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A CRITICAL EVALUATION OF JULES DUPUIT'S CONTRIBUTIONS TO ECONOMIC THEORY AND POLICY.

Louisiana State University and Agricultural and Mechanical College, Ph.D., 1967
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A CRITICAL EVALUATION OF JULES DUPUIT'S CONTRIBUTIONS
TO ECONOMIC THEORY AND POLICY

A Dissertation
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Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
in
The Department of Economics

by
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January, 1967
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ABSTRACT

The economics of the 19th century French engineer, Jules Dupuit, has received but scant attention. His contributions to various areas of economic theory, however, were appreciated in varying degrees by several important neo-classical theorists. These and later acknowledgments were made primarily to two of Dupuit's major economic works, and of them, only F. Y. Edgeworth presented excerpts from the original source. Neo-classical and contemporary evaluations, moreover, have focused on specific points of Dupuit's analysis, and little attempt has been made to evaluate or appraise his total contribution. The purpose of this research has been to investigate and analyze Dupuit's contributions to economic theory and policy in a larger framework. To this end, translations of some of his important economic works have been required.

Dupuit presented the first important statement of the marginal utility theory of value, but he did not rest content with the statement that marginal utility diminishes with quantity. Adding the marginal utility functions of
individuals, he obtained an aggregate marginal utility curve and identified it with a market demand function. This addition, together with the identification of demand and utility functions, is legitimate only under certain restrictive assumptions. The marginal utility of money, for example, must be assumed constant in order for the demand curve to represent utility.

Nonetheless, Dupuit used the identification to develop several important welfare concepts. Consumers' surplus or "relative utility," as Dupuit called it, was the difference between what individuals had to pay and what they would be willing to pay for a quantity of a good. This concept of consumers' surplus played an important role in Dupuit's interpretations of the pricing behavior of firms.

Dupuit analyzed, independently of Cournot, the profit maximizing behavior of the simple monopolist. He saw monopoly at the apex of a range of problems regarding the size and distribution of welfare. The amount of "absolute utility" (or what could be called total net benefit) was lessened by monopoly profit maximization. Dupuit also pointed out that the interests of the profit maximizing monopolist could be inimical to the welfare
interests of consumers. It is interesting to note that Alfred Marshall's doctrines of "total benefit" and "compromise benefit" bear striking resemblance to Dupuit's earlier statements on monopoly and welfare.

One of Dupuit's most important contributions to economic theory was his early discussion of the discrimination monopolist. Price discrimination could exist, in Dupuit's view, with differences in "buyer estimates," with the ability to segment markets and with some degree of monopoly power. The motives for such a pricing policy were to be found in the nature of costs and in the desire to maximize profits. Although Dupuit discussed the effects of discrimination on price and revenue, he was primarily interested in the fact that discrimination could affect the size of the welfare benefit.

Marginal cost pricing as a welfare tool also finds its theoretical frame in the writings of Dupuit. Although Dupuit did not provide an explicit formulation of the principle, one of his bridge examples and other statements strongly suggest the possibilities of such a pricing technique.

In the matter of policy Dupuit recommended that tools be carefully fit to specific problems. If
industries were to be publicly owned or operated, Dupuit proposed the maximization of absolute utility under the constraint of covering total costs of production. This recovery of total costs could be achieved by price discrimination or by a single price technique. It is in this area of public utilities that he departed most significantly from 19th century liberalism. This imaginative application of theoretical welfare principles to the problems of public policy stamps Dupuit's contribution with a mark of genuine originality. In addition to developing microeconomic tools of great theoretical interest, he was the first important welfare economist.
A British economic theorist of some reputation once wrote the following:

The history of . . . forgotten works is indeed, a strange and discouraging one; but the day must come when the eyes of those who cannot see will be opened. Then will due honour be given to all who . . . have laboured in a thankless field of human knowledge, and have met with the neglect or ridicule they might well have expected. Not indeed that such men do really work for the sake of honour; they bring forth a theory as the tree brings forth its fruit.¹

The quotation is from William Stanley Jevons' preface to his second edition of the *Theory of Political Economy* in which, as is widely known, he acknowledged many of the antecedents of his important exposition on marginal utility. One might well imagine the surprise and chagrin that overtook Jevons when printed proof first lay before him which showed that his was not the first voyage into the subjective theory of value. The quotation above directly referred to Augustin Cournot and Hermann Heinrich Gossen,

but it could equally apply to Jules Dupuit, whom Jevons regarded, with great intellectual honesty, as the one who must be "credited with the earliest perfect comprehension of the theory of utility."\(^2\)

Although the pride of English economists must have temporarily been affected by knowledge that the pathbreaking work in marginal utility had been made on other shores, it was restored somewhat in 1903 when E. R. A. Seligman discovered that it was an Englishman after all who had first discovered the doctrine. In his article "On Some Neglected British Economists,"\(^3\) Seligman advanced the case of W. F. Lloyd as deserving credit for the discovery in 1833, a decade before Dupuit. This may have been reassuring to the British, but one could carry on such research \textit{ad infinitum} and arrive at philosophical formulations suggesting marginal utility in the writings of the Scholastics and others. In this sense, discovery of hidden genius is a neverending task since one can find anticipatory formulations for almost any theory. Political theory is replete with such examples and,


\(^3\)E. R. A. Seligman, "On Some Neglected British Economists," \textit{Economic Journal}, XIII (1903), see particularly pp. 357-361 in which Seligman concluded that "England must henceforth be considered the home, not only of the cost theory, but also of the marginal utility theory of value," p. 363. Also \textit{infra}, p.46, n. 40.
unfortunately, the same must be said of economic thought. This writer finds such doctrinal upstaging hopelessly barren in the manner in which much of it is written. Consequently, the establishment of such claims will not be the primary aim of the present research on Jules Dupuit's contribution to economic analysis. Dupuit's distinction of being the first to use certain theoretical tools may emerge from the discussion, but this will be a tangential element only. Moreover, no broad attempt will be made to present a history of marginal utility theory, or any other theory for that matter. The antecedents of the theory of marginal utility, as well as the development of the theory, have been luidly and scholarly described by several economists.\(^4\) A brief perusal of their works will show that there is little left to do in this regard. Some attempt will be made, however, to bring Dupuit's major ideas up to date.

Nor is Dupuit an undiscovered genius. His contributions to economic theory were acknowledged, with varying degrees of generosity, by Jevons, Walras, Edgeworth and others.\(^5\) Alfred Marshall, whose intellectual debt to Dupuit

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was in many respects greater than any of these, was, in
his encyclopaedic Principles, curiously stingy in his acknowl-
edgements to Dupuit, particularly with regard to the
doctrine of consumers' surplus, which subsequently received
so much attention from post-Marshallian economists. Joseph
Schumpeter remarked that in Marshall's hands Dupuit received
but "footnote recognition and this not in the right places."6

In the late Thirties Dupuit's name was invoked in the
mushrooming literature on marginal cost pricing, particularly
with regard to the knotty problem of public utility pricing
techniques.7 The French economists who are attempting to
apply marginal cost theory to the practical problem of the
pricing of electric power admit that Dupuit is their
precursor.8 Moreover, any adequate history of utility
theory does not fail to mention his contribution, even if
only in passing. Indeed, it is in connection with his

6Joseph A. Schumpeter, History of Economic Analysis

7See for example Harold Hotelling, "The General Welfare
in Relation to Problems of Taxation and Railway and Utility
Rates," Econometrica, 6 (1938) in which Hotelling used
Dupuit's argument as the starting point for his analysis.
For reference to this literature see Richard A. Musgrave,
p. 137.

8See James R. Nelson (ed.), Marginal Cost Pricing
in Practice (Englewood Cliffs: Prentice-Hall, Inc., 1964),
pp. vii-viii.
contributions to utility theory that he is best known and this is perhaps as it should be. In any event, Dupuit has already been discovered, and it will consequently not be the task of this research, with scholarly sleight of hand, to attempt to do so once more.

Unfortunately, however, Dupuit has only received what one might call "superficial treatment," from one scholar to the next, with little reference to his original writings. Nor have all his writings been explored, owing principally to the fact that they are in French and are accessible only to those economists who are at home in that language. Only in the past 15 years, under the auspices of the International Economic Association, have translations of two of his articles become available. These are by no means his only contributions, but, following Edgeworth and Jevons, all references regard them as the major ones, if not the only ones. It will be one of the aims of this research to "discover" his other economic writings and to examine them with a view to possible contributions to, or elaborations on, economic policy and theory not covered previously.

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Jules Dupuit, the economist, has not received anything like full-scale treatment in book or article form. Histories of economic thought laud his contributions (when they mention him at all), but even then only briefly and usually in connection with marginal utility theory and/or other economic theorists. This occurs even in Schumpeter's unsurpassed *History of Economic Analysis*, in spite of contributions termed "above his time." Consequently it will be a primary aim of this research to fill this gap.

Further, it is clear that it is only Dupuit the theorist and tool maker that has been discussed. Dupuit the practitioner and tool-user has been tacitly dismissed with the possible exception of the celebrated marginal cost bridge toll example; one which most frequently comes to mind with the mention of his name. Thus attention must be devoted to Dupuit's policy recommendations.

In brief, there will be no attempt to discover Dupuit, not will it be the primary aim of this dissertation to establish Dupuit's priority among utility-demand or price discrimination theorists. The attempt to discover him would be unnecessary. Whether or not he was the first

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10 Schumpeter, *History*, p. 463; also see p. 949.
economist "to make use of a demand curve," as Charles Gide suggested, is, while important in some respects, not to be the major purpose of this research.\textsuperscript{11} The aim of this work is more modest. It will attempt to place Dupuit in the history of economic analysis by discussing and evaluating, on their own merits, his contributions to economic theory and policy as evidenced by his writings.

To this end his contributions will be taken topically. The second chapter will explore his formulation of marginal utility; the third that of consumers' surplus; the fourth, his monopoly-price discrimination theory. The fifth chapter will concern itself with Dupuit's contributions to marginal cost pricing and with the particular applications Dupuit made of his economic tools to public policy. Although his contributions will be analyzed topically, the sixth and concluding chapter will evaluate Dupuit's contributions to economic analysis, it is hoped, in broader perspective than has been possible before. It is impossible to know whether Dupuit has received his just due in the history of economic thought until this broader perspective, that is to say, all

of his economic works, have been evaluated. This is the purpose of this dissertation.

Sources

The source material for this research will revolve around Dupuit's original writings. His major contributions are contained in articles appearing in the *Annales des Ponts et Chaussees* (bridges and roadways) and in the *Journal des Economistes* through the 1840's, 1850's and early 1860's. Only two of these have found translation: these are "De la Mesure de l'Utilite des Travaux Publics," (1844) and "de l'Influence des Peages sur l'Utilite des Voies de Communication," (1849), translated as "On the Measurement of the Utility of Public Works" and "On the Influence of Tolls on the Utility of Ways of Communication" respectively. Consequently, it has been necessary to translate some of his other economic writings, and the author wishes to acknowledge the generous assistance of the L.S.U. Foundation in this regard. A bibliography of all of Dupuit's published works on economics comprises

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12 *International Economic Papers*, Nos. 2 and 11. Unfortunately only one of the four parts of the 1849 article, that entitled "On Tolls and Transport Charges," is translated in the *Papers*. 
Appendix I of this work. Those works for which translations were made are indicated in the dissertation bibliography and in footnote references in the text.

Additionally, Dupuit made a number of minor contributions on such topics as protectionism, free trade, Malthusianism and others. Along with Frederic Bastiat and other leading French economic thinkers, he was a contributor to the *Dictionnaire de l'Economie Politique*, published in 1852 and 1853. Dupuit's name is signed to the following entries; "Eau" (water); "Peage" (toll); "Routes" (roads); "Voies de Communication" (ways of communication or transportation); "Poids et Mesures" (feet and measures); "Ponts et Chaussees" (bridges and public roadways). Excluding the entries on water, feet and measures and roads, which were the concern of Dupuit the engineer, it was felt necessary to translate all of the others.

A collection of his major works was published in Italy in 1934 under the editorship of Mario de Bernardi entitled

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De l'Utilite et sa Mesure: Ecrits Choisis et Republies.\textsuperscript{14}

The collection contains most of Dupuit's major economic articles and the reply he elicited from M. Bordas, a fellow engineer. All but one of the articles it contains have been readily available to this writer in the original journals; the collection's preface, introduction and bibliography have been most helpful however. Moreover, the article not readily available to this author was an interesting one on water distribution, which, as Bernardi suggested in the introduction, represents a detailed application of the theories developed in Dupuit's two articles in the \textit{Annales} to a special problem.

No attempt has been made to investigate purely scientific tracts such as \textit{Des inondations. Examen des moyens proposes pour en prevenir le retour},\textsuperscript{15} or \textit{Traite de l'equilibre des voutes et de la construction des ponts en maconnerie}.\textsuperscript{16} Any works suggesting economic content have

\textsuperscript{14}Jules Dupuit, \textit{De l'Utilite et sa Mesure}, ed. Mario de Bernardi (Torino: La Riforma Sociale, 1934).

\textsuperscript{15}Jules Dupuit, \textit{Floods. An Examination of the Means Proposed to Prevent their Return} (Paris, 1858).

been investigated. While it is not impossible that a purely scientific tract may contain material pertinent to the present investigation, the probability is low enough to remove it from consideration. The dichotomy between Dupuit the engineer and Dupuit the economist, in other words, must be established.

There seems to be a genuine dearth of secondary sources pertaining to Dupuit. With the exception of the Howey work and a few others,\(^\text{17}\) several of Edgeworth's writings and fleeting mention in a few Histories of Economic Thought, little is available on Dupuit. One other exception that should be mentioned is the memorial article written on the occasion of Dupuit's death entitled "The Life and Works of Mr. Dupuit."\(^\text{18}\) A biography by J. Mahyer contained in the Bernardi collection also contains some interesting material.

All of Dupuit's original writings were readily available to this writer in French. The greatest problem was,


\(^{18}\)E. Lame Fleury, "La Vie et Les Travaux de M. Dupuit," translated by Candace Uter and edited by R. B. Ekelund, Jr., *Journal des Economistes*, 3rd Ser., VII (1867), pp. 161-187. Page references are to the translation which is available only in the library of Louisiana State University.
therefore, one of translation. With the exception of a few
minor articles and titles, the lion's share of the work has
been left to professionals. On occasion it has been
necessary or desirable to repeat quotations in the original
French. Fortunately, a minimum of such citations have been
required.

Biographical Orientation

Arsine-Jules-Emile-Juvenal Dupuit was born on May 18,
1804 in Fossano, Italy when this region was a part of the
French empire. At the age of 10, Dupuit returned with his
parents to France where he continued his education in the
secondary schools at Versailles, at Louis-le-Grand and at
Saint-Louis where, as Mahyer pointed out, "he finished
brilliantly by winning a physics prize in a large compe-
tition."20

Dupuit was accepted to the School of Bridges and Road-
ways in 1824 and in 1827 he was put in charge, in the
department of Sarthe, of an engineering district which

19 J. Mahyer, "Biography," translated by Candace Uter
and edited by R. B. Ekelund, Jr., in De l’Utilite et sa
Mesure, ed. Mario de Bernardi, p. 1. Page references are
to the translation which is available only in the library
of Louisiana State University.

encompassed roadway and navigation work. He was married in 1829 and was made first-class engineer in 1836.

Dupuit concerned himself with important problems throughout his illustrious career as an engineer. He conducted experiments on the deterioration of roadways which resulted in his Essay and Experiments on carriage Hauling and on the Friction of Rotation (1837). A subsequent contribution on the same subject, appearing in the Annales des Ponts et Chaussees of 1842, earned him a gold metal, awarded as a result of an engineer's ballot. As a result of these contributions, Dupuit was made second-class engineer-in-chief in 1842 and was decorated by the Legion of Honor on May 1, 1843.  

The floods of the Loire river in 1844 and in 1846 occasioned Dupuit's interest in the Theoretical and Practical Studies on the Movement of Running Water (1848) which was later (1863) revised and re-published. Floods. An Examination of the Means Proposed to Prevent their

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21 Five such metals for engineering tracts in the Annales were voted for him. See Fleury, "The Life and Works of Mr. Dupuit," p. 4.

22 Mahyer, "Biography," p. 3.
Return, published in 1858 was another attack on the same problem.

In 1850 Dupuit was called to municipal duty in Paris with the title of director-chief engineer. Here he studied municipal water distribution and supervised the construction of sewers. This position culminated in the research work entitled *Theoretical and Practical Research on the Conduction and Distribution of Waters* (1854, 2nd ed., 1865). In December of 1855 Dupuit was named inspector-general of bridges and roadways. Additionally, he served for eleven years (1855-1866) on the general council of bridges and roadways, of which, Mahyer claimed, "he was one of the most illustrious members."\(^{23}\)

Even this incomplete listing of Dupuit's engineering interests and publications is sufficient to illustrate the accomplishments of an active and fertile mind. Dupuit profited from each of his assignments, as evidenced by the specialized nature of his publications. These publications were anterior to research on particular problems. And Dupuit's was a scholarly approach for, as Mahyer said,

"for Mr. Dupuit a work was never finished."  

Dupuit's career as an engineer was no more remarkable than his career as an economist. It is unfortunate that his projected book on Political Economy Applied to Public Works, to which he refers as early as 1844, was never brought to completion. With the exception of the short plea for free trade, Commercial Freedom (1861), Dupuit's reputation as an economic theorist must stand with his journal contributions, which were of considerable number.

Dupuit's position on the role of the state in economic affairs is interesting in that it permeates his writings and becomes the matrix for his theoretical contributions. Dupuit was a liberal as regards the majority of economic activities. As he pointed out "... the question of wheat, the question of sugars, question of irons, question of the bakery shop, etc., etc., all resolve themselves in the same way (absolute freedom) and cannot be resolved in any other


25 See for example "On the Measurement of the Utility of Public Works" in Papers, note 1. At other places in his writings reference to "chapters" frequently appear. In his memorial article Fleury quoted Mr. Joseph Garnier, then editor of the Journal des Economistes, as having said that Dupuit "had postponed this project until after the finishing of his engineering work, which was interrupted by his death," "The Life and Works," p. 45.
way. His support of the Malthusian doctrine along with the classical wages-fund doctrine adds credence to this view. His position on these tenets of nineteenth century theoretical liberalism goes far in explaining Dupuit's failure to become an important force in the Society of Political Economists, if Fleury's account is to be trusted.

Dupuit, however, is remembered not for his espousal of absolute economic freedom, but rather for the modifications he thought necessary to make in this freedom. Dupuit stood squarely on the results of his theoretical investigations regarding utility. "Public utility" (or the aggregate of

26 Dupuit, "Food Crises and Means Used to Remedy Them," *Journal des Economistes*, 2nd Semester, XXII (1859), p. 365. Dupuit elaborated on the benefits of free trade and competition in his "effects of the Freedom of Trade - A Letter from Mr. Dupuit," translated by R. B. Ekelund, Jr., *Journal des Economistes*, 2nd Ser., XXV (1860), pp. 516-518. In this "Letter" Dupuit took an extreme anti-protectionist position, concluding that "... in its own interest, a state has no right to seek to produce that which other peoples are able to make at a better price...," pp. 5-6. This translation is available only in the library of Louisiana State University. Page references are to the translation.

27 See Fleury, "The Life and Works" particularly pp. 24-27. Paradoxically, Dupuit supported the control of monopolies, against the equally stringent objections of his peers. See *infra*, p. 20.
society's welfare) could be maximized, perhaps, with ubiquitous conditions of competition. But Dupuit was concerned with the effects of monopoly and discriminatory pricing policies on this public utility. In such monopolistic industries or in the provision of "social goods" the government had a distinct role to play. It was to regulate rates or to assume control in order to "maximize" public utility. Absolute economic freedom could be abridged, Dupuit contended, in the public interest, and utility was the overriding criterion of the public interest. As such, Dupuit was the harbinger of the philosophy of a later day. He was the first welfare economist as well, conceiving of a social welfare function not unlike those of such contemporary writers as Kenneth Arrow and Abram Bergson. The organizing principle of society, to Dupuit, was to the utility or social welfare, and, when conflicts arose between this utility and private interests, utility should conquer. When this fundamental issue is kept in mind, Dupuit's writings exhibit a genuine cohesiveness and order.


Dupuit dismissed the exclusive use of economic facts in his attempt to develop tools with which to study public utility. Dupuit's penchant for the theoretical (and mathematical) method raised its head in every article. As Fleury pointed out, Dupuit conceived "of political economy as a science of reason more than as a science of observation." As Dupuit himself said, "... to better see the facts, to better observe them, one must clarify them by the light of reason." In keeping with this methodology, Dupuit contributed to the development of several important theories: those of marginal utility, demand, consumers' surplus, monopoly-price discrimination and marginal cost pricing. It will become clear that these tools were developed in order to analyze "public utility" with a view to enlarging it wherever possible.

Dupuit's economic lineage remains an interesting questionmark. Fleury referred to a remark made by Dupuit

32Actually the terms is Marshall's. Dupuit called the difference between cost to the consumer and the area under the demand curve corresponding to a given price "relative utility" or "utility remaining to consumers." This triangle has also been called "consumers' rent" owing to the similarities to the Ricardian rent theory. Practice in this dissertation will be to use all of these terms interchangeably.
in 1864 to the effect that he had studied political economy for 40 years.\textsuperscript{33} There can be little doubt that Dupuit was influenced by the writings of J. B. Say since he frequently and respectfully disagreed with that French master in his own work. The ideas of Pelagriino Rossi and Joseph Garnier, contemporary French economists, also appear to have had some influence on the direction of Dupuit's economic thought, particularly with regard to methodology.\textsuperscript{34} But it is difficult to trace the exact origin of Dupuit's interest in political economy. His biographers Mahyer and Fleury shed little light on this issue. To add to the mystery, Augustin Cournot, several years the senior of Dupuit, published his \textit{Mathematical Principles} in 1838. The contents of this work should have been of extreme importance to Dupuit, but he nowhere mentions it. Moreover, Dupuit's education was that of the engineer, with no great economist obtrusively figuring in his intellectual development. In view of the dearth of such information, Mahyer's statement on the matter must suffice; "political economy which attracts at every turn the engineer's interest, had

\textsuperscript{33}Fleury, "The Life and Works," p. 44.

\textsuperscript{34}See Fleury, "The Life and Works," pp. 14 and 44.
been also the object of his Dupuit's constant study, and he was not less learned in that science than in that of public works."35

The unpopularity of Dupuit's ideas during his lifetime is less of a mystery. As noted earlier, his thoughts on population and on the wages-fund doctrine earned him few friends, but his position that the control of industrial and commercial associations was necessary and desirable "... definitely prevented him from being one of the dignitaries of the Society of Political Economists."36

Moreover, Dupuit's approach to such issues was apparently of a "preaching" nature. Fleury described his mien as "... cold, reserved, cutting all at the same time."37

Aside from his family, added Fleury, his life "had no other events than the works of the economist, engineer and of the analyst."38 These are not usually the qualities


36Fleury, "The Life and Works," p. 24. Here one can hardly avoid noting the influence of Rousseau on Dupuit. Suspect always of factions and uncontrolled associations (such as monopolies), Dupuit felt that the volonte general or the general will, which was a criterion of the general welfare, should prevail. This idea is still to be found in French social thought. To this day the French are suspicious of factions which might fragment the general will and welfare.


38Fleury, "The Life and Works," p. 47.
which instill strong alliance or union of interest among contemporaries, and in Dupuit's case, they caused him to be accused of absolutism and paradox. 39

All this accounts somewhat for his relative neglect and obscurity during his lifetime. But at least one contemporary attempted to set the assessment aright. On the occasion of Dupuit's sudden death in 1866 he wrote:

Whoever will take the trouble to look over the whole of the studies or even of the rapid sketches left by Mr. Dupuit will readily recognize that this total work reveals an intelligence whose scope passes up many of those men whose names are more well-known to the public than his own. 40

Unfortunately, generations of economists have not followed up Fleury's adjuration. There has been piecemeal appraisal to be sure, but no real attempt to reconstruct and evaluate Dupuit's unique and original approach to economics. This research, it is hoped, will contribute toward filling the gap.


