia bolstered the case against English products.[31] Dupuit, of course, thought that the intellectual case for free trade was airtight and suggested that "advertising" and knowledge of the fundamental principles of political economy might swing popular opinion to the cause of eliminating international restrictions to free exchange.[32]

A Role for Government?

Dupuit's views on the role of government have often been misunderstood. The famous papers by Harold Hotelling (and Ragnar Frisch) advocating marginal cost pricing and nationalization of industries based on "Dupuit's taxation theorem" (Hotelling 1938, 1939; Frisch

30. Dupuit also suggests a theory of economic change based on the buildup of unappropriated costs and benefits to parties to legislation that transfers benefits and imposes costs.

31. Earlier in his book Dupuit noted that a popular but erroneous conception of England was as the "great exporter, that Bogeyman of prohibitionists, that vampire which stuffs its victims with a mass of its products" (1861a, 57). Rather, Dupuit argued that the English were prosperous because of their willingness to trade (after the Peel reforms) and because trade increased the wealth of both parties to exchange.

32. Dupuit slaps the "economists," including some of his liberal friends, who advocated protection by claiming that they lack the scientific background to call themselves economists (1861a, 230). Indeed, he was constantly defending the position that scientific training was the proper background for studying political economy (1861c, 1863c, 1863d).

1939) did much to establish the impression that Dupuit was some kind of a statist. An examination of Dupuit's views on property and on particular types of economic policy makes clear that this characterization is the very opposite of the truth. According to Hotelling and a host of marginal cost–pricing theorists (e.g., Vickrey 1948), government ownership and management of public works, such as railroads and bridges, could be welfare maximizing (theoretically) when short-run static Paretian rules are applied to decreasing cost industries.[33] The static concept of "bygones are bygones" meant that bridges and other public works and (what we now call) public goods would be provided by or regulated by governments. Dupuit's name has sometimes been invoked in support of this argument.

Dupuit's vision of the world was considerably broader. He did not adopt a static decision rule for measuring costs and benefits of projects (what we call marginal cost pricing), but rather defended a pre-Paretian longer-run view. Government projects that depended heavily on tax subsidies destroyed or had the capacity to destroy public utility. Although Dupuit was ready to abridge some property rights (as indicated below), a full cost, intertemporal evaluation of all proposed projects was the only standard to employ if public utility was to be maximized and costly mistakes were to be avoided. Short-run pricing—making the bridge "free"—was no guide to the rational allocation of resources over time. He abhorred "industrial policy" whereby government allows effective cartelization and promotes particular industries at the expense of others. Monopoly and coalitions, in his view, were essentially government creations. Self-interested politicians and private interest groups, subsidies to particular industries, interest guarantees, rate regulation, bureaucracy, and transfer costs owing to "tax and spend" were all excellent reasons to hold government to the strictest standards in supplanting private enterprise.

For all this, however, Dupuit was not an extreme libertarian. Gustave de Molinari, who was one and whom Dupuit obviously admired, went too far, in Dupuit's estimation. Dupuit (1863a) wrote a review of Moli-

33. Ironically, whether "marginal cost pricing" can improve static welfare or not turns on the nature of the taxation and subsidies that take place. Income taxes were shown not to be "lump-sum" taxes, but even if true lump-sum taxes could be used to finance projects, the direction of the net welfare transfer was ambiguous. Dupuit also did not like subsidies, because of (empirically) negative welfare effects, but he held that a full (average) cost standard had to be met to prove economy and public utility.

nari's *Cours d' économie politique*, published by Guillaumin in 1863. Molinari believed that natural law should reign supreme (though he believed that the free association of workers—unions—was part of that freedom); he favored the private provision of money and an openly competitive system in the provision of all things. Dupuit thought that this extreme view was an error and that "there is no society possible without a certain dose of communalism; there is wealth that comes to be personally appropriated; there are other kinds that are provided communally because of their character or destination. In the very small commune there are streets, places, markets, town halls, schools, cemeteries, churches, that are of common use" (1863a, 118). Economies were possible in common provisions (he uses the example of fire and police protection), but the question of private versus communal provisions was always to be settled empirically. In short, the natural law principles as invoked by Molinari (complete freedom) are not all-encompassing, but they are "only the law of the greatest number" (119). Importantly, Dupuit's examples of these communal provisions were all at the local level where, one might surmise, political subventions were less likely and where more information concerning local legislators and city managers created greater efficiency.