40 Fleury, "The Life and Works," p. 34.
CHAPTER II

UTILITY - DEMAND THEORY

The Subjective Theory of Value

Considerations of economic welfare and social well-being directed Jules Dupuit's attention to the study of political economy in the early 1840's. As chief engineer of bridges and highways, Dupuit sensed the need for analytical tools which could give some measure of the desirability of all public projects. Moreover, the desire to devise tariffs and railroad rates for the "public good" goaded him, as it were, into an investigation of political economy. The quest for sound public policy in these matters required an economic definition of, in his words, "the conditions which these public works must fulfill in order to be really useful."\(^1\) Dupuit, however, found contemporary economic theory wanting of such a measure and


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at the same time recognized that the key to the problem lay in the psychological concept of utility. Dupuit believed that all earlier utility theories were "vague, incomplete, and often inaccurate,"\(^2\) and consequently of little value in the measurement of public welfare. Accordingly, he set out to reshape the concept of utility into a tool of practical import.

**Dupuit and J.B. Say: A Critique of Classical Value Theory**

Dupuit prefaced two of his major articles\(^3\) with critiques of utility theory, exhibiting a basic familiarity with major classical writers on the subject. His sharpest criticisms were directed against J. B. Say, and quotations abound, in Dupuit's critical work, from Say's *Cours d'Economie Politique* and *Traite d'Economie Politique*\(^4\).


\(^3\)Dupuit, "On the Measurement of the Utility of Public Works," *Annales*, (1844), and "On Utility and Its Measure," translated by Eleanor Evans and edited by R. B. Ekelund, Jr., *Journal des Economistes*, 1st Ser., XXXVI (July to September, 1853), pp. 1-27. This latter translation is available only in the library of Louisiana State University. Page references will be to this translation. Since the titles of these two works are somewhat similar, subsequent references will list the short title and date of publication.

\(^4\)Unfortunately, Dupuit did not provide page references to the Say quotations in either of the articles, but the *International Economic Papers* translation supplies them for the 1844 work.
The major issue raised by Dupuit concerned the meaning of the word "utility." Say treated utility as the "faculty which things possess to be able to serve man in any possible way,"\(^5\) and cited the example of the court mantle cloak (manteau de cour), to Say an apparently useless item, having utility if a price could be attached to it. Say thought further that "this price is the measure of the utility which men judge the thing to have . . ." and that "this price is the basis of the demand for products and consequently of their value."\(^6\) But Say thought that value could not exceed costs of production, for if it did, it would pay the consumer to produce it for himself. In sum, utility was the basis for demand and value, and price (or value in exchange) was a measure of utility. Say approved and accepted Smith's distinction between value in use and value in exchange, which amounted to asserting that all goods could not be treated under one theory of value. Water, in this familiar paradox, possessed much value in use, but no exchange value. Diamonds, on the other hand,

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had an abundance of exchange value, but were of little use. Say, attempting not to become embroiled in the confusion, noted that it would be preferable to reserve to the word "value" only the meaning implied by the phrase "value in exchange." He thought that the term "utility" was too capricious to use as a synonym for the word "value."

It is clear that Say thought that "real value," or value in exchange, was determined by costs of production and that the resultant market price was in fact a measure of the utility of that product. In this he followed the general notions of Adam Smith. But Say hastened to add that "one should not draw the absurd conclusion that, by raising the price by force, one increases . . . utility." To illustrate this, he used a wine tax case in which he indicated that a tax of 5 cents (sous) per 10 cent bottle merely shifted 5 cents per bottle from the consumer or producer to the tax collector. Here Say regarded the 10 cent, or cost of production as the "real value" of the wine, and the 5 cents as contribution nothing to utility.

With respect to the wine-tax example, Dupuit readily accepted the fact that the 5 cents tax on wine added no

utility to the product. But at the same time it was equally obvious to Dupuit that the product had to have at least 15 cents worth of utility, or the consumer simply would not buy wine. To substantiate this view, Dupuit invoked the fundamentals of consumers' surplus theory. This theory will be treated systematically in Chapter III of the present dissertation, but it is useful at this point to show that Dupuit, in rejecting the cost of production theory of value, used the utility argument as the basis for his consumers' surplus theory. To wit, with reference to the wine-tax example, he said that "all those who attach to the purchase of wine a value greater than 15 sous will buy, and will derive a kind of profit which will vary according to the significance which they put upon their acquisition." Thus, in arguing that market price and cost of production are not measures of utility, Dupuit arrived at his own measure--a measure not given by value in exchange, but by the highest price that one would offer for a quantity of a good. Carried to its logical end, this concept inevitably led Dupuit to the notion of a

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"consumers' surplus," that is, that the difference between this **highest price** one would pay, and the price actually paid (value in exchange) for **fixed quantity** of output accrued to the consumer in the form of a surplus or net gain in satisfaction. The utility afforded by a product, thus conceived, is not measured by market price, as in Say's scheme, but it is related to maximum-offer price; and this maximum-offer price, to Dupuit, was determined by taste, income, and individual circumstances.

**The Smith-Say Paradox and the Marginal Utility Theory**

Although Dupuit thought that the measure of the utility of any quantity of a good was the maximum price the consumer would be willing to offer for it, utility, in his view, was not synonymous with value, but was only one element of value. In Dupuit's words:

> . . . utility and value are two different properties not independent, but having between a coupled relationship in which enters another circumstance, which is rarity. In order for something to have value, two essential conditions are necessary: first, that it be useful . . . ; second, that it not be in such great quantity as to satisfy completely all desires.\(^\text{10}\)

Here the solution to the water-diamond paradox was at hand; utility and **scarcity** provided the key. The exchange

value of diamonds was high because quantity was restricted so that "only those who are disposed to make the greatest sacrifices"\textsuperscript{11} could afford to procure them.

Dupuit thus attempted to show that water and diamonds both follow the same law of exchange value. And it is in the very solution to the paradox of value that Dupuit found himself giving a starring role to marginal utility in price determination. It is, therefore, necessary to investigate this argument in detail.\textsuperscript{12} Figure 2-1 of the community's total, average and marginal utility functions, although not introduced by Dupuit at this point, can be used to analyze his ideas.\textsuperscript{13}

Dupuit's example was one of a city receiving water in abundance from a stream flowing through it. Water there would have no value in exchange. But, he continued:

\textsuperscript{11}"On Utility," (1853), p. 11.

\textsuperscript{12}Dupuit attacked the value in use - value in exchange dichotomy in the 1844 Annales article, but in not so clear a fashion as in his 1853 revision. His clearest statement, that of 1853, is used here.

\textsuperscript{13}The total utility function does not necessarily have to be drawn so that marginal and average utility decrease over the entire range of output. Conceivable marginal and average utility could increase with the first units of output. See Richard H. Leftwich, \textit{The Price System and Resource Allocation} (New York: Holt, Rinehart and Winston, 1966), pp. 47-50.
... the enemy comes, blockades the city, diverts the stream, the inhabitants have now at their disposal only the drops which escape from the works of the enemy or that of a few wells which dry up easily; there is no longer any more for all usages, everyone is more or less deprived; water then has a value. ... If the enemy, perfecting its works, succeeds in diminishing progressively the quantity of water which enters the city, its price is going to rise more and more and one will not care to exchange a liter of it against a diamond.¹⁴ (emphasis supplied)

In the above quotation, Dupuit said that utility indeed was a determinant of value, but that it was not the only

determinant, since quantity available of water must also be considered. With reference to Figure 2-1, $Q_t$ would be the quantity originally appropriated by the inhabitants of the city, for at this point, total utility is at a maximum and the marginal utility of water is zero. Let some quantity, say $Q_n$, be the quantity of water originally available. Between quantity $Q_n$ and quantity $Q_t$, the average utility of water is positive, but no one will yet pay a price for water because the marginal utility is still negative in that region. Let us recall that Dupuit posited the assumption that the enemy allows only "drops" to flow through and that the inhabitants only had a "few wells which dry up easily." Dupuit here seemed to have indicated that the progressive diminution of the quantity of water available creates a positive and progressively increasing marginal utility for water among the inhabitants. But the material which follows the above quotation seems to make this conclusion less tenable. Dupuit remarked:

Let us say, then, with all the economists, that utility or value in use is the basis of value, but that it is not the only one. Permit us to take the liberty of borrowing from arithmetic a comparison: . . . the value of a fraction . . . depends evidently on its numerator, the greater the numerator, the greater the fraction, but it also depends on its denominator, the greater the denominator, the
smaller the fraction . . . The numerator is the utility, the denominator is the quantity at the public’s disposal, the value in exchange /price/ is the value of the fraction.  

It thus appears that Dupuit held that price, or exchange value, was equal to average utility, or U/Q. But it is clear that he was merely trying to solve the Smith-Say dilemma through an analogy; that is, he reconciled utility with scarcity in the determination of value. He met Smith and Say on their own grounds in formulating exchange value in terms of a ratio of utility to quantity available. In other words, the concept of average utility was used by Dupuit to direct thinking towards a solution to the diamond-water paradox. But his belief that this relationship (between average utility and quantity available) was an inadequate explanation of price is revealed in the sentences following the above quotation:

Heaven forbid that we consider this comparison /average utility/ as expressing exactly the connection which exists between the value in exchange of an object, its utility and the number of similar objects actually available; it is only an indication of the general sense of their influence. The formula which ties these three quantities together is much more complex and it /average

utility only presents us with . . . this analogy, that value increases with utility and diminishes with number.16 (emphasis supplied)

If average utility (U/Q) is not an expression of exchange value, but is only an indication of the mutual interaction of utility and quantity, then some other expression defines value. Presumably Dupuit meant this "more complex" expression "which ties these three quantities together" to be marginal utility.

Dupuit must be criticized for allowing his argument to lose force. His original statement of marginal utility in the example of the besieged water supply was clear enough. But he lapsed into an analogical statement of average utility at a crucial point in his refutation of the water-diamond paradox. The fraction of which he spoke was average utility, and it would be incorrect to assert that such an expression together with the quantity available equals price or exchange value. For such an expression to possess validity, a rather bizarre theoretical

curiosity must obtain. In his eagerness to show that utility, along with quantity available, played an important role in price determination, Dupuit invoked an unnecessary

A rather special form must be ascribed to the total utility function for this to be a possibility. A "roof-shaped" total utility function which emanates linearly from the origin to a maximum and, abruptly becoming negatively sloped and linear once more, contains the possibility. The total utility curve can be thought of as consisting of two segments. With the utility maximum dividing them. For the first segment the rate of change in total utility is constant and marginal utility and average utility coincide. The marginal utility function becomes discontinuous where total utility is at a maximum and then negative at all greater quantities of water. All quantities less than that corresponding to maximum total utility would bear a constant positive price, quite without reference to whether one is speaking of average or of marginal utility as the determinant of exchange value. Since both the average and marginal curves coincide in this case, one could say that either or both determine price. It is clear that Dupuit did not have this case in mind, however, for as the siege continued, the "progressive" diminution of water available caused price to "rise more and more," a situation which would not have occurred had the identity and consequent constancy of marginal and average utility obtained.

Moreover, with reference to Figure 2-1, depicting a "normally" sloped total utility function, Dupuit could not have maintained that average utility and quantity available determined price, for, since water was free before the siege, quantity $Q_z$ would have been taken. But at quantity $Q_z$, total utility is zero and there is no value in exchange or value in use attached to water. If Dupuit felt that average utility determined exchange value, there would be no particular significance to quantity $Q_t$, the utility maximizing quantity, on that diagram. The conclusion that water possessed neither exchange value nor utility before the siege must follow. Since Dupuit knew that this was not the case, it must be concluded that he only intended an analogy. The analogy was ill-timed and confusing however.
analogy which drew attention from his initially correct statement.

Exoneration is possible, however, when one considers the manner in which Dupuit hedged his argument. He clearly stated that a more complex expression (than average utility) determined price, but he cryptically neglected to return to it. A clear mathematical expression for marginal utility at this point would have added great force to his evaluation of Say and classical value theory. The conclusion that he did not fully understand marginal utility would be naive and unguarded in view of his pristine treatment of it elsewhere in his writings. It is likely, moreover, that in the issue raised by the classical paradox (that of the determinants of price), Dupuit found, in embryonic form, the "neo-classical" theory of value. Dupuit thought that utility and demand had to be considered along with quantity available in the determination of price. He felt that Smith and Say would have had only to relate the concepts of utility and scarcity (already in their possession) to point the analysis of value in the right direction. This relationship may have provided a more fruitful line of
inquiry than labor units,\textsuperscript{18} scarcity as in the case of land,\textsuperscript{19} or even bare costs of production.\textsuperscript{20} In short, Dupuit seemed to be chiding the classical economists for not having seen what was obvious to him, and for not having understood what, with modest reflection, should

\textsuperscript{18}See Adam Smith, \textit{Wealth of Nations} (New York: Modern Library, 1937), pp. 30-31. Smith, of course, only held such a theory in the "rude state" of society. David Ricardo was one of the most insistent proponents of the labor theory; see Chapter I in the \textit{Principles of Political Economy and Taxation} (Homewood, Ill.: Richard D. Irwin, 1963).


\textsuperscript{20}See Joseph A. Schumpeter, \textit{History of Economic Analysis} (New York: Oxford University Press, 1954), pp. 308-309, for a discussion of Smith's cost of production theory of value. George Stigler, in an interesting article entitled "Ricardo's 93% Labor Theory of Value," \textit{Journal of Political Economy}, LV (April, 1947), thinks that Ricardo's value theory should be more properly termed cost of production. The "conventional wisdom" holds that he doggedly held to the labor theory, however, although he apologized liberally for it in the case of the introduction of machinery and in the case of non-reproducible goods.
have been obvious to them as well. Dupuit's criticism is well taken, and is of value. It is unfortunate, however, that his usual boldness did not prevail. Much of the sting of his theoretical critique is lost in the analogy, and, more pointedly, in the failure to elaborate on his "more complex expression." But the discussion was not in any sense worthless, and the genuine uniqueness of Dupuit's attack on the famous paradox is not to be denied.

Dupuit's Demand Curve

The purpose of this section will be to present and evaluate Dupuit's formulation of demand curve theory. Dupuit, as will be shown, did not have the "last word" on demand,

21 Dupuit said, for example, that "J. B. Say, after having perfectly defined what was to be understood by the utility of wealth, has often confused it with value, pretending that this value of exchange was the measure of utility. Now, the nature of a measure is to increase or decrease proportionately with the measured quantity . . . In order that the opinion of J. B. Say be admissible, it would then be necessary that value always be proportionate to utility. Now, that is not the relation which exists between these two quantities," "On Utility," (1853), pp. 4-5. Dupuit added in another passage that "the capital error of J. B. Say and all of classical economics, one might add/ is not to have misunderstood value in use or utility, but to have rejected it from science . . ." "On Utility," (1853), pp. 14-15.

and his exposition received criticism before the end of the nineteenth century. Moreover, it is important to indicate at the outset that Dupuit's pure theory of the demand curve and his consumer's surplus theory are inextricably intertwined. His original purpose in studying political economy, it will be remembered, was to find a measure of "public utility." One measure was consumer's surplus, and the demand curve, or the "curve of consumption" as Dupuit labeled it, was a convenient tool to show and manipulate such a surplus. It was as a means of depicting consumer's surplus, then, that Dupuit drew the demand curve. Thus, although the two concepts are linked to Dupuit's presentation, the following will attempt to treat the theory of the demand curve in isolation.

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23It is doubtful, moreover, that the state of demand theory has reached its apogee even today. See, for example, H. H. Liebhafsky, The Nature of Price Theory (Homewood, Illinois: The Dorsey Press, Inc., 1963), p. 531.


25It will be explained later that this is legitimate only if some rather restrictive assumptions are met. See for example Paul A. Samuelson, Foundations of Economic Analysis (New York: Atheneum, 1965, originally published in 1947), Chapters VII, VIII, particularly pp. 199-200, and Chapter III of the present dissertation.
Nineteenth century French writers, it would seem, were especially inventive regarding economic theory, forging tools in advance of their contemporaries in England.\textsuperscript{26} As early as 1838 an important book dealing with the tools of economic analysis appeared in France. Augustin Cournot published in that year his \textit{Researches into the Mathematical Principles of the Theory of Wealth},\textsuperscript{27} which, as indicated in Chapter I, apparently went unnoticed by Dupuit. Cournot, as evidenced by the book, was the first writer to discuss in mathematical terms (and in terms of geometrical presentation) the functional relationship between price and quantity. Additionally, he made important contributions, which were obviously above his time, to the theory

\textsuperscript{26}J. A. Schumpeter is reputed, perhaps apocryphally, to have once said that of the four great economic theorists, three were French: Quesnay, Cournot and Walras. The fourth presumably was Marshall. See P. A. Samuelson, "Economists and the History of Ideas," \textit{American Economic Review}, LII (March, 1963), pp. 3-4.

\textsuperscript{27}A reprint of this classic work has recently become available. See \textit{Researches}, translated by Nathaniel T. Bacon with an essay by Irving Fisher (New York: Augustus M. Kelley, 1960).
of monopoly and duopoly. But it is clear that Cournot eschewed considerations of utility in his formulation of the "law of demand," for he said:

The abstract idea of wealth or of value in exchange, a definite idea, and consequently susceptible of rigorous treatment in combinations, must be carefully distinguished from the accessory ideas of utility, scarcity, and suitability to the needs and enjoyments of mankind, which the word wealth still suggests in common speech. These ideas are variable, and by nature indeterminate, and consequently ill suited for the foundation of a scientific theory.

Although Cournot thought utility a "variable and indeterminate idea," he disclaimed any opinions as to the truth or

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28Modern theorists dealing with problems of imperfect competition often use Cournot's mineral springs model (with conjectural variation of zero) as their point of departure. See Edward H. Chamberlin, The Theory of Monopolistic Competition (Cambridge, Massachusetts: Harvard University Press, 1962), pp. 32, 221-222. William Fellner finds that "it was Augustin Cournot's great achievement to have discovered the distinction feature of the oligopoly problem. The distinctive feature to which Fellner refers is that the kind of assumptions one makes concerning rivals reactions determines the kind of solution one obtains in any given problem. See Competition Among the Few (New York: Augustus M. Kelley, 1965), p. 56 et passim. Until recently, it has been thought that Cournot's model yielded indeterminant results in the absence of an assumed conjectural variation of zero. But Irwin M. Grossack, in an interesting interpretation of the Cournot model, has shown that the "conjectural variation of zero" assumption can be dropped with the model still yielding determinant and plausible results. See "Duopoly, Defensive Strategies, and the Kinked Demand Curve," Southern Economic Journal, XXXII (April, 1966).

29Cournot, Researches, p. 10.
error in discussions on the utility of things. As he pointed out, "we only mean that generally neither the truth or error is capable of proof; that these are questions of valuation, and not soluble by calculation, nor by logical argument." Cournot was not saying here that utility has nothing to do with the law of demand, for further on in his book he pointed out clearly that the law of demand "depends evidently on the kind of utility of the article, ... on the habits and customs of the people, on average wealth ..." Notwithstanding this concession to utility, Cournot consistently entertained only an "empirical" approach to the law. As he lucidly pointed out:

Observation must therefore be depended on for furnishing the means of drawing up between proper limits a table of the corresponding values of D and p; after which, by the well-known methods of interpolation or by graphic processes, an empiric formula or a curve can be made to represent the function in question; and the solution of problems can be pushed as far as numerical applications.

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31 Cournot, *Researches*, p. 47.
Dupuit, as will become apparent, also used observation in obtaining the demand curve; but Dupuit gave the data he observed a different interpretation.

**From Utility to Demand**

Arguing with the flavor of Carl Menger, who later elaborated on the point, Dupuit showed that the marginal utility that an individual obtained from a homogeneous stock of goods is determined by the use to which the last units of the stock are put. In doing so, he clearly pointed out that the marginal utility of a stock of some particular good diminishes with increases in quantity. If one grants his psychological premise that "each consumer himself attaches a different utility to the same object according to the quantity he can consume," his argument follows with ease. The example is once again water. Dupuit argued:

One distributes water on a city which, situated on a height, could procure it only with great pains. There was then such a value that the hectolitre per day was 50 francs by annual subscription. It is quite clear that every 

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hectolitre of water consumed in these circum-
stances has a utility of at least 50 francs.\textsuperscript{35} (emphasis supplied)

Dupuit here suggested that each unit of a given quantity of water will have a different utility. But why should each increment of the same commodity possess a different utility? Dupuit continued his argument, supposing that due to the installation of pumps, costs of production for water have fallen by 20 francs:

> What happens? First, the inhabitant who consumed a hectolitre will continue to do so and will realize a benefit of 20 francs on his first hectolitre; but it is highly probable that this lower price will engage him in increasing his consumption; instead of using it parsimoniously for his personal use, he will use it for \textit{needs less pressing, less essential}, the satisfaction of which is worth \textit{more than 30 francs}, since this sacrifice is necessary to obtain water, but is worth \textit{less than 50}, since at this price he relinquished this consumption.\textsuperscript{36} (emphasis supplied)

Thus, each increment of the same commodity carried a different utility because additional units will allow "less pressing, less essential" needs to be met. The additional utility (marginal) derived from additional units of the same commodity must decline. Dupuit,


\textsuperscript{36}"On Utility," (1853), p. 18.
extending the example, supposed that when price fell to 20 francs, the individual would demand 40 hectolitres "to be able to wash his house every day; give them to him at 10 francs, he will ask for 10 to be able to water his garden; at 5 frs. he will ask for 20 to supply a water font; at one fr. he would want 100 to have a continuous flow, etc." It is the least pressing need, not the most pressing need for a commodity which defined the value of the entire stock of goods. Dupuit's argument can be conveniently summarized in Figure 2-2.

FIGURE 2-2

MARGINAL UTILITY FUNCTION - WATER

Assume that the consumer is originally in equilibrium when the price of water is at $p_1$ and quantity taken is $q_1$. Now assume with Dupuit that the price of water falls to $p_2$. At the lower price for water the individual is in disequilibrium at point c. The marginal utility of the last unit of his existing stock is greater than the now lower marginal utility of water represented by the lower price. In terms of price, what he would pay for $q_1$ of water is greater than the price he must pay for quantity $q_1$. He could buy the same quantity of water ($q_1$) at a lower total expenditure, but Dupuit assumed that the consumer would not do this. Attached to each incremental unit of water between quantity $q_1$ and quantity $q_2$ is a marginal satisfaction greater, albeit diminishing, than that which would obtain for the incremental unit corresponding to price $p_2$. Thus, in an effort to maximize total satisfaction, the individual will increase his purchases of water up to, but not beyond, quantity $q_2$.

In opportunity cost terminology, at $q_1$, (assuming the consumer to originally be in equilibrium), the marginal satisfaction of an extra franc's expenditure on any other good is less than the marginal utility of quantity $q_1$. 
to the consumer. In order to equalize the marginal utility per franc's expenditure, the consumer must increase the quantity of water purchased until the marginal satisfaction per franc's worth of the last unit purchased equals the marginal utility per franc's worth of all other goods in the consumer's collection.\(^{38}\)

This fundamental relationship between marginal utility, total utility and price are given repeatedly in Dupuit's writings. A numerical example can be found in Appendix II of this dissertation.\(^{39}\) It is clear from these examples and formulations that Dupuit understood the relationships between total and marginal utility. Total utility for any given quantity was the area under the marginal utility curve up to that quantity. When price becomes zero, total utility is at a maximum and total revenue is zero. Dupuit was the first French economist, if

\(^{38}\)This line of reasoning must lead to a demand curve of unit elasticity since total expenditures remain constant on water. Dupuit, however, was unaware of this logical implication. \textit{Infra}, Chapter III, p. 64.

\(^{39}\)Appendix II is taken from "On Utility," (1853), p. 42.
not the first economist, 40 to have clearly explained this relationship.

The marginal utility curve described above is Dupuit's courbe de consommation, and although most of his examples

40 In Chapter I it was indicated that E. R. A. Seligman in his article "On Some Neglected British Economists," Economic Journal, XIII (1903), advanced the case of W. F. Lloyd as the "first thinker in any country to advance what is known today as the marginal theory of value," p. 363. Additionally Seligman's article is replete with quotations from Lloyd's Lecture on the Notion of Value (1833). If these quotations are representative, it must be admitted that Lloyd understood the fact that marginal satisfaction diminished with quantity. Little else can be said for Lloyd, however. His ideas, verbally expressed, are disjointed and he presented no rigorous demonstration of them. Moreover, no less an authority than Alfred Marshall credited Dupuit with first "formally describing . . . small increments of price as measuring corresponding small increments of pleasure," relegating to Lloyd the role of having "anticipated" utility analysis. See Marshall, Principles of Economics (London: Macmillan, 8th edition, 1920), p. 101. George Stigler finds that the statement that utility diminishes with quantity is a commonplace and that "the first statement in print of a commonplace is adventitious . . . the statement acquires interest only when it is logically developed or explicitly applied to economic problems." Lloyd's, according to Stigler, was an adventitious act and he credits Dupuit with having first elaborated on and applied the principle. See "The Development of Utility Theory" in Stigler's Essays, pp. 78-79. At least one contemporary British writer remains unconvinced of Stigler's assessment of Lloyd. B. J. Gordon in "W. F. Lloyd: A Neglected Contribution," Oxford Economic Papers, New Series, 18 (March, 1966), has reaffirmed Lloyd as the first important expositor of marginal utility, and, investigating Lloyd's other writings, finds him "a forerunner of the Marxian critique of the operations of a system of laissez-faire capitalism," as well; p. 64.
are concerned with transportation and communication, it is certain that the same laws applied to all goods and services. He provided explicit directions in his article on Toll on the manner in which a demand curve should be constructed:

If, in a table of two columns, one inserts in the first all the prices, from 0, the one which corresponds to the greatest consumption, up to the price that stops all consumption and in the second, regarding the price, the corresponding quantity consumed, we will have the exact representation of what we call the law of consumption.\(^4^2\)

Dupuit neatly constructed such a demand curve in 1844, six years after Cournot's Researches was published. His construction was apparently independent of Cournot's

\(^4^1\) Dupuit used the general term *voies de communication* which signified any mode or method of transportation, hauling or communication.

however. Like Cournot, Dupuit gave the equation for the curve of consumption as $y = f(x)$, or alternatively, $Q_d = f(p)$. Additionally, Dupuit, as Walras was later to do, placed the independent variable (price on the x axis and the dependent variable (quantity) on the y axis. Modern microeconomic diagrams, following Marshallian tradition, reverse this procedure because Marshall treated marginal demand price as a function of quantity. Dupuit's construction is reproduced below as Figure 2-3.

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43 See F. Y. Edgeworth, "Dupuit," Palgrave's Dictionary in which Edgeworth stated that Dupuit "does not appear to have seen" Cournot's book, p. 654. This research seems to lend support to Edgeworth's statement. Additional corroboration on this point was given by Rene Roy in his centenary estimate of Cournot. See his "L'Oeuvre Economique D'Augustin Cournot," Econometrica, 7 (April, 1939). Roy cited the neglect of Cournot's works in the nineteenth century, especially in France, and added that he found "une preuve dans le silence manifesté à cet égard par un autre économiste français, l'Ingénieur des Ponts et Chaussées Jean Dupuit, qui fut le contemporain de Cournot," p. 143.

44 This figure is labeled Fig. 1 in Dupuit's 1844 article "On the Measurement," p. 108.
FIGURE 2-3
DUPUIT'S COURBE DE CONSOMMATION

Dupuit described his construction as follows:

If . . . along a line OP the lengths Op, Op', Op'' . . . represent various prices for an article, and that the verticals pn, p'n', p''n'' . . . represent the number of articles consumed corresponding to these prices, then it is possible to construct a curve Nn'n''P which we shall call the curve of consumption. ON represents the quantity consumed when the price is zero, and OP the price at which consumption falls to zero.  

It is obvious that this curve is identical in conception to Figure 2-2; that is, Dupuit's demand curve is a marginal utility curve. Dupuit made his meaning clear, with reference to Figure 2-3, by stating that "the utility of . . . np articles is at least OP and . . . for almost all of them the utility is greater than Op." Since the

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relationship between price and quantity is an inverse one, the demand curve drawn by Dupuit has a negative slope, regardless of the axis chosen for the independent variable.

Dupuit considered total revenue by supposing that the demand curve in Figure 2-3 is one for a bridge. He then explained that if it is wished to raise a fixed sum of money ($A$), by levying a toll on the bridge it is necessary to solve the equation $xy = A$, where $y = f(x)$. He continued: "if it is wished to raise the greatest revenue, we must solve the equation $\frac{dy}{dx} = 0$."\(^{47}\) Dupuit said that total revenue is at a maximum when marginal revenue is zero; alternatively, when the derivative of total revenue with respect to price is zero, total receipts are maximized.

Characteristics of Dupuit's Demand Curve: Some Problems with His Theoretical Formulation

Dupuit's consumer's surplus argument follows facilely from the above discussion, but it is important at this point to collect some of the characteristics of Dupuit's demand curve and to consider some of the assumptions which he did (or did not) make in his construction as well.

(1) Dupuit's demand curve was derived from observation. As chief engineer of bridges and highways, Dupuit observed

an "operative" law of demand in all of his everyday activities. This was not new. Six years earlier Cournot had commented on the mathematical relationship between price and quantity demanded. But Dupuit's analysis was richer in the sense that he drew from his profession examples illustrating his theoretical contentions. He was under no illusion with respect to the problem of identification, however, since he candidly admitted that this "series of relationships $\overline{\text{demand}}$ is not known for any commodity since it depends on the volatile will of human beings; it is today no longer what it was yesterday."\(^{48}\) Thus he knew that the problem of obtaining an empirical function was compounded since the variables were constantly changing. But the demand curve was nevertheless a "fact of experience" to Dupuit "which has been verified statistically."\(^{49}\)

(2) Dupuit pushed demand theory a step beyond Cournot's formulation by correctly distinguishing the law of marginal utility and by identifying the marginal utility curve with the demand curve itself.\(^{50}\) Additionally, Dupuit described

\(^{49}\)"On the Measurement," p. 103.  
\(^{50}\)While Marshall had certain reservations with respect to this identity, his demand curve, excepting several important points, was Dupuit's. See Schumpeter, History, p. 839.
the relationship between total and marginal utility (demand) in tabular form.\textsuperscript{51}

(3) Dupuit assumed that the price that consumers would offer for a quantity of any good is determined by the utility of that good alone and not by the utility of other goods. Dupuit of course assumed that the utility function for the good could shift, for he said that the demand curve, "would not only be different for each bridge, each canal, each railway, each object but even different for the same bridge, the same canal, the same railroad and the same object with time which modifies use, habits, needs and caprices of man."\textsuperscript{52} But nowhere did he indicate that the demand or marginal utility function might shift due to a change in the utility afforded by other goods in the consumer's collection. In short, he contemplated no complementary or substitute goods. Consequently, it must be concluded that Dupuit assumed that all utility functions were independent (additive) since he gave no information to the contrary.

\textsuperscript{51}See Appendix II.

\textsuperscript{52}Dupuit, "Toll," p. 9.
(4) Dupuit assumed that income was a determinant of demand for a particular good. Although he did not state this explicitly, he indicated the assumption indirectly with the comment that "... the poor man does not attach to the advantage of passing the bridge the same price or the same utility as the rich one ...,"\(^{53}\) and again when he spoke of the "sacrifices"\(^{54}\) which individuals are disposed to make for goods. There is a strong presumption, evidenced by such statements, that Dupuit thought that money income was a determinant of demand.\(^{55}\)

(5) Although it will remain to develop the point in detail, Dupuit implicitly and unintentionally assumed that the marginal utility of money income or expenditures is held constant in addition to the utility functions of other goods as the price of the good in question is increased or decreased. Algebraically, if \(y\) represents all other goods in the consumer's collection, and \(m\) is the consumer's money expenditure, when the price of


\(^{55}\)Such statements give Walras' criticism that Dupuit failed to see that "the maximum pecuniary sacrifice ... depends in part on ... the consumer's means" an air of inaccuracy. See Elements, p. 445 \& passim.
good x is decreased, the following would obtain:\textsuperscript{56}

\[ \frac{\text{MUX}}{px} > \frac{\text{MUy}}{py} = \text{MUm} \]

Dupuit assumed that the consumer re-attained equilibrium by increasing quantity taken of x (thus decreasing the MUx) up to the point where the ratio of MUx/px is once again equal to the MUy/py and to the MU of money income. Since Dupuit nowhere assumed that either the MU functions or the demand functions of other goods (or the marginal utility of money expenditures) shift with changes in the price of x, this conclusion is clear. It is for this reason that Dupuit's demand curve will always have a negative slope.\textsuperscript{57}

Dupuit would be formally correct in identifying the demand curve with the marginal utility curve only in the

\textsuperscript{56}See P. A. Samuelson, \textit{Foundations}, and "Constancy of the Marginal Utility of Income," in O. Lange, F. McIntyre, and T. O. Yntema (eds.), \textit{Studies in Mathematical Economics and Econometrics} (Chicago: University of Chicago Press, 1942). Samuelson proved that in equilibrium "... the marginal utility of expenditure upon each and every commodity must be the same, equal moreover to the marginal (rate of) utility derived from an extra dollar of expenditure distributed optimally over all of the goods," \textit{Foundations}, p. 190. Additionally, "the marginal utility of income, as well as depending upon the particular cardinal index of utility selected, is also a function of all prices and income," \textit{Studies}, p. 76.

\textsuperscript{57}Indeed, economists in the past have invoked the assumption of constancy for this very purpose, i.e., to show that demand curves have a negative slope. For a discussion of the marginal utility of money as it relates to consumers' surplus, see Chapter III, \textit{Infra}, pp.64.
case of a unitarily elastic demand function for all independent demands. All of his numerical examples depicted demand curves of varying elasticity however. The curves are more elastic in the upper reaches and less elastic in the lower portions (see Appendix II). Moreover, if Dupuit were assuming unit elasticity ubiquitously, there would be little point in giving the condition \( \frac{dy}{dx} = 0 \) for maximizing total revenue; for with a demand curve of unitary elasticity the total revenue function has no slope.\(^{58}\)

Thus, one of several conclusions must follow. First, Dupuit could have assumed that all demand functions were

\[ q = kp^{-n} \]
\[ pq = TR = kp^{-n+1} \]

The elasticity of the demand function is:

\[ \frac{Ep}{Ep} = \frac{dq}{dp} \cdot \frac{p}{q} = -nkp^{-n-1} \cdot \frac{p}{kp^{-n}} = -n \]

If the demand curve is of unit elasticity, \( n = 1 \), and \( TR = k \). Thus,

\[ \frac{dTR}{dp} = 0 \]

The slope of the total revenue function (or marginal revenue) would equal zero for the entire range of output and price combinations.

\(^{58}\)This can be shown by considering a demand function in the following form, with \( k \) and \( n \) both positive constants;

\[ q = kp^{-n} \]
\[ pq = TR = kp^{-n+1} \]

The elasticity of the demand function is:

\[ \frac{Ep}{Ep} = \frac{dq}{dp} \cdot \frac{p}{q} = -nkp^{-n-1} \cdot \frac{p}{kp^{-n}} = -n \]

If the demand curve is of unit elasticity, \( n = 1 \), and \( TR = k \). Thus,

\[ \frac{dTR}{dp} = 0 \]

The slope of the total revenue function (or marginal revenue) would equal zero for the entire range of output and price combinations.
independent with respect to changes in price and income (and that the marginal utility of money was constant) and consequently that all demand curves were of unit elasticity. Second, it could be concluded that Dupuit proceeded as if demand functions were not independent and that the marginal utility of money was not constant, unaware that his analysis called for unit elasticity or at least some explanation of his assumptions. Finally, one could maintain that Dupuit was aware of the results yielded by his implicit assumptions and chose to ignore the implications of them, perhaps due to the inconvenience of dealing with shifting demand functions and changing marginal utility of money vis-a-vis changes in price. He may have felt that in partial equilibrium analysis small price changes would have little effect on demand functions for other goods and on the marginal utility of money, and could thus be safely ignored. In short, he might have taken a Marshallian view of the matter.

The implications of the first possibility would be really restrictive. Although empirical demand curves are difficult to obtain, a priori information casts a jaundiced eye on the proposition of ubiquitous unit elasticity. Moreover, Dupuit himself never indicated in any of his
examples that he intended to portray such a function. On the contrary, all of his numerical illustrations show demand curves of varying elasticity. The third conclusion is equally untenable, for to assume varying elasticity of the demand curve in the first place would require some statement about the shifting of demand functions for other goods or changes in the marginal utility of money when the price of the good in question changed. Additionally, this would mean that the demand curve could no longer be identified with the marginal utility function, and Dupuit needed this identification for the consumer's surplus theory. The marginal utility function can be represented by the demand function only in the case of constant elasticity of demand for all goods. Since Dupuit's examples assumed changing elasticities, he would have also have had to assume independent demand functions and changing marginal utility of money; but if he made this latter assumption, he would have to face the fact that the demand curve for a good is no longer identical to the marginal utility function for that good. In short, Dupuit was involved in a contradiction. He showed that demand elasticities vary and at the same time identified the demand curve with the marginal utility curve.
The second conclusion is most plausible. Dupuit proceeded as if utility functions were independent and as if the marginal utility of money varied, quite unaware of the conclusion that his implicit assumptions required. Dupuit was myopically concerned with the demand curve for a good, and if he was cognizant at all of the contradiction woven into his analysis, he chose not to present it in print. This issue of the marginal utility of money, as the following chapter will show, is of special import to the validity of the consumer's surplus theory.
CHAPTER III

DUPUIT AND CONSUMERS' SURPLUS

The Theory of Consumers' Surplus

Dupuit developed a workable theory of demand if not one adequately supported by protective assumptions, and he enthusiastically pointed out some of the implications of his theory. If one grants Dupuit the assumption that the marginal utility curve for a good is the demand curve for that good, several important corollaries can be drawn from the fusion. If the price of a good is a measure of its marginal utility then the area under the demand curve must equal the total utility of the good up to that point. When price is zero, total utility is maximized.

Dupuit's courbe de consommation (Figure 2-3) is reproduced below in Figure 3-1, and, for convenience, the axes are reversed. It will become obvious that Dupuit firmly grasped the consumer's surplus concept which was later to appear in Marshall's Principles in modified
form.\(^1\) Dupuit argued that the total utility of Or' articles is equal to the area Or''n''P under the demand curve. This total utility is called absolute utility by Dupuit or l'utilite absolue. From this absolute utility Dupuit deducted cost of production which is represented by the price of the article multiplied by quantity consumed;\(^2\) this is equal to the area Or''n''p''. Dupuit's relative utility, or what is now called consumers' surplus, which accrued to consumers is the difference between absolute utility and "costs of production." With reference to Figure 3-1, consumers' surplus is equal to the area of the triangle, (curvilinear), p''n''P.

\(^{1}\) Schumpeter, History, p. 1061.

\(^{2}\) Dupuit's theory of costs is treated in some detail in Chapter V of this dissertation. See infra, pp. 193-194; also see Appendix III.
To Dupuit, the utility under any demand curve is "always separated in 3 parts; the utility collected by the proprietor [total receipts or cost of production], the utility collected by the public [consumers' surplus], and lost utility."³ At quantity Or'' in Figure 3-1, this latter utilite perdue is represented by the triangle Mn''r''. Alternatively it can be found by subtracting the area representing absolute utility from the total area under the demand curve.

A change in relative utility or consumers' surplus could be calculated, according to Dupuit, in the following manner: assume that price falls from p'' to p' and that quantity taken increases from r'' to r'. After the price decline (decline in Dupuit's "cost of production"), absolute utility is increased to Or'n'P, and this, less costs of production, Op'n'r', yields a total consumers' surplus of p'Pn', or a net gain in consumers' surplus represented by p'n'n''p''.

In this way Dupuit developed his measure of the utility (or "benefit") of public works and of goods in general. It was to be an area under a demand curve

³Dupuit, "On Utility and Its Measure," (1853), p. 44.
identified with a utility curve. **Absolute** utility, it will develop, is the measurement which Dupuit preferred.\(^4\) But in any case, the spotty history of an important tool of welfare economics had begun.

**Problems with Dupuit's Measurement**

Immediately several lacunae in Dupuit's analysis stand out. In the first place Dupuit's demand curve is a horizontal summation of individual demand curves. It is clear from the construction of his function that Dupuit intended his demand curve to be of this character. Such an additive utility function may not be legitimate due to interpersonal utility comparisons. Specifically, the interpersonal comparison enters when Dupuit used a **market** demand curve, which is the summation of **individual** demand curves to depict a utility surplus accruing to consumers of the product under consideration. The problem does not arise with the addition of demand curves, but with the addition of utility curves. A price may not represent the same utility to different individuals, since the price one would pay for a given quantity of a good depends not only on the utility afforded by the good, but on the income he

\(^4\)Infra, Chapter V, pp. 191.
possesses as well. What the individual would have paid for the quantity varies with the amount of income he holds as well as with the utility the good provides. This might be called the "problem of the apostrophe." If the concept under consideration is consumers' surplus, utility comparison is invoked; this problem is avoided, however, with consumer's surplus. Dupuit's discussions involved both concepts, but he put the greatest emphasis on consumers' surplus. It should be remembered that this additional problem appears when the discussion turns to consumers' surplus. Strictly speaking, then, differences in income distribution would prohibit a utility summation, but as will be developed later, Dupuit circumvented this problem by boldly stating that income distribution was not of the economists' concern.

More fundamentally Dupuit tacitly assumed that utility is a measurable quantity. Utility to him was not an abstract unit measured in "utils" or other subjective units of satisfaction; rather the measure was a real one. The true measure of the utility of an object is the "maximum sacrifice which each consumer would be disposed to make to procure it."\(^5\) Consumer's surplus or relative

utility to the consumer is measured by the difference between the maximum amount the consumer would be willing to pay for each unit in his entire stock and what he must pay for the entire stock. As stated above, it is the area under the demand curve above the total expenditures rectangle, and it is a money measure. But this measure cannot be a valid one if the marginal utility of money expenditures is allowed to change with changes in price. Here, as with the pure demand theory, the problem is one of distinguishing marginal utility curves, and on the one hand, from demand curves, on the other. Dupuit never did make the distinction with the result that his measure, with the exception of one case, would be either understated or overstated.

An example may help to illustrate this conclusion. A decrease in the price of a good, X, will induce a "substitution" effect for good X. The consumer, as always with a price decline, will receive an increase in real income. But the increased quantity taken by the consumer may also be the result of an "income effect;" that is, the consumer may choose to realize all or part of the real income increase (caused by the price decline) in more X. This is the case of the "normal" good. If the demand
curve is inelastic under these circumstances, the marginal utility of money expenditures decreases and the opposite would obtain with an elastic demand. In either case for a price decline, the demand curve for a "normal good" overstates consumer's surplus. Under the same circumstances, the demand curve for an "inferior good" would understate consumer's surplus. Variation in total expenditures on the good is the result of an "income effect," and the presence of an "income effect" therefore means that the marginal utility of money expenditures changes. With no income effect there would be no change in total expenditures and, consequently, no change in the marginal utility of money expenditures. If this were not the case, each cent in the money measure of the surplus would possess a different utility and the sum of money would not accurately describe a utility difference. This leads straightway to the conclusion that given demand curves of varying elasticities, the marginal utility curve is not to be identified with the demand curve. Only in the case of unitary elasticity of the demand curve could

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6 These are the conclusions of John R. Hicks. See his "The Four Consumer's Surpluses," Review of Economic Studies, XI (Winter, 1943).
Dupuit claim that consumer's surplus, calculated cardinally, is equal to the area under the demand function. This problem is indigenous to Dupuit's consumer's surplus theory due to his failure to identify an "income effect" or, alternatively, a varying marginal utility of money.

Another objection to Dupuit's money measure of consumers' surplus, ignoring for the moment the preceding objections, is one arising when the demand curve does not intersect the price axis. In such a case the offer price for the first unit(s) of the commodity would be infinite. Consumers' surplus may be infinite also and thus unmeasurable. Dupuit skirted this problem, however, when he discussed the possibility of measuring changes in or limits to consumers' surplus. He said for example:

"... that when one cannot know something it is already quite a lot to know the limits of one's ignorance ... One will not know that the utility of the canal will be only 5 million, but one could know that it will not be six and it would be enough to give up its construction; one will not know that the utility of a bridge will be 120,000 fr. but one could know that it will be more than 80,000 and that is sufficient to show that it will be very useful."

The problems of the constancy of the marginal utility of money expenditure (and all that this implies) together

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with Dupuit's tacit interpersonal utility comparisons associated with the market demand curve (although later avoided by Dupuit by assumption) are indeed inhibiting factors in the measure of consumers' surplus. This does not mean that he could not use the demand curve as an approximation of this surplus, or that the definition of the surplus was useless or invalid. Moreover, the idea would not disappear, and Dupuit would not be the last economist to proceed in such fashion.

Early Criticisms of Dupuit's Consumers' Surplus Concept

The Bordas Reply

The space of three years was time enough for Dupuit to incur a major reply on his attack of established notions concerning utility. Bordas, a fellow engineer and apparently an individual of some economic sophistication, wrote a critique entitled "Of the Measure of the Utility of Public Works - Answer to the article of the chief engineer, Mr. Dupuit, inserted in Number 6 of the Annales

8The article is signed simply "M. Bordas." See R. W. Houghton, "A Note on the Early History of Consumer's Surplus," particularly pp. 51-52, where Houghton reviews this reply briefly. The Bordas article is reprinted in the Bernardi collection.
of 1844. The article, in large measure, consisted of a melange of confusions (Bordas') on the meaning of the word utility. Bordas defended Say's cost of production theory of value, gloriously reasserting the water-diamond paradox. Bordas, caught in a quagmire of terminology, made some rather "reactionary" statements on utility when one considers the discourse he was attacking. At one point, for example, he stated frankly that "current price . . . depends on the intrinsic value of the monetary measure and on that of the object given in exchange," and that "the utility of . . . tea is inherent to this substance and . . . it does not at all depend on the price at which it is sold." Clearly he had no appreciation for Dupuit's marginal utility theory or for the solution it provided to the value in use-value in exchange dichotomy.

Nonetheless, Bordas brought out some important and relevant points in his assessment of Dupuit's consumers'

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9Bordas, "Of the Measure of the Utility of Public Works," translated by Eleanor Evans and edited by R. B. Ekelund, Jr., Annales des Ponts et Chaussees, 2nd Ser., (1847). References are to the unpublished translation available only in the library of Louisiana State University.

10Bordas, "Of the Measure," p. 5.

11Bordas, p. 13.
surplus concept. These criticisms were to be echoed repeatedly against the doctrine, and to some extent, Bordas presaged Professor Nicholson's criticisms of Alfred Marshall's formulation of consumers' surplus.  

Bordas knew that there was some connection between the utility of a certain quantity of a good and the maximum sacrifice which an individual would be willing to make for it. Although Bordas admitted to a link between the utility of an object and the maximum sacrifice, he made explicit a point that Dupuit did not make clear in the 1844 article concerning this maximum sacrifice. The point is that the sacrifice depends on a person's income and on the price of other goods as well. As Bordas stated:

Let us suppose that it is a matter of appreciating a kilogram of meat and that a person is asked to state the sacrifice that he is ready to make to procure it. Will it be possible for this person to answer categorically? Evidently not. Indeed, doesn't this sacrifice depend on the means of this person as well as the current price of other alimentary products which are capable of being substituted for the meat? . . . Therefore, what theory can one establish on so variable a basis and which depends on the taste as well as the means of each consumer?