There were, in addition, two areas of property-rights abridgment that Dupuit condoned in the name of public utility. The first was an intertemporal constraint on the transfer of property. The second involved quality certification by government of particular private exchanges and activities.

The Issue of Inheritance

Dupuit's utilitarian base led him to urge limitations on the rights of inheritance. His arguments parallel those of Pascal, Bentham, and John Stuart Mill, and his appeals to Pascal make clear the source of his beliefs. A natural rights interpretation of inheritance suggests that inheritance—transmission of property after death—should be unlimited. But Dupuit argued that "as with property, inheritance springs from a natural sentiment, but not from a natural right" (1861b, 330). Since the essence of a natural right is that it is the same everywhere and always, Dupuit notes that, empirically, limitations to inheritance have evolved very differently in France, England, Spain, and in China. Furthermore, "When a man dies: how will his wealth be distributed? I say

in this regard that, in the absence of a written law, which is itself only a convention, the natural law is mute" (1861b, 330).[34]

In his last published essay, titled "On Inheritance" (1865b), Dupuit elaborates on the economic effects of inheritance laws (defending existing codes against the desire of M. Courcelle-Seneuil to change them). Like Mill, Dupuit believed that individuals had a responsibility to see that their direct survivors were fully provisioned (including funds for education) so that they did not become wards of the state. That right, however, should be (and was) limited for adults, collaterals, and the unrelated. Why? "In constraining that freedom in regard to these legal inheritants . . . the law obtains a powerful stimulant to encourage the increase and conservation of wealth. That freedom is perfectly in accord with the public interest" (1865b, 195).

Existing French law also permitted inter vivos gifts. Why, asked Dupuit, does the law do so while prohibiting unlimited transfers after death? It is because incentives matter:

> The law gives the living property owner a very great latitude in the disposition of his property because of the better guarantees he has against the abuse of property and [also] because of the personal interests of the property owner who, without damaging his own interests, will not make a disposition contrary to the public interest. . . .
>
> Property rights and the right of inheritance are established by virtue of the principle of public utility, and within that principle we find limits. Laws are made to contribute to the well-being and happiness of each of the members of society; they are good or bad if they attain or do not attain that end. (1865b, 196)

The right of inter vivos giving preserved the incentive to accumulate when people were alive. To deny unlimited inheritance after death did not, therefore, have a significant effect on the lifetime productivity of legators. Unlimited transfers after death, Dupuit suggests, could create "the prodigal son" (197) and waste from those distantly connected

34. Legal codes differed on the matter, with different incentives built in for property transmission and economic efficiency. English laws—with primogeniture—created concentrated ownership of land (which the socialists attacked). In France, the Napoleonic code applied so that the wife (or husband) received half the inheritance, with the rest distributed equally among all children regardless of sex (a law that still obtains in the state of Louisiana).

to the legator. The heart of the matter, therefore, is public utility—whether incentives created by property assignments do or do not maximize the sum of consumers' and producers' surplus over time. Limitations to the right of inheritance, more stringent than even Bentham's and similar in stringency to Mill's, would have that effect. Property, in short, can be limited to provide incentives in the intertemporal interests of society.[35]

Licensing for Quality Assurance

Another role for government—positive and legislative in nature—was to have government certify certain professions. He was opposed, as we have seen, to "industrial policies" that, in effect, bureaucratized corporations. They were "bad" insofar as they reduced the quality and the quantity of products. In input markets, moreover, there were "many professions, without being necessary, that are more or less regulated by special laws" (Dupuit 1861b, 50). Once more, however, the concept of "natural rights" gave no guide to those occupational restrictions that promoted utility and those that were entirely self-interested (e.g., those that raised wages with no compensating benefits). True always to his theme, some quality certification by government through licenses and restrictions may well produce net benefits. The interesting part of Dupuit's argument is that he believed that the market, not the government, is the best judge of which legal restrictions should be imposed on particular occupations:

> If the free exercise of the professions of medicine, pharmacy, accounting, attorney, barrister, stockbroker, ship's captain, etc., would have a result of multiplying maladies, lawsuits, and shipwrecks, immediately exposing the fortune and health of all, I acknowledge frankly that I would be very disposed to absolve actual legislation, and I believe that most people would agree with my advice; but it is because I am convinced that self-interest, which affects all that are [close to these markets], is infinitely more clairvoyant than the state, that I think it advisable . . . [to remove control] . . . in a certain number of professions, a guardianship more hurtful than useful. In a word,

35. Bentham (1795, 14–16) wanted to limit the amount of inheritance that laws of escheat would give collaterals and nonrelatives. Mill wanted to abolish collateral inheritance altogether with strict and progressive limits on direct heirs ([1848] 1965, 223–26). It is likely that Dupuit had the benefit of Mill's work (there are oblique references in some of his writings to Mill), but I find no direct connection in the matter of inheritance.

> one should only demand freedom compatible with the public interest; to demand absolute, radical, and complete liberty is to demand the savage state. [But] recognition of the necessity of laws in the measure of public interest is not to justify abuses. (1861b, 50–51)

Here we have a clear opening for the role of law and legislation in the labor markets. Dupuit would impose a "net benefit" test to justify each piece of legislation, and it would be an empirical test.

Dupuit, to his everlasting credit, shined the light of political economy on his own profession. The *Dictionnaire de l'économie politique* was published in 1852–53; among a number of entries, Dupuit wrote about the Corps des Ponts et Chaussées, his employer. The essay addresses, in very specific terms, the occupational licensing of the corps under the auspices of the French government. In his *Cours complet d'économie politique practique*, published in 1828–29, J. B. Say had raised multiple objections to the government's support of the engineering establishment, by which he meant the Corps des Ponts et Chaussées and the Ecole Polytechnique. Dupuit addressed Say's objections head-on, admitting that "in reading the signature of this article [his own], the reader will find that we are not in a very good position to judge. He will then have to take that position into account" (1852–53b, 380).

Dupuit's tack was to argue that virtually all nations recognize certain goods and services as "public." Canals and railroads are objects of private provision, but the building and maintenance of highways, ports, and rivers are not. As Dupuit notes, "Whether it be the entire state, the province, the department, the commune or the parish, it is an affair of administration that can be different in all the countries, but basically, the economic principle is always the same: it is recognized that the power of establishing or of maintaining certain roadways enters into the functions of the state or subdivisions of the state. The question is to know who will be entrusted with the direction of the works" (1852–53b, 380). The issue therefore is not whether engineers will get involved in such projects; the issue is at what level. And the evidence that Dupuit cites did not support the efficiency of a system of outside contracting for engineers, nor did it support appointments of highway overseers (for maintenance) at the local levels (an actual situation created by a law giving local governments the option of federal or local maintenance in 1836).[36]

36. One of Say's criticisms was that government-appointed civil engineering is "part-time work." Dupuit responded by noting that road maintenance is basically a full-time job, but even

The real issue is whether government licensing did or did not produce net benefits in the engineering profession. Dupuit provides two arguments in favor. The first regards the advantages that engineers have over the purely political provision of public goods:

> The prejudice that the existence of the corps has to combat is almost the same as that encountered by [the practical use of] political economy. The projects of engineers are pertinent to private interests; when it is a matter of planning a road, five or six directions are usually suggested, and each has its partisans. The route proposed by the engineer necessarily results in creating five or six adversaries and . . . [the engineer must defend his view]. . . . now it is well known how interests are rationalized. Instead of the engineer, whose position, education, and even the spirit of the corporation give a certain independence, put, let us say, a civil servant whose nomination, promotion, and discharge are at the discretion of local political authority subject to all sorts of influences: do you think that the proposed route will be the best or do you think it will be the one with the most political influence? (1852–53b, 381)