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13 Bordas, pp. 41-42.
Here Bordas asked a legitimate question. Should not the price of potatoes be assumed constant in the process of determining the utility for meat in money terms? He asked this in another example as well. Referring to Dupuit's method of determining the utility (and consumers' surplus) of a good, quarry rock, Bordas asked,

\[ \text{... while the rock will be taxed by a tax increasing by degrees, will it be necessary to sell the brick at its original or at its new price? Or should a tax be levied both on the rock and the brick? The result will be quite different according to what will be done.}^{14} \]

If the price of brick is not held constant, Dupuit's measure of consumers' surplus cannot be valid. The demand curve for rock would shift erratically under such circumstances. Bordas attacked Dupuit for lack of clarity on this issue. Moreover Bordas implied in these passages that, since the necessary assumption of "other things equal" generally does not obtain in any practical case. Dupuit's measure of consumers' surplus is practically useless. He was within the bounds of legitimate criticism on the former point since Dupuit failed to involve the explicit assumption of constancy of the prices of other goods.

\[ ^{14}\text{Bordas, pp. 46-47.} \]
Bordas also cast a jaundiced eye on Dupuit's tacit interpersonal utility comparisons. Dupuit, in measuring the desirability of bridges and other public projects, compared the utility produced by the project with the costs of the project raised by taxation. The utility of the project was measured, in the case of a bridge for example, by placing incrementally increasing tolls and their corresponding quantities yielded a measure of consumers' surplus. Bordas objected to this calculation since,

... it will be necessary, before applying it, to logically establish the relationship which ties the decrease of revenue of the taxpayer, to the sum of the relative utilities which constitute this method ... . This connection seems, in effect, very difficult, for the quantities to be matched or compared, although expressed in money, are nonetheless of a different kind.15

Bordas' statement is clear. The marginal utility of a dollar collected from the taxpayer does not necessarily equal the marginal utility received from a dollar spent on any particular public project. In ignoring the problem altogether Dupuit made yet another interpersonal comparison. The building of public projects required taxation and consequently a redistribution of income. But such a redistribution required an illegitimate interpersonal welfare pronouncement. If the marginal utility of money

15Bordas, p. 48.
was the same (and constant) for every individual in the economy, or alternatively, if the distribution of income were of no concern to the economist, it would be possible to say that welfare is increased by a transfer if the increase in consumers' surplus (in money terms) exceeds the money amount of the subsidy. Under such conditions a net increase in the money measure of utility is all that is needed. But if some such assumption is not invoked, can one say out of hand that there is an increase in welfare by redistributing income from personal consumption to public projects if the money measure of the increase in consumers' surplus is greater than the money amount of taxation required? Conceivable such a transfer may involve a diminution in aggregate utility although there is a net money measure increase. This would occur if the utility decrease surrounding the tax receipts exceeded the utility increase to the consumers of the public good (which was the money measure of the increase in consumers' surplus). Bordas correctly pointed out that "The whole question consists in knowing on what side the difference lies."16 This issue of interpersonal comparisons

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16 Bordas, p. 48.
centers around differences in the distribution of income
as did the problem of the market demand function
representing a utility measure, and the Bordas criticism
struck squarely at Dupuit's theory. But Bordas overlooked,
or at least did not mention, Dupuit's position on income
distribution. In the 1844 article Dupuit maintained that
income distribution did not matter with respect to utility
calculations, and that it was not in the province of
political economy, but was the proper concern of the
state. "Because the losses and gains counterbalance each
other," said Dupuit, changes in the distribution of
wealth are not to be considered in utility calculations.
Although Dupuit's assumption that income distribution
"does not matter" was not an especially good one, Bordas
failed to recognize that Dupuit had any assumption whatso­
ever on the question.

In what is the most interesting passage of the reply,
Bordas was on the threshold of unlinking demand curves
from utility curves. In the passage Bordas assumed that
because of a new process in the manufacture of stockings,

17Dupuit, "On the Measurement of the Utility of
the price falls from 6 francs to 3 francs. If the consumer set aside 24 francs a year to buy 4 pair when the price was 6 francs per pair, after the price decrease he will be able to buy 8 pair. But, said Bordas:

In order to consume as many before, he would have been obliged to set aside for the acquisition of this product, a sum of 48 francs and to subtract 24 francs from his other consumptions. His situation, in relation to the former state of things, is then the same as though he were making an annual gain of 24 francs, or that his income had been increased by this sum. If, instead of consuming 8 pair of stockings, he only consumed 7 and used the 3 francs left over to buy other objects of which the price would not have varied, his relative gain would not be more than 21 francs.  

Since money expenditures on stockings do not change in the first part of the illustration, neither can the marginal utility of money expenditures change. The following equation is an expression for the price of stockings (x):

$$P_x = \frac{MU_x}{MUe}$$

When $P_x$ declines, if expenditures remain constant on $x$, the marginal utility of total expenditures cannot change, and the increase purchases of $x$ lead to a decline in $MU_x$. This may be called "Dupuit's case" since the demand curve can be identified with the marginal utility curve for $x$.

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18 Bordas, p. 16.
and declines in price can be associated with proportional declines in marginal utility.

It is in mentioning the other alternative open to the consumer that Bordas came close to exposing an error in Dupuit's consumers' surplus theory. In this example the consumer took only 7 pair of stockings when the price falls to 3 francs per pair, as in the indifference curve treatment of Figure 3-2.

The consumer is in equilibrium at A'. Now the price of stockings is reduced to 3 francs per pair and the budget line of the consumer assumes a new position. The new point of tangency with indifference curve $I_1$ is at point

![Figure 3-2: The Bordas Variation](image)
B', after equilibrium is re-established and all effects have been accounted for. The new quantity taken, $q_1$, can be explained by both income and substitution effects in the following manner: remove an amount of money income from the consumer equivalent to the increase in real income. Clearly the consumer would choose combination C' of money income and stockings. Thus, due to the decrease in price alone, the consumer increased purchases of stockings by an amount $q_0q_2$. The substitution effect is represented by $q_0q_2$. The simultaneous price decrease – real income increase however caused him to increase his purchases to $q_1$. But in equilibrium at B', total expenditures on stockings have declined from $y_{0r}$ to $y_{0m}$, or alternatively, expenditures on all other goods have increased from $0r$ to $0m$. In short, a part of the increase in real income is not realized with additional stockings, but with other goods. Now, the demand curve for stockings cannot depict consumer's surplus for several reasons.

In the first place, given the inelastic demand curve for stockings, which would result from the indifference curves of Figure 3-2, part of the increase in real income consequent to the price decline is spent on other commodities. This is a part of consumer's surplus which the
demand curve for stockings does not show. Moreover, since expenditures on other goods have increased, the marginal utility of money expenditures has decreased vis-a-vis the price decline. Given the formulation $P_x = \frac{MU_x}{MU_e}$, the change in the marginal utility of $x$ can no longer be assumed proportionate to the change in the price of $x$. A price elasticity of anything but unity would guarantee this conclusion because expenditures on any good cannot remain constant in the face of any other coefficient.

Although Bordas did not draw any of these implications from his discussion of "income effects," it is to his credit that he recognized their existence, particularly at such an early date. He did see that the entire real income increase caused by a price decrease may not be spent entirely on additional units of the same commodity, and that the additional expenditures would disturb the demands for other goods. Had Bordas carried the argument a step further and shown that such "income effects" may disturb the marginal utility of income or money expenditures, he would have presented a most convincing theoretical argument against the use of demand curves to measure consumer's surplus. His discussion, as is, could at least be said to presage the theoretical interests of
the Russian economic theorist Eugen Slutsky or the British economist John R. Hicks. In any case, Bordas should be considered in the vanguard of the critics of consumers' surplus theory.

**Dupuit's Rejoinder**

Dupuit took the opportunity to reply to Bordas in his article "De l'influence des peages sur l'utilite des voies de communication," which appeared in the *Annales* of 1849. The article is divided into four sections, the

19J. R. Hicks, *Value and Capital* (London: Oxford University Press, 1946). Also see his "The Four Consumer's Surpluses," *Review of Economic Studies*, XI (Winter, 1943), and "A Reconsideration of the Theory of Value," *Economica*, XIV (1934). Professor Houghton in his "Note on the Early History of Consumer's Surplus," sketches in several of the Bordas criticisms, but with the notable absence of the "income effect passage." Moreover he makes a rather poor assessment of this point when he refers to a like criticism made later by Walras. Said Houghton, "Dupuit's implied confusion (identification?) of demand and utility curves was of course a must less serious blunder (abstraction?) than Walras believed...", p. 52. Unfortunately, Professor Houghton does not offer one jot of evidence to defend his point. The presence of a real income effect and of a varying marginal utility of money expenditures strikes the death blow to demand and utility curve identification and, therefore, to the use of demand curves to measure a "utility" surplus. Since Dupuit did not hedge his theory with protective assumptions, his use of demand curves for such measurement is illegitimate on a theoretical level at least, except in some rather rare circumstances. Houghton shows no appreciation for this crucial issue in his note.

first three sections consisting of the rejoinder, the fourth entitled on "Tolls." The lion's share of the first three sections consists of an attack on Bordas' confusion on the meaning of the word utility. Dupuit dwelled upon the ambiguities found in Bordas with a gusto befitting the first important contributor to the theory of marginal utility.

Dupuit criticized Bordas for having had not one, but four separate definitions of utility: "1st, in ordinary language, 2nd, in political economy; 3rd, that when it is joined to the word public; 4th, in my article." Dupuit added sarcastically that "I swear that I do not yet today understand the nuances which, in the spirit of Mr. Bordas, distinguish these four exceptions," and found that "he Bordas has added to the errors of these economists others proper to himself."

Unfortunately, only the fourth selection "On Tolls and Transport Charges" has been translated. See International Economic Papers (1962). Subsequent footnote references are to the untranslated material of the first three sections of the article. Page references are to the original.


Dupuit replied to Bordas' charge that utility was unmeasurable with two rather dubious arguments. In the first place, avowed Dupuit, J. B. Say had thought utility measurable, although Say had admitted that utility "... has nuances, a diverse importance, an intensity, degrees." Although their measures differed, Dupuit pointed out that they both thought utility was a measurable quantity.

Thus, with subtle incantation, Dupuit brought J. B. Say to his side against Bordas. Dupuit also indicated that Bordas had not proved that utility was unmeasurable and that, in consequence of this fact, the Bordas attack had simply been negative. "I would have preferred to have found demonstrations," said Dupuit. Neither of these arguments are very convincing, but it was in this manner that Dupuit held to his original position. He consistently maintained that the maximum sacrifice that a consumer would be willing to make for an object is the measure of the utility of the object. He firmly asserted that "... there is not an axiom of geometry more evident for me." In addition to the conjured arguments in defense

26 Dupuit, "De l'influence," p. 182.
of utility measurement, Dupuit ignored the issue raised by Bordas on the necessity of interpersonal comparisons in practical applications of the theory.

Bordas had discussed, in his reply, the matter of the determinants of the "maximum sacrifice," and on this issue Dupuit did capitulate. In the 1844 article Dupuit did not clearly explain that the maximum sacrifice that a consumer would give up for a quantity of a good depended on income, tastes and the price of other goods. Bordas correctly chided Dupuit for having forgotten these other determinants. Dupuit's comments on the issue, however, seem to indicate that he had acknowledged these determinants all along (which he had failed to do), thus jading Bordas' applicable criticism. This point is clearly brought out in the following passage in which Dupuit discussed the determinants of the "maximum sacrifice" (or price) that an individual would pay for meat:

Would this price be the same for all persons? Evidently not. Because not only does this price depend on the income of that person, as Mr. Bordas observes, but on his taste for meat, on his hunger, on the price of other nourishing commodities, and on a thousand other circumstances impossible to enumerate in a complete manner; but all these circumstances do not mean that this price does not
exist for each object, for each person and at each instant.\textsuperscript{28} (emphasis supplied)

Here Dupuit clearly implied that he wished to invoke the ceteris paribus assumption when calculating the demand curve and consumers' surplus. The explicit content of his "other things equal" is composed of the following items: money income of the consumer; the price of related goods, and; tastes or intensity of desire. One is left to guess what "thousand other circumstances" Dupuit had in mind. Thus in defending his theoretical position, Dupuit concluded that such a maximum sacrifice does exist for each person and at "each instant."

Nonetheless, Dupuit seems to have missed the flavor of Bordas' criticism which was that the measure of consumers' surplus could not be valid since, in a practical case, the determinants do in fact change. Dupuit's calculations are not made at "each instant," and he should

\textsuperscript{28}Dupuit, "De l'influence," p. 184. This important passage reads as follows: "Ce prix sera-t-il le même pour toutes les personnes? évidemment non. Car non-seulement ce prix dépend de la fortune de cette personne, comme le fait remarquer M. Bordas, mais de son goût pour la viande, de sa faim, du prix des autres denrées alimentaires et de mille autres circonstances impossibles à énumérer d'une manière complète; mais toutes ces circonstances n'empêchent pas que ce prix n'existe pour chaque objet, pour chaque personne et à chaque instant. (emphasis supplied).
have acknowledged and made allowance for the fact. Instead, he avoided any further discussion on the demand determinants and proceeded, with great pains, to show that Bordas was in error and that the utility for various units of a stock of a good were in fact different. As Dupuit himself put the matter, "I have only wanted to make understood the diverse degrees of utility that the same product has for the same consumer." Unfortunately, Dupuit let the matter rest there and did not go on to probe into the other variables which affect demand and consumers' surplus. Although he admitted that "a thousand other circumstances" affect the demand curve, he was apparently content to enumerate several important ones, and then to proceed, in an actual measure, as if these could be held constant. This last conclusion follows from his statement that the utility of a canal should be compared "with the anterior state."30

Dupuit's rejoinder, as a whole, was rather disappointing. Although he took due note of Bordas' point

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29 Dupuit, "De l'influence," p. 187. These "diverse degrees of utility" are none other than the marginal utilities.

that income and the price of other goods affect demand and, therefore, his measure of consumers' surplus, he did not rigorously investigate Bordas' germinal suggestion, although it was hardly more than that, that price changes may have "income effects." If the issue of the marginal utility of money had been clarified at this early date, later theorists would have been spared considerable confusion. In sum, although Dupuit clarified the fact that other variables, besides the utility of the particular product, impinged on the maximum sacrifice, he was deaf to several of Bordas' criticisms. As Dupuit himself summed it up, "I persist in the considerations on utility that I developed in 1844; I do not wish to change the formula that I gave for the measure of utility."31

Walras and Dupuit's Concept of Consumers' Surplus

At the hands of Leon Walras, Dupuit's ideas on monopoly theory, to be discussed in Chapter IV of this

31Dupuit, "De l'influence," p. 205.
dissertation, fared quite well. But while Dupuit's monopoly theory came off virtually unscathed in Walras' formidable Elements, the doctrine of consumers' surplus was left in disarray. Walras wished to call attention to "an egregious error which Dupuit committed in a matter of capital importance" with respect to consumers' surplus. After having presented the theory of consumers' surplus as Dupuit had given it in the 1844 article, Walras concluded that "all these statements are erroneous." This conclusion followed, according to Walras, for several reasons. In the first place, Walras maintained that Dupuit neither considered the effect that the utility and price of other goods would have on the "maximum sacrifice" for the good in question, nor did he understand that the "consumer's means" also contributed to the

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32 Walras, Elements, pp. 435-436. "Unfortunately," said Walras, "economists have not thought it worth their while to look into this theory [Dupuit's], with the result that their ideas on the subject of monopoly are reduced to a state of confusion which is accurately reflected in their verbal obfuscations," p. 435. For the filiation between Dupuit and Walras on the issue of monopoly see Chapter IV, infra, p. 162. Houghton in his "Note on the Early History," claims that Walras "lifted" his illustrative examples on discriminatory pricing from Dupuit, p. 52.

33 Walras, Elements, p. 443.

34 Walras, Elements, p. 445.
determination of this sacrifice. This much of the attack was clearly misdirected since Dupuit had, in his rejoinder to Bordas, acknowledged that the price of other goods and the consumer's means affected this sacrifice. Moreover, in the same article, Dupuit implied that these factors should be held constant. Walras was apparently unaware of Dupuit's precise statement on the matter, and the point merely repeated the one made by Bordas much earlier.

A second point made by Walras was more significant. In the elegant general equilibrium framework set out by Walras for an economy, income or "wealth" is measured in terms of a numeraire commodity, one of constant purchasing power. This numeraire is also the commodity in terms of which the prices of all others are expressed. Walras found that "Dupuit failed to see that the maximum pecuniary sacrifice in question depends in part, ... on the quantity of the wealth (measured in terms of


36 In the Elements, however, Walras referred to both of Dupuit's major articles. But there is no indication in Walras' writing that he was acquainted with the Bordas reply or that he had read the salient passages of Dupuit's rejoinder.
Thus, this maximum sacrifice is determined not only by the utilities of all other goods in the consumer's array, but also on the quantity of wealth he holds in terms of the numeraire commodity. In the Walrasian system, however, the "marginal utility functions of every participant, for every commodity . . . are functions of the quantity of this commodity alone . . .\(^\text{38}\) Since the demand curve is determined by the quantity of wealth which the consumer holds, together with other variables, Walras felt that Dupuit's egregious error was his "complete failure to distinguish between utility or want curves on the one hand, and demand curves on the other."\(^\text{39}\)

The Walrasian criticisms are important for the consumers' surplus doctrine, although some of them would not have been necessary had Walras given Dupuit's works a more careful reading. Walras' view of the economic system, moreover, was truly catholic, quite without parallel up to his time, while Dupuit's frame of reference was more

\(^{37}\)Walras, Elements, p. 445.

\(^{38}\)Schumpeter, History, p. 1005 et passim.

\(^{39}\)Walras, Elements, p. 446.
modest. As pointed out earlier, Dupuit's aims in political economy were simply to find a standard by which public projects could be evaluated. The problem itself is not suggestive of the interdependencies of the general equilibrium system. The tools which Dupuit developed were partial equilibrium concepts. He had no truck with a general equilibrium theory of exchange in which demand in one market truly depended on all other variables in the system. Dupuit was content to let the "thousand other circumstances" remain constant.

Additionally, it is surprising that a theorist of Walras' gifts did not have one contribution in the Elements of a correct measure of consumers' surplus, especially after having attacked Dupuit's formulation with such a vengeance. This is even more surprising when one considers the fact that Walras had so few reservations concerning the measurability of utility.40

These points should not be construed as apologetics for Dupuit, since the criticisms of Walras were, in point of fact, fertile. But equally important for the history of economic theory is the fact that these criticisms were largely ignored, especially by English economists. While

40 Walras, Elements, pp. 115 and 117.
Dupuit's ideas on consumers' surplus received such utter rejection at the hands of the most important French theorist of the day, his thought was being woven into the fabric of Alfred Marshall's *Principles of Economics*. Dupuit himself could not have chosen a more influential home for his theory of consumers' surplus.

**Dupuit and Marshall on Consumers' Surplus**

While it is correct to maintain that Dupuit's theory of consumers' surplus found a home in Marshall's *Principles*, the statement, taken by itself, must be qualified. Dupuit's ideas were absorbed into the *Principles*, but through the "back door." Chapter VI of Book III, which contains Marshall's discussion of consumers' surplus, does not provide a single reference to Dupuit. But as Schumpeter has remarked in this connection, "the essential idea - not every detail - is Dupuit's." Schumpeter continued, "Marshall does not mention Dupuit's name, and only

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41In 1870, twenty years before Marshall's *Principles*, Jevons had lauded Dupuit's contributions to utility theory. Marshall had discussed consumers' surplus theory earlier in his privately circulated *Pure Theory of Domestic Values* (1879).
inadequate amends are made for this by means of a statement occurring in another and far distant place. "42

There certainly can be little doubt, on perusing these passages of Marshall's book, that his mentor was Dupuit. Although Marshall made some important qualifications to the bare statement of the doctrine, his definition paralleled Dupuit's exactly. For example, in referring to the measure of the consumer's surplus of an object to an individual he remarked:

The excess of the price which he would be willing to pay rather than go without the thing, over that which he actually does pay, is the economic measure of the surplus satisfaction. It may be called consumer's surplus.43

The famous example in which Marshall examined the mechanics of the determination of this surplus was that of the commodity tea. His individual had the following demand schedule for tea:

<table>
<thead>
<tr>
<th>Price per pound</th>
<th>Quantity taken per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>20s</td>
<td>1</td>
</tr>
<tr>
<td>14s</td>
<td>2</td>
</tr>
<tr>
<td>10s</td>
<td>3</td>
</tr>
<tr>
<td>6s</td>
<td>4</td>
</tr>
<tr>
<td>4s</td>
<td>5</td>
</tr>
<tr>
<td>3s</td>
<td>6</td>
</tr>
<tr>
<td>2s</td>
<td>7</td>
</tr>
</tbody>
</table>

42 Schumpeter, History, p. 1061.

Marshall wanted to use consumer's surplus as an "aid in estimating roughly" some of the benefits accruing to his individual when the price of tea is 2s. His method is identical to Dupuit's. For example, in calculating the surplus to the individual when price falls to 14s from 20s, Marshall observed:

When the price falls to 14s, he could, if he chose, continue to buy one pound. He would then get for 14s what was worth to him at least 20s; and he would obtain a surplus satisfaction worth to him at least 6s., or in other words a consumer's surplus of at least 6s.  (emphasis supplied)

When the price has finally declined to 2s, the total utility using Marshall's measure is 59s. Total consumer's surplus at 2s is found by subtracting total expenditures (Dupuit's cost of production) on tea, 14s, from total utility, yielding a surplus of 45s. This is none other than Dupuit's measurement. But while Marshall unabashedly stated the doctrine in Dupuit's fashion, he, unlike Dupuit, shored up the theory on all sides with protective assumptions.

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The Marshallian demand curve, according to the prevailing interpretation, is drawn assuming the following variables constant: (1) tastes and preferences of purchasers; (2) money income, and; (3) the price of every other commodity. Given these constants, the real income of the consumer increases (decreases) as the price of the good in question decreases (increases). By dint of this fact, there would be an income effect when the price of tea declined in the above example from say 20s to 14s, unless demand is unitarily elastic. A money income equivalent to the increase in real income could be presented to the consumer instead of the price decline so that he could purchase 2 pounds of tea at the old price. This

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46 See Milton Friedman, "The Marshallian Demand Curve," Journal of Political Economy, LVII (December, 1949), pp. 463-495. This essay is reprinted in his Essays in Positive Economics (Chicago: The University of Chicago Press, 1953), pp. 47-99. Professor Friedman gives a different interpretation to what Marshall "really meant." He thinks that Marshall meant (or at least should have meant) to hold real income and the average price of all other commodities constant while constructing the demand curve. "The currently accepted interpretation can be read into Marshall only by a liberal - and, I think, strained - reading of his remarks," says Friedman, Essays, p. 48. As a measure of consumer's surplus, as Friedman points out, both the "real income" demand curve and the money income demand curve would yield error. If the fraction of expenditures devoted to the commodity is small, "the estimates will approach the correct value," p. 72. Friedman is also careful to point out that the analysis of consumer's surplus in Marshall "must be distinguished from his definition of the demand curve," p. 73.
is the same procedure used in analyzing the Bordas case, and it is Professor Hicks' "equivalent variation." Unless the demand for tea was unitarily elastic, total expenditures on tea and on all other goods would vary. The marginal utility of money expenditures or income would vary inversely with this change; or in Marshall's terminology, there would be a variation in the marginal utility of money. When the marginal utility of money varies, the demand curve can no longer be associated with the marginal utility curve, as previously indicated. Moreover, if the price decline yielded smaller total expenditures on tea, the consumer, in Marshall's own terms, "would get an element of consumers' surplus from buying other things at prices which now yield him no rent." Thus Marshall protected the demand curve as a

See Figure 3-2 of this chapter.

See Hicks, Value and Capital, p. 331.

See Samuelson, Foundations, p. 190, and "The Constancy of the Marginal Utility of Income," in the Essays, p. 80. Samuelson finds that "it is reasonably clear from everything that Marshall has written and from the cast of his thought that he definitely intended to convey the meaning of money simply as a euphemism for income or expenditure, reckoned in pounds or dollars," Foundations, p. 190.

Marshall, Principles, Note VI, Mathematical Appendix, p. 842.
measure of consumers' surplus by explicitly assuming "that the marginal utility of money to the individual purchaser is the same throughout." 51 It is for this reason that Marshall chose tea for his example, since expenditures on "unimportant" commodities are a small part of total expenditures. Hence, when the price of tea varied, the change in income or money expenditures would be negligible. Had Marshall allowed a variable marginal utility of "money" in his own words, "The substance of the argument would not be altered," but the "form would be made more intricate without any corresponding gain." 52


52 Marshall, Principles, p. 132. Directly after this statement, Marshall cryptically discussed the Giffen paradox, treating it as an "exception." Here the income effect would "outweigh" the substitution effect with an "inferior" good. Marshall does not consider that the change in money expenditures may be considerable vis-a-vis price changes for commodities which constitute a large portion of a consumer's total expenditures, i.e., "important" commodities. In the words of Schumpeter, "Marshall knew why he used tea as an example" in the consumer's surplus argument, History, p. 1061. For the most exhaustive treatment of the paradox in the literature see G. J. Stigler, "Notes on the History of the Giffen Paradox," Journal of Political Economy, LV (April, 1947).
Marshall craftily avoided other problems with his measure. For example, if it is reasonable to assume that a certain amount of a commodity is necessary for life, then the utility of units of the commodity up to this amount (or the price he would be willing to pay for them) is infinite. Consumer's surplus is also infinite. If tea in the example above were such a commodity, and one pound was necessary for life, how would the utility of increments of the first pound be calculated? Marshall artfully eliminated the problem when he said that "we must . . . take life for granted, and estimate separately the total utility of that part of the supply of the commodity which is in excess of absolute necessaries."\textsuperscript{53}

In the early editions of the Principles Marshall was unqualifiedly enthusiastic with regard to utility measurement. Professor Stigler has pointed out that while

\begin{footnotesize}
\begin{footnotes}{53}Marshall, Principles, p. 841. Mathematically, if \( y = f(x) \) is the equation for the demand curve with \( y \) as price and \( x \) as quantity demanded, total utility is measured by

\[ \int_{a}^{\infty} f(x) \, dx, \text{ where } a \text{ is the amount consumed.} \]

If an amount \( b \) is necessary for life, the function will be infinitely great for values of \( x \) less than \( b \). Ignoring the quantity, Marshall adjusted the measure to

\[ \int_{b}^{a} f(x) \, dx \]
\end{footnotes}{53} \end{footnotesize}
Marshall became increasingly reticent on the issue in later editions, he "seems never to have been seriously skeptical of the measurability of utility." Stigler's assessment is borne out in Marshall's chapter on consumer's surplus in the eighth edition. In this chapter Marshall not only claimed that utility was measurable, but was unreservedly prepared to make interpersonal comparisons, although there are passages elsewhere which seem to contradict this view. One passage in the chapter is especially significant and it deserves to be quoted in full:

On the whole . . . it happens that by far the greater number of the events with which economics deals, affect in about equal proportions all the different classes of society; so that if the money measures of the happiness caused by two events are equal, there is not in general any very great difference between the amounts of happiness in the two cases. And it is on account of this fact that the exact measurement of the consumers' surplus in a market has already much theoretical interest.

Stigler, "The Development of Utility Theory," in Essays, p. 130; also see pp. 128-129.

In Chapter II, Book III, for instance, Marshall stated that "price will measure the marginal utility of the commodity to each purchaser individually: we cannot speak of price as measuring marginal utility in general, because the wants and circumstances of different people are different," Principles, p. 100.
and may become of high practical importance,\textsuperscript{56} (emphasis supplied)

Thus Marshall had few qualms concerning utility measurement. It is equally obvious from the position of the apostrophe in consumers', that Marshall was not above interpersonal utility comparisons. His justification is the interesting point however. Marshall assumed, not unlike the modern macroeconomic theorist, that differences in income distribution "cancel out." A measure of aggregate consumers' surplus was for this reason feasible in Marshall's mind.

**The Two Formulations Compared**

It is interesting and instructive to contrast the Marshallian formulation with Dupuit's. On the issue of interpersonal comparisons Marshall knew that differences in income distribution could prohibit the addition of individual surpluses. But, to obtain a measure of consumers' surplus for tool using, he invoked the assumption that differences in income distribution do not matter, buttressing the assumption with the alleged fact that such differences cancel out. Dupuit also thought that income

\textsuperscript{58}Marshall, *Principles*, p. 131.
distribution could be neglected in the measure of aggregate consumers' surplus, but for a different reason. He refused to consider problems of income distribution by simply eliminating them from the concern of the economist. While Dupuit's justification is perhaps more questionable, it is interesting that the conclusions are identical in both cases. But Marshall's reasoning on this point is unquestionably superior in the final analysis.

As in this last case, so goes a large part of the comparison of Marshall and Dupuit on consumers' surplus theory. Whereas Marshall at least recognized the problem of a varying marginal utility of money, Dupuit was dammingly silent on the issue. Although Marshall was probably unaware of all the implications of his assumption of constancy, he did recognize the necessity of such an assumption in order to depict consumers' surplus as the area under the demand curve. Dupuit proceeded unaware.

Dupuit did bridge the difficulties of measuring the surplus of a commodity "necessary for life" by stating that the usefulness of the tool did not hinge on knowledge of the entire demand curve. The knowledge of a limited segment of the curve would be sufficient to estimate
changes in consumers' surplus.\textsuperscript{57} Marshall also devised a way to avoid the pitfall of an "infinite surplus." The adequacy of the separate approaches could be compared, but the issue itself is not a crucial one.

Although one could scarcely maintain that Marshall's presentation is no improvement over Dupuit's, Marshall's analysis is often given an unguarded amount of praise. Several contemporary economists, for example, have understated the completeness of Dupuit's contribution in comparing it with Marshall's. Professor Stigler, in referring to Dupuit's presentation of consumers' surplus theory says that "there is no intuition of the difficulties in the concept," and that it is "Marshall's measure without his restrictions."\textsuperscript{58} Professor Blaug, moreover, claims that "when we compare Dupuit's original paper with Marshall's refinements of the same concept, we are struck by the inadequacy of Dupuit's discussion."\textsuperscript{59} While there is some truth in these assertions, there can be little doubt that they were made without benefit of Dupuit's

\textsuperscript{57}\textit{Supra}, Chapter III, pp. 66-67.

\textsuperscript{58}Stigler, "Development" in \textit{Essays}, pp. 82 and 80 respectively.

rejoinder to Bordas. As indicated earlier in this chapter, Dupuit acknowledged in that rejoinder that consumers' surplus depended on income and on the price of other goods and the "thousand other circumstances," indicating at this time that he wished to hold them constant.\(^{60}\) Although the content of Marshall's \textit{ceteris paribus} is somewhat richer than Dupuit's, Dupuit explicitly included income, the price of related goods and his thousand other circumstances. This should be taken into account in any assessment of Dupuit's contribution to consumers' surplus.

Additionally, the end result is the same for both economists. Marshall concluded with Dupuit that:

\begin{quote}
It will be noted . . . that the demand prices of each commodity, on which our estimates of its total utility are based, assume that other things remain equal, while its price rises to scarcity value . . .\(^{61}\)
\end{quote}

One of the most striking features emerging from a comparison of Marshall and Dupuit on consumers' surplus is their uncommon similarity in analyzing the problem. Both of them wanted a tool of practical import and both were willing to invoke a great deal of \textit{ceteris paribus} to arrive at it.

\(^{60}\) \textit{Supra}, p. 82.

The major difference distinguishing the two presentations, then, is the realization, on Marshall's part, that constancy of the marginal utility of money must be assumed. Moreover, Marshall did understand some of the problems associated with interpersonal utility comparisons, although he summarily dispensed with them by assumption. All this suggests that the gulf which is currently thought to exist between the two interpretations may not be so distant when one considers all of Dupuit's writings on consumers' surplus.

There is still another reason why Dupuit's theoretical performance on the matter of consumers' surplus should not be judged so blatantly inferior to Marshall's. Marshall had the benefit of received doctrine on the issue, that is, Dupuit's, and although Marshall claimed to have arrived at marginal analysis independently, the writings of Jevons, Walras and the members of the Austrian school were available. The marginalist "revolution" was in full swing by Marshall's time. Economic theory had advanced in the period between Dupuit and Marshall, although admittedly not as much in England where the members of the British Historical School were voicing a plethora of criticisms against the orthodoxy. Consequently, when each economist is put into his respective theoretical milieu, Dupuit's analytical
performance does not necessarily suffer beside Marshall's. Unfortunately no such allowances are given by contemporary appraisals of the two contributions.

Some Post-Marshallian Developments

Marshall's formulation of the theory of consumers' surplus in the Principles was, as Professor Hicks has noted, "immediately recognized as the most striking novelty in the book." While, as has been indicated, the theory was certainly not a novelty in view of Dupuit's earlier formulation, Marshall did much to popularize the idea. The theory gathered force through its acceptance by several continental economists in addition to the


63 For an excellent example see Maffeo Pantaleoni, Pure Economics, translated by T. Boston Bruce (London: Macmillan and Co., 1898). It is interesting that although Pantaleoni discussed the Marshallian formulation, he acknowledged the doctrine's originator, Dupuit, p. 136. In this connection, the contribution of two Austrian economists cannot be ignored. In T. Rudolph Auspitz and Richard Lieben's Untersuchungen über die Theorie des Preises (Leipzig: Duncker and Humbolt, 1889) an analysis of consumers' surplus was given before the publication of Marshall's Principles. In the French translation of their work, Recherches sur la Theorie du Prix (Paris: Giard and Briere, 1914), Lieben claimed that the two authors had had no knowledge of Marshall's privately
Cambridge coterie. At the same time, however, an undercurrent of dissent began to appear. Representative of this criticism was the writing of J. Shield Nicholson who, in his three volume *Principles of Political Economy*, took issue with many of the Marshallian assumptions.

Professor Nicholson raised serious objections to Marshall's attempt to measure consumers' surplus cardinally in money terms. He thought it quite impossible to measure utility in terms of a commodity, money, whose value itself fluctuated with quantity. As he pointed out:

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63(continued) circulated *Pure Theory of Domestic Values* (see Houghton, "Note on the Early History of Consumer's Surplus," pp. 53-54). From this Houghton makes the largely gratuitous conclusion that "since their consumer's surplus analysis was completed by 1889, it clearly can owe nothing to Marshall and is simply a development of Dupuit's work," p. 54. This of course may be so, but it is within the realm of possibility that Auspitz and Lieben developed their concept independently. Lieben, in a note "On Consumer's Rent," *Economic Journal*, IV (1894), defended Edgeworth's support of Marshall's assumption of constancy (of the marginal utility of money) without mentioning Dupuit's earlier formulation. Moreover, the reasoning in the *Untersuchungen* was in terms of total utility curves and "offer curves." This does not convey the flavor of Dupuit's demand curve approach to the topic. It is clear that Marshall's analysis was much closer to Dupuit's in diagramatic presentation.

... a change in the cost of some things must change his consumer's so-called subjective valuation of other things. The money measure, then, of the final utility of anything varies not only with his desires and means of satisfaction in respect of that thing, but with his desires and means in respect of all other things.\textsuperscript{65}

Nicholson, apparently unimpressed with Marshall's qualification that the marginal utility of money could be held constant with respect to unimportant commodities, found instead that "in all cases we must consider the marginal utility of money" and that "the great mass of the people spend the bulk of their earnings on a very few commodities."\textsuperscript{66} He also took issue with Marshall's mathematical convention\textsuperscript{67} regarding commodities necessary for life since he felt that "all incomes are limited."\textsuperscript{68} Untenable as well, in Nicholson's view, was the Marshallian contention that the demand curves of individuals within socio-economic groups could be summed in order to obtain total consumers' surplus. Marshall had suggested that this could be done since the rich, middle and poor classes in society had similar incomes.


\textsuperscript{66}Nicholson, \textit{Principles}, I, p. 64.

\textsuperscript{67}\textit{Supra}, note 53, of this chapter.

tastes, etc. The obvious fault with such a construction, thought Nicholson, was that "the marginal utility of money is very different in the three groups, and what the difference is is plainly indeterminate." 69

Nicholson's criticisms, almost predictably, centered around the issue of the necessity of a varying marginal utility of money. This argument against the use of the Marshallian triangle under the demand curve to measure consumers' surplus was to become the most important criticism against the doctrine, a criticism which ultimately brought on its total eclipse as well as that of other Marshallian arguments. But a doctrine of such deceptive analytical simplicity would not die so effortlessly. Important neo-classical economists rose to its defense.

F. Y. Edgeworth, for example, with specific reference to Nicholson's critique of the doctrine, issued a reply in the Economic Journal. 70 Edgeworth defended, in cavalier fashion, Marshall's use of averages in estimating aggregate consumers' surplus as well as other Marshallian assumptions. But Edgeworth missed Nicholson's major point

69 Nicholson, Principles, I, p. 64.

respecting the importance of the marginal utility of money in the cardinal calculation of consumer's surplus. Nicholson pointed out this fact in his rejoinder: "my principle objection to his Edgeworth's criticism is that it is not directed to the main point at issue, namely the measurement of utility by money." 71

The correctness of Marshall's technique of holding the marginal utility of money constant was really not the issue in question, as Edgeworth apparently thought. 72 The important issue was whether such an assumption did damage to the use of the Marshallian demand curve to depict consumer's surplus. The protracted debate, which ultimately destroyed the consumers' surplus theory of the Principles, centered around this question. If the marginal utility of money can be assumed constant with respect to changes in price or real income, then it is incontestable that the demand curve can be used to depict the surplus. But is such


72 Edgeworth sarcastically remarked that "the very genius of the applied calculus consists in not considering such variations when they are of an order of magnitude which may be neglected," "Professor J. S. Nicholson on 'Consumers' Rent,'" p. 156.
an assumption wholly reasonable? Marshall thought it so for unimportant commodities, but such a limitation would severely limit the usefulness of the tool. As one modern writer on the subject has said:

Use of the Marshallian triangle when the $\text{MUm}$ (marginal utility of money) is not constant involves measurement in money, the marginal utility of which changes in the course of the measurement. While there are pitfalls in using units of measurement, money, which do not have a constant relationship to the thing being measured, utility, there must also be objections to using any money of constant utility to measure changes in a case where the utility of money is not in fact constant.73

This, then, is the most serious problem with the money (demand curve) measure of consumers' surplus. The Marshallian demand curve would, with a changing marginal utility of money, or alternatively, with an "income effect," either overstate or understate the loss or gain associated with price changes. Thus it is necessary to change the curve to account for this variability in the utility of money, or, as an alternative, the Marshallian definition of consumer's surplus itself could be changed to fit the curve. Contemporary economic theory contains contributions along both lines.

The Hicksian Rehabilitation

For reasons given in the section above, the Marshallian money measure of consumer's surplus fell into disrepute. While a consumer's surplus still existed, the Marshallian approach demanded a constant marginal utility of money to measure it. This constancy was untenable in any practical case, and the very concept smacked of subjectivity. For reasons such as these, consumers' surplus as a partial equilibrium welfare tool soon became passe. The emerging distinction between welfare economics and "positive" economics contributed to the downfall. It is also notable that Marshall's brilliant pupil A. C. Pigou, who followed Marshallian dicta in many other respects, failed to lend the weight of his authority to the consumers' surplus theory judging the attenuating problems "insuperable in practice."74 His objection, it should be noted, was directed against aggregate consumers' surplus as in the

74 Pigou, The Economics of Welfare (London: Macmillan and Co., Ltd., 4th edition, 1962), p. 57. This is not the case with some of Pigou's earlier writings. In his "Monopoly and Consumers' Surplus," Economic Journal, 14 (September, 1904), for example, Pigou used the Dupuit-Marshall approach in showing how a monopolist, via discrimination, could attack consumers' surplus and appropriate it as profits. He did not mention Dupuit, however, and his earlier beliefs did not carry over into the Economics of Welfare. See p. 388 of Pigou's article and Chapter IV of this dissertation.
national dividend and not against the partial equilibrium concept, which, in the *Economics of Welfare*, Pigou eschewed entirely. The insuperable problems to which he referred occurred when the economist attempted to add individual surpluses in order to obtain a measure of total surplus for one good and then proceeded to add all of these together for the entire surplus accompanying the national dividend. Most of the theoreticians of the period did not get past the problem of the marginal utility of money.

The doctrine, however black its history, has enjoyed a renascence clothed in a new and perhaps more wearable coat. Sir John R. Hicks sought a more "objective" theory of value, and in 1934 forcefully reintroduced concepts originated by Edgeworth. Hicks used the "marginal rate of substitution" and indifference curves to prove all of the familiar properties of demand curves, and, importantly,

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75 It must be noted that Marshall returned a like verdict on the aggregation of surpluses. See his *Principles*, p. 131, n. 1.

76 Hicks and Allen, "A Reconsideration of the Theory of Value."

77 See Edgeworth's *Mathematical Psychics, an Application of Mathematics to the Moral Sciences* (London: C. Kegan Paul and Co., 1881). This work has been reprinted by Augustus M. Kelley, 1961.
his analysis was framed in a manner which avoided dependence on rigid cardinality. In the course of his presentation Hicks translated Marshall's constant marginal utility of money into "exactly definable terms." Hicks pointed out that:

If the marginal utility of commodity Y is constant, the marginal rate of substitution between X and Y must depend on X only. If the quantity of X is given, the marginal rate of substitution (or the slope of the indifference curve) is given, too; the tangents to the indifference curves at all points with the same abscissa must be parallel . . . and the income elasticity of demand for X must be zero.79

78 Hicks and Allen, "Reconsideration," p. 64.

79 Hicks and Allen, "Reconsideration," pp. 64-65. This dissertation has consistently made use of Professor Hicks' interpretation of Marshall's constancy of the marginal utility of money. Hicks thinks that Marshall meant the marginal utility of money to be constant with respect to changes in income. Samuelson, however, found that "the marginal utility of income cannot be invariant under changes in income and each and every price," and he interprets Marshall's "true" meaning as "constancy of the marginal utility of income with respect to n prices but not with respect to income," Foundations, pp. 191-192. The implications of Samuelson's interpretation are that the income elasticity of demand for each good must be unitary and that the price elasticity for each good in terms of its own price must equal minus one. This squarely contradicts Hicks' conclusion that the income elasticity of demand is zero. Also see, of course, Samuelson's "Constancy of the Marginal Utility of Income," in Studies in Mathematical Economics and Econometrics.
This statement acquired new import in the early 1940's when Hicks wrote a series of articles reaffirming the value of consumers' surplus as an economic tool, and in the process, amending Marshall's demand curve measure. In the "Rehabilitation of Consumers' Surplus" Hicks reasserted the fact that constancy of the marginal utility of money "implies that the consumer's demand schedules are unaffected by changes in his real income."\(^8\) The Marshall-Dupuit demand curve measure, in other words, did not account for the income effect. Marshall could not hold that the income effect caused by price changes was non-existent, except in the case of a constant marginal utility of money which implied an income elasticity of zero and a price elasticity of unity. The Marshallian demand curve fit the definition in this case, but it could not measure consumer's surplus if a substantial income effect was provoked by price movements. There is still a Marshallian consumer's surplus consistent with his definition, but the Marshallian demand curve does not measure it. Hicks retained Marshall's definition and chose to "... adjust the ordinary demand

\(^8\)J. R. Hicks, "A Rehabilitation of Consumer's Surplus," p. 109.
curve so as to allow for the effects of the changes in real income . . . "81

Hicks went about this modification using two theoretical techniques to arrive at the same adjustment. The "four consumer's surpluses" which Hicks discerned can be illustrated with the aid of the traditional Marshallian demand curve, or with indifference curves. The indifference curve technique possesses a greater degree of theoretical neatness, while the presentation in terms of the ordinary demand curve shows more clearly the shades of difference between the Marshallian measure, on the one hand, and Hicks' four measures, on the other. For the sake of contrast, the latter method will be presented below.

In his article entitled "The Four Consumer's Surpluses," Hicks chose to illustrate his measures by enlisting the aid of the ordinary demand curve. Hicks assumed that the good under consideration was "normal" with respect to income changes (he also considered the case of the inferior good), and he retained Marshall's assumption that the prices of other consumer goods remain constant during the course

81Hicks, "Rehabilitation," p. 109.
Hicks assumed that the individual possessing a given amount of money income faces given market prices for n-1 commodities to which he must confine his purchases. Given this situation the individual will allocate his income in a particular manner. A new commodity is introduced with only one unit available. Whether the individual will purchase this nth commodity or not clearly depends on its price. And, as Hicks pointed out:

There will be some price which will separate the high prices, at which he will not purchase, from the low prices at which he is just on the edge of purchasing. I shall call this price his marginal valuation of the unit. (Evidently it is the same thing as Marshall's "marginal utility in terms of money").

If the actual price is less than the marginal valuation, the unit will be purchased. The marginal valuations of all units can be determined once the market price is given, and a marginal valuation curve, such as AV in Figure 3-3 below, can be constructed. Curve AV is the marginal valuation curve corresponding to market price OH. At

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82 Hicks, "Rehabilitation," p. 109.
83 Hicks, "The Four Consumer's Surpluses," p. 31.
84 Figure 3-3 of this chapter corresponds to Hicks' Figure 3 in the "Four Consumer's Surpluses," p. 34.
price OH, quantity HP will be purchased since, given price OH, all units of the good less than quantity HP have marginal valuations greater than OH. Point P is found by extending a horizontal from price OH to the marginal valuation curve. A new marginal valuation curve Av would correspond to a lower price Oh. In the case of a normal good (as in Figure 3-3), the increase in real income occasioned by the price decrease will shift the new marginal valuation curve Av to the right and above the one corresponding to higher price OH. Other things being equal, an increase in income will raise the marginal valuation of any given quantity of the good. This is the Hicksian "income effect," and he identified it with the movement from one curve to the other; the substitution
effect of a price fall, therefore, consists of movements along the marginal valuation curves. The ordinary Marshallian demand curve can be traced out by connecting the equilibrium points, resulting in the dotted line APpD. It is clear that when the income effect is of little significance the Marshallian curve approaches the marginal valuation curves. But when this is not the case, Hicks provides alternative measures for consumer's surplus.

When the marginal utility of money is allowed to change, or identically, when there is an income effect, the gain to the consumer from a price fall can be viewed in several ways, some of which have already been discussed in connection with the Bordas example (Figure 3-2). At the core of Hicks' macro-oriented compensation principle is this development of the various "variations" as measures of consumer's surplus. Hicks inquired into the amount of money income which, taken from the consumer at the new price Oh, would leave the consumer no better off than he was at the former price OH. The amount is called price compensating variation, and it is obtained (with reference to Figure 3-3) in the following manner: allow the

consumer to purchase HP units at price OH and, for the following unit, lower price only as far as necessary for him to purchase it. Continuing in this fashion, a curve HPC can be traced where, at C, the consumer is neither better nor worse off than at point P. The segment PC lies above marginal valuation curve PV since the consumer is better off than if he were forced to pay OH for hc units. But segment PC is below Marshallian segment Pp since he is in a worse position than if he were allowed to purchase all these units at Oh, although he does purchase a marginal unit at price Oh. At C the consumer is in the same position as if he had been allowed to purchase all the units at price Oh, but he has been forced to part with an amount of income equal to HPch which is the compensating variation and a measure of consumer's surplus.

This Hicksian measure can be conveniently contrasted to Marshall's measure which, geometrically, is equal to the area HPph. Marshall's money measure assumed that the marginal utility of money was the same at positions P and at p, a condition which could not possibly obtain with an income effect. The marginal utility of money does in fact vary on the Marshallian curve. A positive income
effect would mean that the first cent added to the consumer's income would have a higher marginal utility than the last cent. In order to get the demand curve to express consumer's surplus, Marshall had to assume that each cent in the money measure of consumer's surplus added a constant amount to total utility. Hicks' compensating variation assumes, more properly, that, with an income effect, each cent in the money measure added a diminishing increment to the total utility of the consumer. Hicks' compensating variation takes account of this diminishing marginal utility of money and is less than the area under Marshall's demand curve.