Dupuit suggests that engineers, whose independence and scientific training provide them with a far more objective stance in public goods assessment, are far better than administrators and decision makers appointed through the political process. Thus a public choice defense—partially supported by empirical observation—underlies Dupuit's defense of the Corps des Ponts et Chaussées.[37]

Finally, Dupuit directly addresses the question of whether and why occupational licensing is justified in any profession, including engineering. He asks, "Has political economy the pretension of giving full

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if it was not, the criticism would be economically irrelevant. He notes that "we must not conceal the fact from ourselves that the public pays, in private industry, not only for the time necessary to make products, but even for unemployment (1852–53b, 381).

37. Say had also suggested that society as a whole pays for the "mistakes of the engineers," citing that the government had to pay the contractors for a bridge that collapsed at the Invalides (designed by corps engineer Henri Navier) because a state engineer had designed it. Say also extolled the privatization of engineering in England. Dupuit retorted by noting, first, that that was what insurance was for, and second, that the design and building of a tunnel under the Thames also cost English society millions, "for it is known that this monument is only a useless curiosity, habited by organ players and frequented by the curious, which proves that countries who do not have a corps of bridges and highways are no more sheltered than others from the costly errors committed by engineers" (1852–53b, 381).

and complete liberty to all professions by allowing the public to choose among those who practice them, according to their merits and their successes? Must there be bad doctors, bad lawyers, bad pharmacists, like bad tailors or bad grocers—whose neglect by the public is justice enough?" (381–82). Should political economy recognize, in other words, that public utility demands state intervention? The answer, in Dupuit's time and our own, concerns market information, especially a lack of information on the side of those in less-informed positions. Dupuit then argues that intervention of the state in some cases is necessary "to prove the skills of those who exercise certain professions, an aptitude that the public would not know how to judge because of the long and difficult studies that they require, in the same way as the state stamps coins and precious metals to indicate: *this is gold or silver*" (382). The same applied to engineers, Dupuit believed. None of these markets, including engineering, gave perfect results, and, as we have seen, occupational licensing by government was certainly not a ubiquitous promoter of public utility. Reinforcing his belief that careful empiricism and a comparison of outcomes were required before saying anything, Dupuit argued that before destroying a particular licensing procedure (as that of the *ponts* engineers), "one would do well to examine whether what one wishes to substitute is really worth more" (382).

Conclusion: First of the Moderns?

Dupuit's fully integrated views on property, policy, and economic theory make him the first modern economist. Although his contributions to static neoclassical economic theory were astonishing enough, a thorough survey of his views on institutions and policy reveals a sophistication and prescient knowledge of the interplay between institutions and incentives, that is, a very modern approach to economic study. Although the problems attacked—food crises, unions, free trade, taxation, and inheritance, for example—had a "classical" flavor to them, Dupuit was able to view them through a neoclassical-modern prism. In addition to the contributions to static analysis, I have attempted to provide evidence that his achievements include the following:

1. Dupuit was the first writer to link a modern marginal-utility-based theory of value with the incentive-based management of property rights. His view was both theoretical and empirical. Natural rights were, observationally, no means for establishing rights to property. It

was Dupuit's contention that maximum public utility was the principal aim of society. In such a world there was no nirvana. Rather, Dupuit espoused a system of property rights that would fit the nature of resources in the presence of personal incentives and constraints.

2. Dupuit's utility and analytically based inquiry included all goods and services, economic as well as "social," all of which constituted a theory of economic policy. Economic analysis was brought to bear by him on outcomes in markets for all kinds of goods and services, including fully reproducible goods, irreproducible goods, and common property resources. This holistic perspective clearly indicated that utility was also produced in implicit as well as in explicit markets and that economics could be used to analyze all. These markets included intellectual and artistic productions, prizes, and awards, as mentioned earlier, but a market for marriage as well. As he constantly suggested, "It is a gross misunderstanding to believe that man attaches a price only to material things" (1853, 8). These "goods," as well as all others, produced public utility that could be discouraged or encouraged by the placement of property rights and incentives.