Analogous reasoning can be used with the Hicksian measure of consumer's surplus termed by him "price equivalent variation." Here Hicks asked the question, "what amount of money income would be required, in the absence of the price decrease, to raise the individual to the level of satisfaction attained at p?" Hicks employed similar reasoning by asking the consumer, starting at p, to state the maximum price he would require for the diminution of his holdings of the commodity, one unit at

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86See "The Four Consumer's Surpluses," p. 35.
a time. The segment $pE$ can be traced out with such information. Area $HEph$ is yet another measure of consumer's surplus, termed "price equivalent variation" by Professor Hicks. At point $E$ the consumer is no worse off than at $p$, but he is consuming at price $OH$. The Hicksian equivalent variation is a larger money sum than Marshall's money measure under the demand curve because the value of money in terms of goods is different in the two situations $P$ and $p$. The equivalent variation takes account of the increased level of satisfaction attained at $p$. In order to maintain this new level of satisfaction at price $OH$, the sum of money given to the consumer will have to be greater than the money amount under the Marshallian curve, since the marginal utility of money would have declined at $p$.

Hicks' compensating and equivalent variations take account of this non-constant marginal utility of money. Hicks, however, did not couch his discussion in terms of increments of utility; rather his concepts measured consumer's surplus as a perfectly determinant amount of money income. The measures are, without question, superior to Marshall's measure in all cases where income effects
cannot be neglected.\textsuperscript{87}

Hicks also extended his analysis to the case of an inferior good. The normal good case, however, appears sufficient to illustrate why the Marshallian triangle, except in some rather unusual circumstances, cannot be employed as a valid measure of consumer's surplus. In addition to the price compensating and price equivalent variations, Professor Hicks considered what he called the quantity compensating and quantity equivalent variations. The quantity compensating variation, for instance, would measure the change in income required to offset the rise in quantity acquired at the lower price. In order to obtain this measure, with reference to Figure 3-3, Hicks proposed that the individual continue down the segment PC, again paying the maximum price he would offer for additional units of the commodity until point M is reached. At M the individual is no better or worse off than at P, and he is consuming the same quantity as at Oh, but an amount of income HPch \textit{minus} cpM has been extracted from him. The result is the quantity compensating variation. Similarly, the quantity equivalent variation is the amount of income which, if presented to the individual, would allow him to maintain the level of satisfaction at p while consuming the quantity associated with the former price OH. Its geometrical measure can be obtained by having the consumer follow segment pE, presenting him with the minimum price required to make him part with the commodity, a unit of time. Arriving at position m, the consumer obtains the same amount of the commodity as at P, but he has received an amount of income, HEph \textit{plus} PmE, which maintained the level of his satisfaction as at position p. This is the quantity equivalent variation. Hicks has expressed a preference for these latter two quantity measurements as most accurately reflecting Marshall's real intent; see his \textit{Revision of Demand Theory} (Oxford: Clarendon Press, 1965), p. 96, n. 2, and Chapter X for still additional refinements of the measures.
all these cases, Professor Hicks' "new" measures are more appropriate.

The Status of the Dupuit-Marshallian Measure

The partial equilibrium concept of consumer's surplus was used by Hicks as a path to his famous "compensating principle," which was that a given policy change is desirable if the gainers can compensate the losers in money with a resultant net gain. As one writer has pointed out, "the concept of consumer's surplus, by itself, is of little value in welfare theory, since any policy change affects large numbers of individuals."^88 Hicks' measure is, however, free from interpersonal comparisons since it does not pretend to measure changes in satisfaction but rather the amounts of money income required to offset these changes in satisfaction. Under the Hicksian technique, therefore, the problems surrounding the aggregation of consumers' surplus are avoided. A high-level debate has grown up around the Kaldor-Hicks "criterion," which was soon modified by Tibor Scitovsky.^89 An excellent summary of the issues involved, which cannot be covered

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here, together with some important contributions to the debate, is to be found in I.M.D. Little's *Critique of Welfare Economics*.  

Although many of the issues on the validity of welfare measures are, as yet, unresolved, it is interesting to note that at least one author has recently proposed a return, under certain conditions, to the Marshallian triangle as a measure of economic gain. David M. Winch has shown that, in all circumstances involving market situations subject to measurement by demand curves where compensation is not actually made or where it is impossible, the Marshallian demand curve is a useful measure of the change in society's welfare. This, even though the marginal utility of money is not constant, Winch believes that welfare shifts should be viewed from society's criteria and for this reason can neglect the changing marginal utility of money. The validity of the measure hinges on how society regards a redistribution of income. As Winch points out:  

Any net gain or loss resulting from aggregation of the gainers' and losers' utilities in

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terms of money... is an accurate measurement of the gain or loss of welfare only if society is indifferent to the distribution involved. If the redistribution is considered good in itself, aggregation underestimates a net gain and underestimates a net loss. Policy decisions can therefore be based on the gain criterion in cases where the effects of the policy change would manifest themselves in price changes and where compensation is not practicable.91

Thus the Dupuit-Marshallian formulation of consumers' surplus may still possess some usefulness as a practical policy guide, at least where the Hicksian compensation principle is inapplicable. This writer, along with Professor Winch, does not share Samuelson's view that "the subject is of historical and doctrinal interest, with a limited amount of appeal as a purely mathematical puzzle."92 On the contrary, the concept invented by Dupuit over a century ago may be, as Winch has shown, of practical import. Certainly a doctrine possessed of such a long and interesting history, as well as one which brings the economic aim of "maximum satisfaction" into full focus, should not be merely exhibited in a showcase for what Samuelson calls "superfluous"93 theories.

91 Winch, "Consumer's Surplus," p. 422.
CHAPTER IV

DUPUIT'S MONOPOLY - PRICE DISCRIMINATION THEORY

Introduction

Augustin Cournot presented, in what was surely one of the most remarkable theoretical performances in the history of economic analysis, an elegant mathematical formulation of monopoly theory. The familiar conditions for profit maximization are analysed both for the monopolist with and the monopolist without costs of production. Cournot meticulously showed that the monopolist would maximize his net receipts or, alternatively, would produce where marginal costs equaled marginal revenue. He proceeded to discuss other important aspects of monopoly theory, including the famous duopoly case (mineral springs example) and provided an admirable

1See Mathematical Principles, p. 57. Chapters V and VI of Cournot's work contain the corpus of his contribution in this area.

2Supra, note 28, Chapter II.
analysis of the incidence of taxation. 3 Cournot, however, neglected an important aspect of monopoly theory in his contribution. This neglected issue was the problem of price discrimination. 4

Price discrimination and the problems surrounding it has always been of special interest to economists dealing with public utilities and public regulation of business. A brief perusal of transport and public utility pricing policies would suggest the existence of such discrimination. Observation of such policies brought Jules Dupuit to a discussion of this important aspect of monopoly theory, and with his discussion, Dupuit filled an important void left by Cournot. Moreover, as the following discussion will show, Dupuit's presentation of simple monopoly pricing, especially in view of the fact that Cournot's writings were unknown to him, had a flavor peculiar to itself.

3Cournot felt that, since the legislator had the power to alter the distribution of taxes, "the theory of the incidence of taxation is one of the great objects of investigations in Political Economy," Mathematical Principles, p. 67. In 1838 Cournot pointed out that a lump sum tax on a monopolist would "have no direct influence on the price of the article which he produces, and consequently none on quantity produced, and that it will not be a burden to the consumer in any way," p. 68.

4See Schumpeter, History, p. 978.
In the course of his economic writings Dupuit was led to investigate the problem of monopoly pricing. Conditions existing in the French railroad companies were of particular interest to him. As scores of later economists were to show, Dupuit pointed out that "... the interest of ordinary capitals is regulated by the law of supply and demand ... while the roads of transportation capitals are monopolies." Thus, generally speaking, "ways of communication," or forms of transportation were sheltered from competition. Dupuit illustrated this point by comparing the economic principles which determine house rent to those affecting transport rates. Exorbitant rents for lodging, according to Dupuit, could not exist for very long for "if it was known that house rental yields a revenue superior to the rental of other capitals, speculation would focus very quickly on the construction of houses and equilibrium would be established." The entry


6Dupuit, "Toll," p. 3.
and exit process prohibits monopoly rents over the long-run in dwelling houses, but as Dupuit indicated, this freedom to enter the railroad industry is inhibited by certain factors indigenous to that industry. Enormous amounts of capital, in the first instance, restricted the possibility of entry to an extremely limited number of persons. Additionally, Dupuit claimed that because of the uniqueness of the first enterprise, a "new one can survive only at the expense of the first and . . . the profit which is sufficient for one is not sufficient for two." He also showed that the economies of being established stood as a formidable barrier to the entry of new firms. Competition in such circumstances, would, because of the revenue effects on the separate firms, have disastrous results. Dupuit's statement on this matter implied that the sudden encroachment of a competitor on a monopoly railroad line would "spread" the fixed traffic too thin for either to survive. Costs, moreover, would be higher for the new enterprise, since "the first enterprise . . . had the choice of layout;" and the second enterprise arrives "after habits are

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7 Dupuit, "Toll," p. 4.
8 Dupuit, "Toll," pp. 4-6.
formed, and relations are established." Because of such barriers to entry, these transportation firms "are necessarily monopolies and the proprietor of a capital monopoly, can draw a superior revenue from it than that of capitals submitted to competition."\(^9\)

Dupuit's analytical contribution to monopoly theory emerged when he addressed himself to the principles on which the simple monopolist, as constituted above, behaves. In the course of his discussion on the effects of tolls and transport charges on utility, Dupuit uncovered the rule of monopoly profit maximization. The following table (Table 4-1) reproduced from the 1849 article "On Tolls and Transport Charges,"\(^10\) will be useful in illustrating Dupuit's grasp of this well-known principle.

\(^9\)Dupuit, "Toll," p. 5.


\(^11\)Jules Dupuit, "On Tolls and Transport Charges," translated by Elizabeth Henderson, Annales des Ponts et Chaussees (1849) in International Economic Papers, No. 11 (London: Macmillan, 1962), p. 21. It should be noted that this is the same demand curve and utility calculation used by Dupuit in another connection. See Appendix II.
TABLE 4-1
A MONOPOLY DEMAND AND UTILITY CALCULATION

<table>
<thead>
<tr>
<th>Tariff</th>
<th>Number of Passengers</th>
<th>Utility</th>
<th>Yield of the toll</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gross</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
<td>445</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>80</td>
<td>425</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>63</td>
<td>391</td>
<td>126</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>352</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>41</td>
<td>316</td>
<td>164</td>
</tr>
<tr>
<td>5</td>
<td>33</td>
<td>276</td>
<td>165</td>
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<td>6</td>
<td>26</td>
<td>234</td>
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<td>20</td>
<td>192</td>
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<td>14</td>
<td>144</td>
<td>112</td>
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<td>9</td>
<td>9</td>
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<td>6</td>
<td>69</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The example above refers to a tariff or rate which a monopoly railroad may charge for passage. Here Dupuit considered the case of an unregulated monopolist free to charge a rate which would maximize profits. Dupuit elsewhere pointed out that "if the road or bridge or canal or any other undertaking is private property, the owner company has only one aim, and that is to get the largest possible income from the toll."\textsuperscript{12} Thus the monopolist with no costs of production facing the demand schedule above would charge a rate of 5 in order to maximize

\textsuperscript{12}Dupuit, "On Tolls and Transport Charges," p. 11.
profits or gross receipts. But Dupuit expanded the example to the monopolist with costs of production. Dupuit supposed that the monopolist's "cost of traction" could be represented by the figure 2 per unit of passage. These traction costs may be identified with marginal or average variable costs. In this case, as Dupuit correctly pointed out, "the rate which maximizes net yield is not the same as that which maximizes gross yield. The latter rate was 5, the former is 6, and it would grow indefinitely with the cost. It follows that when traction cost \( \bar{\text{marginal cost}} \) diminishes, the toll must diminish to yield maximum receipts."\(^{13}\)

It is notable that Dupuit did not reason in terms of the familiar marginal revenue-marginal cost criterion for profit maximization. Dupuit did not extend the argument as did Cournot who symbolically produced the marginal condition for profit maximization, and consequently stated that "the producer will always stop when the increase in expense exceeds the increase in receipts."\(^{14}\) Dupuit, however, correctly stated that if the level of marginal

\[^{13}\text{Dupuit, "On Tolls and Transport Charges," p. 20.}\]

\[^{14}\text{Cournot, \textit{Mathematical Principles}, p. 59.}\]
(or traction) costs increased, the profit maximizing tariff would increase and output would decrease. The net receipts, additionally, are net only of variable expenses. Fixed costs, such as "certain administrative expenses, interest on construction expenditure, etc.," must also be covered in the long run. Consequently, Dupuit's net receipts are not monopoly profits as are his gross receipts (without costs of production).

Referring to the above chart, Dupuit said that "if fixed costs were more than 104 and it were possible to charge only one uniform rate, the railroad would be a losing proposition with any tariff."\(^{15}\)

Dupuit's approach to the profit maximizing condition is no less valid for being different. Moreover, Dupuit had an illustrious follower in the use of the net revenue approach. Alfred Marshall in his chapter on monopoly\(^{16}\) used a concept similar to Dupuit's in order to discuss and portray monopoly revenue. Marshall, eschewing the marginal method, proceeded to develop and refine what he called the "monopoly revenue schedule."\(^{17}\)

\(^{15}\)Dupuit, "On Tolls and Transport Charges," p. 21.


\(^{17}\)Marshall, *Principles*, p. 479.
approach was to subtract the supply price for each amount of the commodity from the corresponding demand price. Marshall, unlike Dupuit, included other costs, such as interest on capital, "salaries of directors, etc." in his supply price.\textsuperscript{18} After supply price is subtracted from demand price, the residue, or monopoly revenue, is set against the corresponding quantity in order to obtain the monopoly revenue schedule. This latter schedule, together with the demand curve and "constant revenue curves," are elegantly combined and constructed by Marshall to show that the monopolistic seller will always maximize monopoly revenue. Although this technique has not been favored with economists' attention, there can be little doubt that, with reference to this analytical apparatus, Marshall's presentation was more akin to Dupuit's than to Cournot's. Again, as in the case of the consumers' surplus argument, Marshall enlarged the analytical value of the tool by probing the implications of the monopolist's net revenue. Specifically, Marshall showed (among other things) that due to various economies of scale, to the ability to finance technological improvement, both

\textsuperscript{18}Marshall, \textit{Principles}, p. 479.
associated with monopoly market structure, "the supply schedule for the commodity, if not monopolized, would show higher supply price than those of our monopoly supply schedule." Marshall went further and stated that, given that the monopolist had unlimited command over capital, equilibrium quantity under free competition would be less than that for which the demand price is equal to supply price under monopoly.

Marshall also indicated other interesting features of monopoly control, some of which are strikingly evocative of Dupuit's views. One of these issues is the important relationship between monopoly revenue and consumers' surplus which will now be investigated in some detail.

Dupuit supplied a utility calculation for his railroad example as indicated by Column three of Table 4-1 of this chapter. The net revenue maximizing price would be a tariff of 6 in that example. Absolute utility produced by this tariff would be 234. This utility is segmented in the following fashion, according to Dupuit:  

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Utility lost in traction cost 52
Utility accruing to the owner of the railway 104
Utility remaining to the 26 passengers 78

If we momentarily depart from Dupuit's presentation and assume that fixed cost is exactly 104, there is no monopoly revenue. In the short run, the 104 accruing to the owner of the railway is of the nature of an economic rent on fixed investment, but as Dupuit succinctly pointed out, these fixed costs must be met by the monopolist in the long run. Thus, under the assumption that fixed costs are 104, there would be no monopoly revenue. Consumers' surplus is produced, however, in the amount of 78.

Although Dupuit's theory of discrimination will be developed in detail further in this chapter, it is significant at this point to show that Dupuit knew that this consumers' surplus of 78 could be diminished (or increased) by a policy of price discrimination used to enhance monopoly revenue. Dupuit assumed that fixed cost in the above example was 110, clearly indicating losses to the railroad under the one-price policy. But Dupuit assumed

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that discrimination was possible, and that 14 passengers could be induced by some form of differentiation to pay 8, while 12 could be carried at 6. Here Dupuit took discrimination to mean the selling of one and the same commodity at more than one price. The same 26 passengers now yielded a net revenue of 132. This is the so-called "necessary case" and monopoly revenue is now 22 at the former output; consumers' surplus has decreased from 78 to 50, however. Thus Dupuit did not view the relationship between monopoly net revenue and consumers' surplus as necessarily a symbiotic one. Monopoly profits could be increased at the expense of consumers' surplus.

Although Marshall did not discuss price discrimination in any context, he went to great lengths in his chapter on monopoly to point up the implications of this dichotomy between monopoly revenues and consumers' surplus. Although Marshall knew that the profit maximizing monopolist was not concerned with consumer welfare, it was his position that the simple monopolist may calculate the effects that their pricing decisions have on consumers' surplus. He proposed that the consumers' surplus arising from the sale of the

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commodity at any price be added to the monopoly revenue and
that the money sum of the two be called the total benefit.
And, according to Marshall,

... if the monopolist regards a gain to the
consumers as of equal importance with an equal
gain to himself, his aim will be to produce just
that amount of the commodity which will make this
total benefit a maximum.\(^\text{23}\)

Marshall modified the total benefit theory for the
event in which the monopolist did not regard a gain in
consumers' surplus as equal to a gain in monopoly revenue.
The result was his theory of compromise benefit.\(^\text{24}\) A
monopolist behaving on the principle of compromise benefit
would calculate the monopoly revenue to be had at any
given price and add to it some percentage (one-half, one-
third, etc.) of the corresponding consumers' surplus. He
would then set out to maximize this compromise benefit.
Marshall knew that monopolist's were not philanthropic in
the role assigned to them by economic theory, and yet he
thought that some industries, and he specifically mentioned
railroads, felt a communion of interests with the public.


\(^{24}\) Marshall, \textit{Principles}, p. 489. This "theory of
the altruistic entrepreneur" may be an example of Marshall's
partial recantation of strict laissez faire precepts.
Additionally, Marshall thought that the government should be interested in maximizing consumers' welfare, although he strongly indicated that they should do so only under the constraint of equating total revenue to total costs, an application of compromise benefit.25

The bulk of Marshall's analysis of the relationship between monopoly revenue and consumers' surplus is a reiteration of Dupuit's invention. Dupuit, it is true, assumed that the unregulated simple (and discriminating) monopolist was a profit maximizer, an assertion challenged by Marshall to some degree. But the fundamental point that, at any given quantity, there exists an inverse relationship between consumers' surplus and monopoly revenue, and additionally, that rates could be changed to yield various combinations of consumer utility and monopoly returns was Dupuit's. Although Dupuit's example shifts from one of simply monopoly to one of discriminating monopoly, the similarity between Dupuit and Marshall is

25As Marshall pointed out, "even a government which considers its own interests coincident with those of the people has to take account of the fact that, if it abandons one source of revenue, it must in general fall back on others which have their own disadvantages. For they will necessarily involve friction and expense in collection, together with some injury to the public, of the kind which we have described as a loss of consumers' surplus . . ." *Principles*, p. 488.
still clear in this regard. Both economists showed that
the monopolist's pricing decisions impinge on and are
important to the consumers' surplus of the commodity.

With the aid of another of Dupuit numerical examples
(which directly follows that reproduced in Table 4-1 of
this chapter), the points of analogy in the two statements
can be illustrated.26 Dupuit's example (Table 4-2) is
one of discrimination with a two-class tariff. He was

**TABLE 4-2**

**THE TWO-CLASS TARIFF**

<table>
<thead>
<tr>
<th></th>
<th>One-class tariff</th>
<th>Two-class tariff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(6)</td>
<td>(6,8) (5,10)</td>
</tr>
<tr>
<td></td>
<td>(4,7) (3,7)</td>
<td>(2,6)</td>
</tr>
<tr>
<td>Number of passengers</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td>Traction costs</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>66</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>126</td>
</tr>
<tr>
<td>Net receipts</td>
<td>104</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>129</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td>130</td>
<td>104</td>
</tr>
<tr>
<td>Utility remaining to</td>
<td>78</td>
<td>50</td>
</tr>
<tr>
<td>passengers</td>
<td>81</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>122</td>
<td>161</td>
</tr>
<tr>
<td>Net utility</td>
<td>182</td>
<td>182</td>
</tr>
<tr>
<td></td>
<td>210</td>
<td>234</td>
</tr>
<tr>
<td></td>
<td>252</td>
<td>265</td>
</tr>
<tr>
<td>Profit on the assumption that fixed cost equals 110</td>
<td>- 6</td>
<td>22</td>
</tr>
</tbody>
</table>

immediately alive to the revenue possibilities of such a
device. The Table clearly shows that net receipts can be
increased by selling a given quantity discriminatorily.
Taking the tariff (4,7) as an example, Dupuit's calcula­
tions can be approached in the following manner. Of the
41 possible passengers at a toll of 4fr. (see the demand
curve of Table 4-1 of this chapter), Dupuit assumed it
possible to distinguish 20 who would pay a toll of 7 fr. for
the journey. This would yield total receipts of 224
francs (20 X 7 + 21 X 4). Subtracting traction costs
(which remained constant at 2 fr. per passenger) from
total receipts yields net receipts of 142. The total
utility corresponding to the 41 journeys is, from Table
4-1, 316. Subtracting the monopolist's total receipts
from this total utility results in a consumers' surplus
(or "utility remaining to passengers") of 92. Net utility
is the sum of net receipts and consumers' surplus. Profit
is the difference between total receipts and total costs
of production (fixed and traction costs), or 224 - (82 +
110) = 32. Dupuit's "profit" in the table is analogous
to Marshall's monopoly revenue. Since Dupuit assumed
profit maximizing behavior, he pointed out that "the
tariff (4,7) yields decidedly more than the others and
that is the one which a private company would adopt."\textsuperscript{27}

This profit maximizing two-class tariff nevertheless results in an improvement in consumers' surplus (or "utility remaining to passengers") over the simple monopoly rate of 6. Output would increase and average price would decline as well.

But the new profit maximizing prices and output do not maximize consumers' surplus, and this was an important point in Dupuit's presentation. Should the monopolist be imbued with the public interest or should the government assume ownership of the enterprise, some sort of "compromise benefit" policy would be established, as Marshall later argued. But Dupuit, much earlier than Marshall, considered a "compromise benefit" policy and its effect on consumers' utility. This can be shown by the following statement which refers to Table 4-2.

The tariff (2,6) maximizes utility \(\sqrt{\text{net utility}}\) and consumers' surplus, though it does involve the railway in a loss of 6; but this loss can be avoided by raising the second-class price just a little above 2, which would reduce utility to about 260 and passengers to 60. This is the tariff which the government would adopt, because it would cover all costs. The railway operated by a private company would

\textsuperscript{27}Dupuit, "On Tolls and Transport Charges," p. 22.
serve only forty-one passengers and give them a utility of 92; if operated by the government, it would serve sixty passengers and give them a utility of about 160.28 (emphasis supplied)

While Dupuit did not consider the altruistic monopolist, he considered the case of a "compromise benefit" policy instituted by the government. Dupuit seemed to indicate that a privately owned enterprise could attain the same results, but he did not dwell on the idea and in the quotation, he reverted to the statement that the monopolist will maximize profits.

The treatment of costs under government ownership is identical in both Marshall and Dupuit. Although Dupuit's argument may have changed in the marginal cost pricing case (see Chapter V of this dissertation), in this case at least, both realized that consumers' surplus could be maximized by giving the commodity away, but both Dupuit and Marshall had serious misgivings on the attenuating difficulties of financing the losses and both recommended that the government "compromise" and recover costs. Dupuit wanted the government to maximize "utility remaining to passengers" under the total cost constraint and this is none other than the theory which was to receive the

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appellation "compromise benefit" from Marshall at a much later date.

In sum, Dupuit's contributions to the development of simple monopoly theory, particularly when one appreciates their apparent influence on Alfred Marshall's Principles, were considerable. His approach to simple monopoly profit maximization was used by Marshall in preference to Cournot's marginal apparatus, although Dupuit's theoretical ideas were melded with practical examples, possessing, therefore, none of the theoretical neatness exhibited by Cournot. Having been, however, the first major developer of utility theory, Dupuit was able to see welfare implications in monopoly pricing. Cournot lacked the analytical apparatus which would have enabled him to analyze these implications.

By means of examples Dupuit showed that the profit maximizing behavior of the monopolist could be inimical to the interests of the consumer, if maximization of consumers' surplus was the criterion. A "compromise benefit" policy could be instituted by a private monopolist or by the government, although he implicitly deemed the former far-fetched and did not discuss the possibility. Dupuit's simple monopolist ends up a discriminating
monopolist, the analysis of which is a first-rate contri-
bution it itself; but this in no way obscures the relation-
ship Dupuit plotted between monopoly revenue and consumers' surplus. And it is this important relationship and a discussion thereof which mysteriously re-emerged in Marshall's chapter on monopoly without a scintilla of credit to Dupuit.

The "compromise" and "total benefit" theories, terms with an aura of originality, were merely refurbishments of concepts obtrusively present in one of Dupuit's major articles. Other elaborations were largely in the form of some elegant (perhaps over-elegant) Marshallian graphics. It is not impossible that Marshall arrived at the "compromise benefit" theory independently. But there is a strong presumption, especially in the light of Professor Schumpeter's remarks with regard to Marshall's treatment of Dupuit's consumers' surplus theory, that his neglect of Dupuit in regard to monopoly theory was merely representative of the typically ungenerous attitude Marshall harbored for the French economist throughout his writings.

29See Figure 36, Principles, 8th ed., p. 488, for example.
In the final accounting, however, Dupuit's discussion of monopoly pricing and of the effects of it on the size and distribution of economic welfare was a unique and positive contribution to the economic tool-kit.

**Dupuit's Theory of Price Discrimination**

The genuine originality of Dupuit as an economic theorist is nowhere more forcefully displayed than in his theory of monopoly price discrimination. Even so astute a theorist as Cournot, who devoted the space of two chapters in his book to monopoly theory, did not discuss the problem and its implications. Indeed, Dupuit's contributions in this area were not to be surpassed until the writings of Pigou and Edgeworth.30

The existence of multiple prices for the same commodity (produced under similar or identical cost conditions) apparently fascinated Dupuit, evidenced by the fact that he discussed such phenomena in most of his economic works. Dupuit, in his various articles, outlined some of the motives and conditions necessary for discrimination to be feasible. Although he did not possess the concept of price elasticity of demand, Dupuit recognized that the

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30 *Infra, p. 163.*
maximum price that a buyer would offer for a commodity would not be the same among different individuals; he knew, further, that this difference in "buyer estimates" was necessary for discrimination. As he pointed out when discussing discriminatory tolls on bridges:

Why two different prices for one same service? Because the poor man does not attach to the advantage of passing the bridge the same price or the same utility as the rich one . . . On a canal or on a railroad, the tariffs distinguish between the classes of merchandise and travelers and imposes upon them variable prices although costs are almost the same.  

Thus Dupuit implicitly indicated that discrimination is possible because the poor man and the rich man possessed different elasticities of demand for passage on the bridge. Differences in "buyer estimates" were, however, not the only explanation for discrimination. Dupuit found another motive in the special cost characteristics of certain industries. The presence of high fixed costs or of common costs in such industries would be sufficient to induce discriminatory pricing to increase utilization

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32 Contemporary explanations of this characteristic are very much similar to Dupuit's. See D. P. Locklin, Economics of Transportation (Homewood, Illinois: Richard D. Irwin, Inc., 1960), p. 134 et passim.
of plant. Dupuit argued as follows:

... when one realizes the manner in which things happen on the canals, on the railroads, one recognizes that, if one could dispose of the number of travelers and of the quantity of merchandise, their double or triple could be transported without perceptibly increasing the costs.33

How did Dupuit explain these low marginal costs present in such industries and how did this fact lead to discrimination? Dupuit's intent on the matter becomes clear as he continued:

From this, it results that it is impossible to know what is the real cost of a traveler or a ton of merchandise at a given distance; that it is the nature of all production to be broken down into general fixed costs /common costs/ and proportionate costs /variable costs/. Now, for certain productions, the general costs constitute almost all of the expenditure and they can be paid by such and such a product and dispensed with the others. It is thus that in commerce, merchandise is found which is sold in a consistent manner well below cost price, when this price is calculated by applying the general costs; that stems from the fact that they are paid by other products in the manufacturing of which they concur ... There is almost no industry where this phenomena is not present, but no where does it appear more remarkably than in the railroads ... 34

Differences in cost did not explain price discrimination to Dupuit; rather it was the mass of costs common to "certain

33Dupuit, "Toll," p. 15.

productions" which provided a motive for discrimination. As long as the "proportionate" or variable costs could be covered it was profitable to allow additional traffic to move. As Dupuit himself put the matter, "all tolls, which result in turning away from a roadway travelers or merchandise which could benefit from it without their transportation being burdensome or abusive, are badly established tolls," (emphasis supplied).35 The large mass of common costs provided a powerful stimulus for price discrimination, for, although some traffic did not provide as large a contribution to fixed expenses as other traffic, the additional costs due to the new business would be met, as well as providing some contribution to the mass of common costs.

It should be noted that Dupuit definitely stated that discrimination due to high fixed costs, as well as discrimination in general, was not only to be found in railroad pricing or in public utilities. He knew that discrimination was practiced ubiquitously by business men involved in both public and private undertakings. Some of his most lucid examples of discriminatory practices were drawn from strictly private enterprise, such as ones involving theatre

tickets,\textsuperscript{36} book printing,\textsuperscript{37} and others. Price discrimination is ". . . well known in commerce, and it has been exploited for a long time. This is what serves as a basis for all the speculations which are protected from competition either by the secret of fabrication or by any other circumstance which assures the benefit of monopoly to the seller."\textsuperscript{38} Dupuit's observation that the practice of price discrimination permeated monopolistic structures goes far in explaining why he devoted so little time to a discussion of the simple monopoly market structure. His role as a theorist concerned with price discrimination is best defined by one of his own enlightening quotations. "Today," said Dupuit, "the problem is one of according scientific treatment, if we may say so, to a question in the solution of which business men have already made good progress by just going ahead at random."\textsuperscript{39} Observation of actual business practice, then, brought Dupuit to his "scientific treatment" of price discrimination.

\textsuperscript{36}Dupuit, "On Tolls and Transport Charges," p. 16.

\textsuperscript{37}Dupuit, "Toll," p. 16.


\textsuperscript{39}Dupuit, "On Tolls and Transport Charges," p. 16.
Dupuit was as adamant in his insistence that price discrimination was due to monopoly power as was Pigou some decades later when he entered into the celebrated debate with Professor Taussig.\footnote{The debate began with Professor F. W. Taussig's "A Contribution to the Theory of Railway Rates," Quarterly Journal of Economics, 5 (1891), and continued with Pigou and Taussig, "Articles and Controversies between Pigou and Taussig," Quarterly Journal of Economics, 27 (1913); A. C. Pigou, The Economics of Welfare (1920), chapters 17 and 18. Taussig put in a final word in his "The Theory of Railway Rates Once More," Quarterly Journal of Economics, 47 (February, 1933).} Briefly Taussig's position was that discrimination existed on the railroads because of the over-riding presence of joint costs. Pigou took Taussig to task and denied that preponderance of conditions of true joint supply on the railroads, asserting instead that discrimination in that area was due to monopoly power coupled with high \textit{common} costs. Although Dupuit did not specifically entertain a discussion of joint supply, with one exception to considered later in this chapter, he adhered to the belief, as did Pigou, that discrimination was the result of monopoly power. After discussing differential tolls imposed on users of a canal, Dupuit compared these discriminatory charges with the price of transportation on roadways where competition existed:
Never would a transport contractor be imprudent enough to say to his clientele: From A to B, I will ask 10 fr. per ton for sand; but I will ask 48 for pit coal and 87 for flour. Never does one find in the same truck...merchandise paying transport prices so different. This is very simple; for the contractor could profitably transport sand at 10 fr.; he would have an enormous profit transporting flour at 87 and very soon numerous competitors would come to make more reasonable offers to the public and would bring the price back to a level almost similar to cost price. The toll differential is then a result of monopoly; competition would necessarily cause it to disappear. The rate of toll then is not determined by any economic law, it is only the result of the will of the one who imposes it.41

Consequently, it was Dupuit's position that the practice of discrimination required a degree of monopoly power. It is true that in the presence of competition, granting joint supply, differential rates could still exist, but Dupuit did not consider this case. He apparently felt that monopoly was the dominating element allowing discrimination and that a large mass of costs common to the venture provided an added incentive for the monopolist to engage in this form of pricing. Monopoly power, to Dupuit, was a necessary but not a sufficient condition for discrimination; "buyer estimates" also had to be considered. As he pointed out, "The one who exploits a monopoly can

very well arbitrarily fix the price of the services he
must render, but he does not control their number ...." \(^\text{42}\)

The crucial issue of demand conditions also had to be considered.

Dupuit briefly considered the case of "time-jointness," in which supply (capacity) offered at a given time cannot be transferred to another time. \(^\text{43}\) Such a situation demanded rate discrimination in Dupuit's view. His example was one of a goods train which had to leave at a fixed hour regardless of the amount of freight on board. "In these circumstances," said Dupuit, "additional freight does not occasion proportional additional expense and there is room for a considerable reduction of the toll." \(^\text{44}\) The low marginal costs of carrying additional traffic would justify rate discrimination. Closely linked with this is the problem of obtaining better utilization of capacity. Dupuit posed a problem of half-empty railroad carriages. In this situation a small increase in "traction costs," or marginal


\(^{43}\) See Donald H. Wallace's classic article, "Joint and Overhead Cost and Railroad Rate Policy," Quarterly Journal of Economics (August, 1934) for an excellent discussion of all aspects of this variety of jointness.

\(^{44}\) Dupuit, "On Tolls and Transport Charges," p. 20.
costs, would permit "three times as many" passengers "as is the case today" to be carried by rail. \(^{45}\) To bring the railway to better utilization Dupuit advised:

Raise the fare for days when the rush of travelers obliges you to put on two locomotives, lower it for days when passengers are few. Why not issue full season tickets, or season tickets with a supplement, or valid only for certain days or certain trains. \(^{46}\)

Dupuit seemed to imply here that the existence of excess capacity justified differential rates. His dictum was to raise rates at "peak" loads, where marginal costs increase sharply and to lower them when less-than-capacity loads occasioned low additional costs for extra traffic. All this would lead to better utilization of capacity, a goal which Dupuit evidently thought desirable. Moreover he thought the goal attainable, but only through the use of discriminatory pricing practices. Thus, excess capacity together with the existence of high fixed costs provided an additional goal to the monopolist to practice price discrimination.

Price discrimination could not be practiced if a unit of the commodity sold in one market could be transferred

\(^{45}\)Dupuit, "On Tolls and Transport Charges," p. 25.

\(^{46}\)Dupuit, "On Tolls and Transport Charges," p. 25.
to another market. If this were allowed, arbitrage would soon bring the price of the commodity or service to equality. In short, the markets must be separable in some fashion. As Pigou later showed, "services applied directly by the seller to commodities handed to them for treatment, such as the service of transporting different articles, are . . . entirely non-transferable." Pigou was getting at the fact that coal cannot be transferred into steel, nor can steel be transformed into flour in order to take advantage of differential rates. Dupuit was cognizant of the problem of non-transference, but he did not belabor it; his statement on the matter is suggestive, however, of his position on another important issue. Dupuit contrasted passenger with commodity traffic on the railroad with respect to the railroads ability to discriminate. He observed:

> Passengers cannot, like goods, be classified by external characteristics and must be left to classify themselves. Hence a host of measures which are not always understood by the public, and sometimes not even by the railway company.

It can thus be concluded that Dupuit looked upon the unit of service offered for sale, i.e., the transport unit, as

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homogeneous on the supply side with respect to the transportation of goods at least. It was this non-homogeneity on the demand side for transport, owing to differences in "external characteristics," that permitted discrimination. Thus the demand for copper transportation was independent and distinct from the demand for coal transportation. Discrimination could then take place due to the fact that differences in external characteristics of units carried made transportation a kind of multiple-product industry. Although the unit offered for sale, transport service, was homogeneous, the fact that the demand was heterogeneous may be said to change the character of the unit offered for sale.

Different conditions existed in the passenger market. Dupuit knew that, regarding passenger traffic, product differentiation was in order. Passengers are generally indistinguishable by "external characteristics;" Dupuit thus reasoned that the unit offered for sale would, of necessity, have to be differentiated in order to successfully practice discrimination. By offering first-class, second-class, etc., passage, the railroad itself created a non-homogeneous supply. The method and intent of the railroads in this matter was well-understood by Dupuit as the
following excerpt illustrates:

It is not because of the few thousand francs which would have to be spent to put on roof over the third-class carriages or to upholster the third-class seats that some company or other has open carriages with wooden benches ... What the company is trying to do is to prevent the passengers who can pay the second-class fare from travelling third class; it hits the poor, not because it wants to hurt them, but to frighten the rich ... And it is again for the same reason that the companies, having proved almost cruel to third-class passengers and mean to second-class ones, become lavish in dealing with first-class passengers. Having refused the poor what is necessary, they give the rich what is superfluous.49

The statement is surely a classic in the literature of price discrimination. Dupuit saw that such activity could not exist in a society in which "all citizens are about equal in rank and wealth" or in which all citizens are "brought up like Spartans" and "appreciate neither deep-piled carpets nor soft cushions."50 In such a society, "a single uniform tariff would be the only possible solution."51

Types and Desirability of Discrimination

In the *Economics of Welfare* Professor Pigou scientifically outlined three types of discrimination.\(^5\) Unfortunately Dupuit's presentation was not so systematic. At several points in his writings he indicated that what is now called first-degree discrimination should act as the "foremost principle" on which pricing should be based.\(^6\) In order to "greatly extend the utility" of certain services, Dupuit recommended that the private entrepreneur "impose on each traveler, on each merchandise, only a price inferior to the one which would prevent them from using the road."\(^7\) Such discrimination would of course increase producers'

\(^5\) In Pigou's own words, "a first degree would involve the charge of a different price against all the different units of commodity, in such wise that the price exacted for each was equal to the demand price for it, and no consumers' surplus was left to the buyers. A second degree would obtain if a monopolist were able to make \(n\) separate prices, in such wise that all units with a demand price greater than \(x\) were sold at a price \(x\), all with a demand price less than \(x\) and greater than \(y\) at a price \(y\), and so on. A third degree would obtain if the monopolist were able to distinguish among his customers \(n\) different groups, separated from one another more or less by some practicable mark, and could charge a separate monopoly price to the members of each group," *Economics of Welfare*, p. 279.


\(^7\) Dupuit, "Toll," p. 21.
utility, or monopoly profits, but it would eliminate all consumers' surplus: utilization of the service would be expanded however. Additionally, Dupuit felt that such discrimination should be invoked "provided that this does not involve the company in a loss." \(^5^5\)

Although he recommended first degree discrimination, it is significant that Dupuit's examples do not entertain such conditions. The example given in Table 4-2 showed two-class railroad tariffs. In this connection Dupuit knew that a three-class tariff would increase receipts and the number of passengers, adding that "by multiplying classes indefinitely, the passengers could be made to pay over all the utility they derive from the railway." \(^5^6\)

But, conscious of the infeasibility of carrying this to the limit of first-degree discrimination, Dupuit adjudged this a "very difficult matter" in practical application. \(^5^7\) As a practical matter then, Dupuit thought that first-degree discrimination was difficult to achieve. He believed other forms more viable, however, and thought that the task of the entrepreneur was to define "the general characteristics

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\(^5^6\) Dupuit, "On Tolls and Transport Charges," p. 23.
\(^5^7\) Dupuit, "On Tolls and Transport Charges," p. 23.
by which consumers may be classified in the tariff schedule." This surely connotes a form of discrimination other than first-degree.

Dupuit thought that discrimination was desirable because it increased the total utility and consumers' surplus (utility remaining to consumers) of a good when contrasted to simple monopoly pricing. Referring to Table 4-2, discrimination increased consumers' surplus in all cases where output is increased over that of simple monopoly. Dupuit clearly pronounced profit-maximizing discriminatory output to be greater than simple monopoly output in the "necessary case," i.e., the case where no output would be forthcoming in the long-run with a single monopoly price. In this case discrimination always increases output. But Dupuit presented no real analysis of other cases in which discrimination may increase, decrease, or leave output unchanged over simple monopoly pricing. A full discussion of these problems awaited Mrs. Joan Robinson's elegant and penetrating work.  

58 Dupuit, "On Tolls and Transport Charges," p. 16.

59 See Joan Robinson, The Economics of Imperfect Competition (London: Macmillan and Co., 1961), particularly Chapters 15 and 16. The analysis in these chapters probably represents the high-point of theoretical formulations of price discrimination to date.
Dupuit's discussion contained the strong presumption that if only one of the markets could be served by the simple monopoly price, discrimination would cause output to increase. If discrimination brings in additional markets, output should increase. Dupuit, however, showed that if both markets could be served at the simple monopoly tariff 6 in Table 4-2, a discriminatory tariff of 6 and 8 would conceivably cause traffic to remain constant at 26 passengers. The tariff combination 2 and 6 yielded an increase in output over the simple monopoly price from 26 to 63. Here both markets could not have been served at the simple monopoly price. All of the other tariff combinations involve rates both above and below the simple monopoly rate. This suggests that Dupuit was not really aware of the problem of comparing simple monopoly output with discriminatory output in order to assess the relative desirability of simple and discriminating market forms.

The most important point to Dupuit was the effect of discrimination on the utility of the project. If discrimination increased output, it also increased utility. The relative "share of utility" accruing to the monopolist and the share remaining to consumers was also an issue. The
effect, as pointed out earlier in this chapter, depended on the exploiter. If the exploiter is a private non-regulated monopoly, the aim is profit maximization; and if discrimination is practicable, profits can be increased. Utility remaining to consumers, or consumers' surplus, could also be enlarged by such discrimination. It was the size and distribution of utility that concerned Dupuit. In the event of private ownership, profit maximization was the goal of the monopolist who concerned himself not at all with consumers' interests. Absolute utility (monopoly revenue and consumers' surplus) of the good was made larger by discrimination, however, if output was increased over simple monopoly pricing.

Dupuit envisioned very different principles for a governmentally owned or regulated project. In this case, as discussed above in connection with Table 4-2, Dupuit thought that the government should maximize consumers' surplus under the constraint of recouping all costs of the project. As Dupuit pointed out, the government would

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60 This is in contrast to his famous "bridge example" to be considered in the following chapter. In this example Dupuit advocated a type of "marginal cost pricing" by the government, with a possible recommendation that any attenuating losses to be recovered by taxation.
choose the discriminatory two-class tariff (2,6), "because it would cover all costs." Although Dupuit's example is of the "necessary case," he seemed by it to strongly imply that the government should recoup all costs in any and all cases where discrimination was practiced. This result may be contradicted by one of his other pricing techniques to be developed in the succeeding chapter. But it is clear that the size and manipulation of the total utility of a commodity was the heart of the problem to Dupuit. He was not interested *per se* in the effect of discrimination on output and on prices: it was the issue of utility that held his attention. As he put it:

> By varying the *price* or differentiating it in various manners, the three parts of total utility assume variable proportions at each other's expense.

> The conduct of a monopoly raises a series of important questions . . . Is the largest possible profit to be earned? Is the yield to be a fixed sum and the loss of utility reduced to a minimum?62

It was one of Dupuit's great contributions to have discerned the principles allowing a solution to the questions posed in the above quotation. Dupuit's reference to the possible recovery of a "fixed sum" is not necessarily compatible

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with his advocacy of recouping "all costs," but this merely illustrates the generality of Dupuit's theory of discrimination. It was a tool which would provide a frame of analysis for either profit maximization or, under government ownership or control, the recovery of variable costs, total costs or some other variant. The theory was perfectly general in its description of the pricing technique. It was a theory of how monopolists, given certain conditions, behave. Dupuit's contribution was to provide a scientific analysis of this behavior and to show that profit maximization was not sacrosanct. Given the preponderance of the public interest in any industry, the government could regulate so as to maximize the utility from the commodity or service in question given the cost constraint. Additionally, he showed that, under private control, the utility of certain projects could be enlarged by better utilization of plant via discriminatory pricing.

Dupuit's Influence on Subsequent Theorists

Literature on the theory of price discrimination from Dupuit to Joan Robinson was broadly of two types. Contributions to the branch of theory have come from both the theoretical economist and from the practitioner, the latter consisting mainly of discourses on railway rates.
The discussion will be confined to the former types of contribution, although the distinction is by no means clear-cut.\(^6\)

Leon Walras unhesitatingly credited Dupuit with the first discussion on multiple prices for the same commodity.\(^6\) Walras, however, was content to present an analysis quite similar to Dupuit's. He showed how total receipts could be increased by discrimination and, like Dupuit, stated that "this hypothetical situation is realized in the actual world of trade and industry more frequently than one generally supposes."\(^6\)

\(^6\) The exclusion of such material should not imply that it is not valuable or that it is unimportant. Many such discussions are in the nature of scholarly contributions. In this class, several works may be mentioned. The most important early work of this type was Dionysius Lardner, *Railway Economy* (New York: Harper and Brothers, Publishers, 1850). Lardner's book influenced many academic economists, chief among them W. S. Jevons, (see his *Theory of Political Economy*, p. xviii). Also see William Larrabee, *The Railroad Question* (Chicago: Schulte Publishing Co., 1893), particularly pp. 379 et passim; Arthur Twining Hadley, *Railroad Transportation* (New York: G.P. Putman's Sons, 1907); W.M. Acworth, *The Elements of Railway Economics* (Oxford: Clarendon Press, 1911). Professor Hadley, who was a scholar of truly catholic interests, is probably best known among economic theorists for his famous "oyster case" in which he provided an example in which all parties benefited from discrimination. See his *Railway Transportation*, pp. 116-119.

\(^6\) Walras, *Elements*, p. 443 et passim.

original contribution to the theory of price discrimination was to show that discrimination could exist in the short-run in a regime of pure competition. As he pointed out, however; under perfect competition "it is much more difficult to continue playing these artful tricks, precisely because the differences in price . . . tend constantly to be narrowed by competition." This was Walras' addition to Dupuit's theory of discrimination. As pointed out earlier, Alfred Marshall was not among the contributors to the theory of price discrimination. Marshall, like Cournot before him, ignored the subject and it did not even appear in his index.

F. Y. Edgeworth, the neo-classical theorist, built his theory of discrimination on foundations laid by Dupuit. Of all the economists familiar with Dupuit's writings, Edgeworth was his greatest champion. Edgeworth found

66 Walras, Elements, p. 442.

67 See F. Y. Edgeworth, "A Contribution to the Theory of Railway Rates," Economic Journal, XXII (1912); and "Applications of Probabilities to Economics," Economic Journal, XX (1910), and his "Dupuit" in Palgrave's Dictionary. The first two articles are reprinted in Edgeworth's Papers Relating to Political Economy (London: Macmillan and Co., 3 Vols., 1925) in Volumes I and II respectively. Edgeworth's brilliant contributions to economic analysis have, like Dupuit's, been largely ignored. As Professor Schumpeter remarked, these contributions "amount to as much as, or more than, do Marshall's Principles," History, p. 831.
Dupuit's papers "epoch-making" and proceeded to review and elaborate on his fundamental propositions regarding discrimination. Edgeworth set out the conditions and motives necessary for discrimination with great care and precision. He added, in a discussion similar to Marshall's regarding simple monopoly theory, that the discriminating monopolist may consider his "future interests" and may be imbued with "altruistic motives" in his pricing practices. In short, Edgeworth thought that the discriminating monopolist may consider a kind of "compromise benefit" in his pricing policies, a point Dupuit had made earlier. Edgeworth, unlike Walras or any other economist who felt Dupuit's influence, reached the crux of Dupuit's message regarding discrimination and the public interest. As Edgeworth said:

... the public interest which I here, after Dupuit, emphasise, is one quite distinct ... It consists in minimising through discrimination that loss ... of consumers' benefit which is apt to result from unitary price.69

It was indeed this ability to increase the absolute utility of a good by discrimination that so intrigued Dupuit, and


69 Edgeworth, "Railway Rates," p. 198.
Edgeworth was the only neo-classical writer to appreciate the point. Unfortunately Edgeworth's projected contributions to the theory of discrimination were not forthcoming, but his article on "Railway Rates" is sufficient to credit him with the only adequate appreciation in his day of Dupuit's theory of discrimination.