3. Dupuit not only suggested but forcefully argued that institutions evolved—and here he spoke of laws and legislation affecting all markets—in the direction of public utility maximization. This position, put forward and debated only in recent years, is a recognition of the role of interest groups in institutional change. Legal evolution has been characterized in this manner (Rubin 1977; Priest 1977), as has the new institutional economics (North 1981).

4. The basis for the public choice paradigm is also found in Dupuit's later works. Dupuit's example of "voting one's economic interest" directly anticipates Stigler's (1971) famous modern explanation. Furthermore, the example of how tariffs and other utility-reducing regulations affect political outcomes is forcefully applied to a variety of regulatory situations. Dupuit, moreover, goes on to make the further and critical point that relevant interest-group shifts occur when costs to regulation or unappropriable benefits become so large that a change in regulatory regime takes place. He believed that ideas are always superseded by interests in the give and take of institutional change. When good ideas finally come to dominate policy, it is because enabling interests have coalesced around them.

5. Most critically perhaps, Dupuit was the first economist to fully understand the nature and role of technology in the dynamics of mar-

ket functioning. The development of "scientific" theory was critical but only as a starting point to actual market investigation. As he told the liberals in 1853, "In political economy, defective data are what usually bars a complete solution; but this inconvenience only makes it more necessary to know the rules and general principles that are at the base of every solution. They alone can fill in our gaps of knowledge, indicate what is missing and, consequently, furnish the wherewithal to search and find a solution if possible, or to provide one if it is not. As in geometry, . . . political economy must draw its adroitness and precision in practice from the analytical rigor of science, because the data available are often incomplete and uncertain" (1853, 26–27).

Although Dupuit did not support what came to be called "natural monopoly" or "decreasing cost conditions" as a rationale for regulation, he completely supported the view that monopoly was natural in markets. In this pre-Paretian world he envisioned competition as a utility-creating dynamic process wherein full price, including time and transactions costs, motivated consumers and producers, demanders and suppliers. This viewpoint meant that an almost infinite range of options in manipulating products—new qualities, most especially new technologies applied to older or new products, alternative locations, different intertemporal offerings, and a whole host of nonprice activities—were as relevant to "competition" as the alterations of nominal price. Temporary monopoly, through technological change or a plethora of business activities, was a necessary and expected part of this process, as price-cost margins were constantly opened and closed through competitive activity. Technology, a topic so neglected by his classical contemporaries and by important neoclassical writers as well, was the wellspring that created market and institutional change. "Rarely," as he pointed out, "does a cost-reducing change in production not also change the quality of products; they become better or worse, larger or smaller, lighter or heavier, faster or slower . . . [and] all these qualities have a value that can be measured by the calculation of utility" ([1844] 1952, 84). As an engineer he viewed new technology every day. But as an economist Dupuit understood its impact on and import in all markets, institutional change, and economic progress. These views are working their way into contemporary economic theory and policy, and some of them are already associated with present-day Austrian movements.

In sum, I believe that Dupuit deserves a far more exalted place in the pantheon of pre-twentieth-century economists than he has achieved.

He was part of an ongoing tradition of engineering inquiry at the Ecole des Ponts et Chaussées, and there are other names, such as Charles Ellet, Dionysius Lardner, Clement Colson, and Emile Cheysson, who tested the boundaries of formal economic analysis and who belong in any list of distinguished early contributors. But these writers, along with Augustin Cournot, were primarily contributors to a rationally mechanical conception of economic theory. Dupuit was a unique and central jewel in the crown of early-nineteenth-century contributors, both analytically and in matters of application. He thought as an economist and he was an economist. His integration of economic theory, legal and political institutions, and economic policy was the essence of the modern view of how wealth and welfare are created and destroyed in a ceaseless interplay of freedom and restraint motivated by self-interest.

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