A. C. Pigou, who has been mentioned in regard to the debate with Taussig, made important contributions to the theory of discrimination, although his relationship to Dupuit is uncertain. Pigou brilliantly analyzed three "degrees" of discrimination and discussed the relative desirability of pure competition, simple monopoly and discriminating monopoly using as his criteria the effects of each on output and on welfare measured in terms of marginal social product, a concept invented by Pigou. He also discussed, in some detail, the effects of increasing and decreasing supply schedules on discriminatory price and output. There can be small doubt that Pigou's tightly reasoned argument was an important breakthrough in this area and it was to Pigou's contribution that

70The body of his contribution in this area is contained in his Wealth and Welfare (London: Macmillan and Co., 1912), especially chapters XII and XIII, and in his Economics of Welfare, chapters XVII and XVIII.
Mrs. Robinson looked in building the most elegant theoretical analysis of discrimination to date. But, although Dupuit's name is nowhere mentioned in his writings, Pigou built on stones placed by Dupuit. The filiations between discrimination and economic welfare were, after all, Dupuit's main concern, and it is the analysis of these relationships which fill Pigou's pages.

An Evaluation of Dupuit's Contribution

Dupuit was the earliest and, for many decades, the most thorough contributor to the theory of price discrimination, although he was presaged by Cournot with the discussion of simple monopoly theory. Moreover, Dupuit was unquestionably the mentor of Alfred Marshall on the issue of the relationship between consumers' surplus and monopoly profits, a relationship which Cournot was ill-equipped to analyze. Dupuit's analysis of the method and purpose of product differentiation was also a contribution of the first order. But it is possible to place this phase of his work in an even better light.

Cournot is widely regarded as the precursor of modern theorists concerned with imperfect competition.

71 Robinson, Economics of Imperfect Competition, p. 186n and 187n.
Dupuit, it seems to this writer, is at least as deserving of such an evaluation. It is well known that Cournot's duopoly example involved a hypothetical mineral spring, a curiosity. Although Professors Edgeworth and Bertrand tinkered with Cournot's analysis and in the process exposed the unrealistic assumption of a "conjunctural variation" of zero, the theory of imperfect competition during the long period from Cournot to Chamberlin and Robinson is thought to have remained largely one of duopoly, a special case at best. Dupuit's writings could have been read profitably in this regard. His examples of monopolistic discrimination of such activities as book publishing, theater tickets, not to mention railroads, canals and all manner of public works, are filled with the suggestion that monopoly elements were present in industries which could certainly not be described as pure monopolies or even duopolies. Dupuit was adamant in his statement that monopoly control of some degree was necessary for such discrimination, but he always hastened to modify his results when competitive elements arose. In discussing the interindustry competition for example, between railroads and road transport he said, "whatever the merchandise, the railway cannot charge on it a fee much in
excess of the price of road transport, unless speed itself be of the essence . . ."72 Such statements, together with the whole of Dupuit's writings, show that he was well aware that the market forms of perfect competition on the one hand and pure monopoly, on the other, did not adequately describe real world structures. In keeping with this awareness, he modified his conclusions whenever necessary. His writings, although not couched in mathematical concisness, seem to be at least as suggestive of intermediate structures as were Cournot's.

Dupuit's insistence that price discrimination is the general case where monopolistic elements are present is, in this writer's opinion, an important point and one with a modern ring. Although it would be naive to assert that Dupuit was on the brink of contributing to the theory of price discrimination and connected problems in multi-product firms, his dogged persistence that discrimination is not in the least a "special case" is an approach which could have been followed up by later economists with great advantage. It is only in recent times that economists have attempted to add to the realism of the theory of the firm by discussing the existence of price

discrimination in multiple product firms. One economist concerned with the problem has pointed out that it is "impossible to find in the whole of our economy a single firm that sells a single product at a single price." Dupuit's insistence that price discrimination be practiced due to excess capacity, as long as marginal costs are covered, exactly parallels Professor Clemens' dictum that "what the firm has to sell is not a product, or even a line of products, but rather its capacity to produce." Dupuit's whole analysis contains the flavor of such an approach.

Dupuit's theory of discrimination, moreover, was woven into the fabric of neo-classical analysis, especially by Walras and Edgeworth, and, as such, it is part of received economic theory. Although the trappings of utility analysis, with which Dupuit encased his theory of


74Clemens in Readings, p. 263. Professor Clemens' conclusion that "price discrimination and multiple-product production are not exceptions to general practice, but are rather the essence of customary action," p. 276 could well be Dupuit's words.
discrimination, have fallen into disfavor, the superstructure remains. That tool of economic analysis by which economists study the phenomenon of multiple prices for the same commodity was Dupuit's invention. Additionally, his statement of the theory of price discrimination was more than an adventitious act. He analyzed problems with his tool and indicated possible solutions. The tool takes on new significance as contemporary economists, such as Clemens, begin to take a closer look at firm's pricing policies. Discriminatory pricing may well be as ubiquitous as Dupuit thought.

In short, it is this writer's opinion that Dupuit's early analysis of the facets of price discrimination was a stellar contribution to the economists "tool-kit." His discussion does not require utility analysis for support or validity; it can stand alone as an explanation of economic behavior. Indeed, in the light of the hostility heaped on utility doctrine, the analysis of price discrimination may well be Dupuit's most important and durable contribution to economic theory.
CHAPTER V

DUPUIT'S MARGINAL COST PRICING ARGUMENT: APPLICATIONS OF ECONOMIC THEORY TO PUBLIC POLICY

Introduction

The theoretical market model of perfect competition, free from governmental restraint, implies, among other things, several important long-run conclusions respecting price, costs of production and, more generally, welfare. If freedom of entry is allowed in the model, price will equal minimum production costs, a condition which successfully eliminates all "unnecessary" or "economic" profit. Moreover, and most importantly for welfare, price also equals marginal cost. If short-run marginal cost, (or the addition to total cost incurred by producing an additional unit of the good), represents the value of the sacrifice necessary to obtain additional units of the good in question in terms of "alternatives foregone," and price represents the money measure of "satisfaction" derived from the good, then it must follow that an efficient allocation of resources (and economic welfare)
demands their equality. This benevolent equality, as economic theory asserts, does not necessarily obtain in imperfectly competitive market structures, to the end that resources are usually misallocated. An obvious recommendation would be to advocate policies to bring about such "marginal cost pricing" for each separately produced good in all industries, as Harold Hotelling did in the 1930's. But since marginal cost is independent of the volume of fixed cost and is actually the rate of change in variable cost, losses may result. This depends in general on the slopes and positions of the demand and cost functions. Given that losses attend such a pricing scheme in decreasing cost industries, some means of reimbursement, itself designed to leave marginal conditions unaffected, must be devised to cover total costs. This, as has been pointed out, is no mean task, and the problem of financing such losses has constituted a serious difficulty in recent marginal cost pricing proposals.

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1Harold Hotelling, "The General Welfare in Relation to Problems of Taxation and of Railway and Utility Rates," (1938). Hotelling's article was probably the most important contribution to marginal cost pricing in the period.

Moreover, the practical difficulties of simply defining marginal cost in any given situation, not to mention the problems of multi-product production, have discouraged theorists. Should long-run or short-run costs be used for such pricing schemes? As it will develop, the validity of Dupuit's statements suggesting marginal cost pricing may hinge on the concept one considers as controlling; but the following discussion of Dupuit will evaluate his proposals in terms of short-run analysis, unless otherwise indicated.

The implications for economic welfare which inheres in such a pricing scheme have, nonetheless, been considered important by generations of economists. Alfred Marshall used an essentially similar concept to justify, on welfare grounds, the subsidization of decreasing cost industries and the taxation of increasing cost industries.\(^3\) The resurgence of interest in such a pricing technique as applied to transportation and public utilities in the pre-War and immediate post-War period\(^4\) is evidence of the strength of such an idea. At present the French are experimenting with marginal cost techniques in the


\(^4\)Hotelling, "The General Welfare."
provision of electric power. Economists concerned with public utilities eagerly await their findings. But the origin of the theoretical principle is of capital interest to this investigation. Jules Dupuit was the proclaimed mentor of the marginal cost theorist Hotelling, whose presentation was regarded, by at least one economist, as the best modern statement of the principle.

Thus, Dupuit's alleged statement of the principle of marginal cost pricing in his famous bridge case (and other examples) will be dealt with in this chapter, along with his attitude towards taxation. Additionally, the overall relationships between his various pricing tools for public policy will be examined. It will be shown that Dupuit did not have only one all-efficacious tool to prescribe for the enlargement of "public utility." In order to fully understand Dupuit's marginal cost argument, it will be necessary to discuss the demand curve and "utilite perdue" in some detail.


6See Ruggles, p. 110. Hotelling's original assessment of Dupuit's achievement, however, was possibly not a wholly accurate one; see infra, Chapter V. pp. 209-210.
The Demand Curve and Utilite Perdue

It is well, at this point, to briefly review Dupuit's notion of the demand curve and to elaborate on a conclusion Dupuit drew from it. The character of this demand curve, as it will be shown, has important welfare implications regarding the levy of a tax. In a passage on the law of consumption, Dupuit wrote:

One of these laws is that consumption expands when price falls; another, that the increase in consumption due to a fall will be greater, the lower the initial price. If a fall in the price of an article from 100 to 95 francs brings in another thousand consumers a further fall from 95 to 90 will bring in more than a thousand. This property reflects the structure of society which, if it is divided into groups according to income, and these groups are placed one on top of the other starting with the poorest, has a shape similar to one of those pyramids of cannon-balls which are to be seen in parks of artillery... Thus, as the price of an article falls, its use spreads to more and more consumers, quite apart from the fact that existing consumers purchase it in greater quantities, as we have seen. All this is a fact of experience which has been verified statistically too often to need labouring here.\(^7\)

The exact nature of the demand curve, that quantity expands absolutely as price declines, is thus given by Dupuit. Granting that the word tariff or toll can be

\(^7\)Dupuit, "On the Measurement," (1844), p. 103.
substituted for the word tax, and remembering also that the total area under the demand curve, for Dupuit, was an expression of the total absolute utility of the good, the effects of a tax (tariff, toll or price) can be measure. With the aid of the following Figure 5-1, Dupuit's analysis can be synthesized.

FIGURE 5-1
THE EFFECTS OF A TAX ON UTILITE PERDUE

The construction can be gleaned from Dupuit's argument, although the axes have been reversed (i.e., contrary to Dupuit's manner) for the sake of convention. The demand

8Hotelling thought the theory of taxation to be extensively analogous to the theory of public utility and transport rates. He said that although "two independent bodies of economic literature have grown up . . ., the underlying unity is such that the considerations applicable to taxation are very nearly identical with those involved in proper rate making." "The General Welfare," pp. 242-243.
curve PZ is of the nature of Dupuit's "law of consumption," and for simplicity it is drawn as a linear function. A constant marginal cost curve AA', which is closest to Dupuit's intentions, and in any case makes no difference as to conclusions, is assumed. To further simplify the analysis, it is assumed that there are no fixed costs, and therefore that for quantity ON, total variable costs equals total costs equals DARN. In other words, there is no "producers' surplus." The total net benefit to society is the sum of consumers' and producers' surplus and, assuming marginal cost curve AA', is geometrically equal to the curvilinear triangle PAR, which is identical with consumers' surplus. Dupuit proposed that a per unit tax be levied on the commodity, which in Figure 5-1, would cause a parallel shift upward of marginal costs to BB'. The effect of this per-unit tax is in contrast to the effect of a "lump-sum" tax, which would not change the position of the marginal cost curve.

The total net benefit of the commodity to society, after the increase in the marginal cost curve, is PR'B, consumers' surplus, plus the yield of the tax, ABR'Y to the

9See bridge example (infra., p. 187) and cost assumptions of Chapter IV.
government, or the total area PR'YA. The tax receipts are included in net benefit on the premise that government expenditures out of these revenues will be utility producing. The effect of the tax in the amount AB has been twofold: (1) to reduce consumers' surplus from PAR to PBR', which can be regarded as a shift in the distribution of utility or benefit, and (2) to reduce total utility from amount PAR to PAYR'. The amount of "utilite perdue," or utility lost to society, is then equal to the triangle R'YR, the "dead-loss" to society. It is this loss which bothered Dupuit, and led him to measure it and to discuss its important implications.

The Measure of Utilite Perdue

Dupuit, without the aid of geometrical presentation, presented an arithmetic estimate of this "utilite perdue."

As he said:

\[... it is possible to lay down the principle that the utility lost or gained through a change in price has for its upper limit the amount by which the quantity consumer changes, multiplied by half the change in price. If a tax of 5 francs reduces the number of consumers from 30,000 to 10,000, the utility lost is below 20,000 \times \frac{1}{2} \times 5 = 50,000 \text{ francs}. \]

Further it is easily seen that the smaller the tax the nearer does this limit approach the actual figure.\(^{10}\)

\(^{10}\)Dupuit, "On the Measurement," p. 104.
Increasing and equal increments of tax would cause consumption to decrease. Thus "utilite perdue," due to the imposition of a tax, increases absolutely as, in Figure 5-1, quantity is reduced. The measure of this lost utility is given by Dupuit as the reduction in quantity multiplied by one-half the amount of the tax. Geometrically, with regard to Figure 5-1, it is the expression \( \frac{1}{2}(YR \times YR') \), or roughly the area \( R'YR \), as indicated earlier. Dupuit was even more specific. He also pointed out that "where a tax is small relative to the cost of manufacture . . . it is legitimate to suppose a uniform rate of decrease in quantity consumed."\(^{11}\) Granting this, as Dupuit correctly suggested:

\[ \ldots \text{the utility lost as a result of a tax of 1 franc is this unknown number \( \frac{1}{2} \) of the amount by which consumption decreased \( \frac{1}{2} \) of 1; the utility lost through a tax of 2 francs will be twice this number \( \frac{1}{2} \) the same decrement in quantity as the first \( \frac{1}{2} \) of 2; for 3 francs, \( \frac{1}{2} \) of 3.} \]

loss of 100 times more utility than a tax of 1 franc.12

12Dupuit, "On the Measurement," p. 104. Dupuit offered no "proof" for this theorem, and although Hotelling mentions Dupuit's conclusion ("General Welfare," p. 246), he does not prove it for the single market case. The author of this dissertation is indebted to Professor William J. Stober for suggesting the following proof of "Dupuit's theorem." Consider the linear demand function of Figure 5-12-1 reproduced below. Dupuit's theorem is that the loss in utility (ΔU_m) is proportional to the square of the tax or price (P_m^2). Or, algebraically,

$$ΔU_m = αP_m^2$$

where α is a constant factor of proportionality. Since the price increments in Figure 5-12-1 are equal by construction, we have P_m = mP_1. Since quantity is a linear function of price, (equal increments of price produce equal decrements in quantity with an inverse function), AQ_m = mAQ_1

The area of the triangle which represents "utilite perdue" is equal to one-half the base times the height, or,

$$ΔU_m = \frac{1}{2}AQ_mP_m$$

$$= \frac{1}{2}mAQ_1mP_1$$

$$= \frac{AQ_1m^2P_1}{2}$$

$$= \frac{AQ_1m^2P_2}{2P_1}$$

or

$$ΔU_m = \frac{(AQ_1)}{2P_1}P_m^2$$

Where $$\frac{(AQ_1)}{2P_1} = α$$, we have $$ΔU_m = αP_m^2$$.

This result holds for any linear demand curve; and, with a curvilinear demand function, Dupuit's result would obtain for small tax or price changes.
It is clear then, that if demand curve segment R'R in Figure 5-1 can be considered a straight line, the decrement in utility caused by imposing taxes between OA and OB will be proportionate to the square of the tax. When the demand curve can be approximated by a straight line, Dupuit's result will also be approximated.

Welfare Implications of Utilite Perdue

Dupuit's analysis of "lost utility" is central to his entire system for increasing public utility. Clearly, marginal cost pricing as a welfare tool finds its roots here. An increase in total utility can be achieved, following this portion of Dupuit's analysis, by pricing goods, where monopoly power exists, at marginal costs. A price (rate or tariff) above marginal cost of production has an effect on the utility of goods to society which is totally analogous to the imposition of a tax. Dupuit, in this sense, was not so much interested in the distribution of utility between producer and consumer, as he was in increasing the net benefit (producers' and consumers' surplus), or alternatively, as he was in reducing "utilite perdue."

It is worthwhile to pause, at this point, to note that there is an inevitable loss of utility to society
when a price is charged for a good. The portion under the demand curve, RNZ, in Figure 5-1 represents this unavoidable loss, a loss stemming from the fact that resources are not in limitless supply. This loss cannot be side-stepped short of giving the good away. It is due to the very existence of an economic problem. Additionally, the area RNZ will exist quite without reference to the slope and position of the marginal cost curve.

The monopolist (using the term in its broadest possible sense), by charging a price above marginal cost, is causing double damage. In the first place, he expropriates a larger share of net benefit and, most importantly in Dupuit's view, he causes the total utility available to society to decline. Figure 5-2 is a more modern-flavored graph depicting the demand (PZ) and marginal revenue curve of the monopolist, together with a rising marginal cost curve (AA') and average cost curve (C). The momentary departure from Dupuit's presentation will be rewarding in clarifying the spirit of his views on this important issue.

The marginal cost pricing position at R (in Figure 5-2) will yield, depending on the slopes of the demand and marginal cost curve, a given distribution of net
benefit. In this example producers' surplus is represented by the area ABR, the difference between total receipts, OBRN, and the area under the marginal cost curve, OBRN, and the area under the marginal cost curve, OARN. Consumers' surplus is equal to BPR. Evidently, marginal cost pricing does not mean that consumers' surplus will be equal to net benefit; rather, it means that total net benefit, or the curvilinear triangle APR will be maximized. The monopolist, however, would have to be truly altruistic to engage in marginal cost pricing. In Figure 5-2, such "altruism" would be tolerable since there are "economic" profits at price OB (quantity ON). In other words, producers' surplus is greater than fixed
costs. This condition notwithstanding, the crucial point is that net benefit or utility remaining to society is at a maximum.

Unfortunately this analysis does not correspond with prevailing notions (and Dupuit's notion) on the behavior of monopolists, who, under the assumptions of formal economic theory, are profit maximizers. The profit maximizing price $p$ and quantity $q$ are relevant in this situation. The amount of net benefit, however, is lower than under marginal cost pricing by an amount $X'R'R$. This is the loss to society, and portions of both consumers' surplus ($Y'R'R$) and producers' surplus ($YXR$) have been rendered extinct. Profit maximizing producers' surplus ($AXR'F$) is greater than it was under marginal cost pricing and consumers' surplus has declined (to $PFR'$).

But the important thing as Dupuit pointed out, is not that the monopolist takes a larger share of net benefit, but that the price above marginal cost causes total net

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13 One can imagine a situation, the intersection of the demand curve with falling marginal and average cost curves, for example, in which the monopolist's altruism would be put to the test. He would have to be willing, in such a case, to cover losses. The issue of the best manner in which to cover these losses, in the case of government ownership or regulation, has been a central one in discussions of marginal cost pricing.
benefit to be smaller than it would be under marginal cost pricing. The monopolist increases his surplus by appropriating FBR'Y of consumers' surplus. Distribution, here, is not the thing. The maximization of total net benefit eclipses this latter issue. It is the "utilite perdue" which is the drag on society. As Dupuit said: "this loss of utility due to a price which is not payment for labour expended plays in political economy the part which friction plays in mechanics."\(^1\) The engineering analogy was a good one. Just as friction impedes motion, "lost utility," due to the inequality of price and marginal cost, prevents society from obtaining maximum net benefit. The graphite, in this latter case, could be marginal cost pricing.

Dupuit and Marginal Cost Pricing

Several proposals could follow from Dupuit's desire to reduce or eliminate "utilite perdue." One such possibility would involve the advocacy of \textit{ubiquitous} marginal cost pricing. But obtrusive difficulties would arise immediately, especially where firms are operating on a

\(^{1}\text{Dupuit, "On the Measurement," p. 105.}\)
decreasing segment of their average cost curves, as is often alleged for rail transport firms and for certain public utilities. The losses attending such a practice would have to be covered by subsidization, and taxes would have to be devised so as not to cause lost utility in other parts of the system. Moreover, the theoretical argument surrounding "utilite perdue" could have allowed Dupuit to adjudge excise taxes inferior to other forms of taxation. In short, many different proposals could follow from such reasoning.

Some crucial questions about Dupuit's formulation remain unanswered. Was Dupuit's an explicit statement of the principle? To what extent did he wish to invoke the marginal cost principle in practical policy? How did he propose to finance attenuating losses? Exactly what was Dupuit's theory of costs, and how developed was it? Under what circumstances would Dupuit depart from marginal cost pricing as a guide to policy? These questions have not been investigated by economists concerned with Dupuit. Dupuit did not provide a systematic analysis of these questions, unfortunately, and relevant

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15 This is actually the problem which Hotelling faced.
textual statements must be sifted from all of his various writings. Nonetheless, the following analysis will attempt to "uncover" Dupuit's statements on issues apropos to the theory and application of marginal cost pricing.

The Case of the Bridge

It is of the moment, in discussing Dupuit's marginal cost argument, to note the ambiguity involved in referring to "the" bridge example. There are no less than six bridge examples in the writings of Dupuit, some of them not illustrating what has come to be known as marginal cost pricing. But it seems possible that a marginal cost argument was his intent in at least several of these passages. His best discussion of the operation of the principle appeared in an arithmetic example in the 1849 article "On Tolls and Transport Charges." In the example,

16 This is an excellent example of the necessity of looking at the total of his work. One article will simply not do.

17 See, for example, "On Tolls and Transport Charges," p. 15. Although Dupuit did point out that "bridge tolls lend themselves less well to the kind of varied combinations [price discrimination] which is possible with other transport charges," p. 15. The difficulty with discriminatory pricing on a bridge is the difficulty of grouping users according to some distinguishable mark.
Dupuit considered the case of several bridges under monopoly control. Apparently Dupuit was assuming that the bridges were privately owned, or were given an exclusive right to operate from the government. If the latter was the case, he envisioned a non-regulatory situation because the bridge owners were free to charge any toll rate they desired.

Again, as in other examples, Dupuit was cognizant of the variability of the law of consumption from place to place. In other words, he knew that demand conditions were different due to differences in income, the prices of other goods and due to the portmanteau statement of the "thousand other circumstances."

The downward sloping nature of the demand curve was re-affirmed by Dupuit in his bridge examples. Moreover, the demand curve (as in the case of monopoly and price-discrimination) was a welfare tool. Never, in all of his writings, did Dupuit change his opinion on the ability of the demand measure to represent a utility measurement. There is no evidence that he wished to modify his original statements on the measurement of utility. Thus,
Dupuit analyzed the effect of tolls on the utility of three different bridges, each with a different "curve of consumption." His "Bridge C" is reproduced below as Table 5-1.18

The demand curve for bridge C, as can be verified by columns 2 and 3, conforms to Dupuit's theory of demand. Column 8, representing "consumers' surplus, it should be noted, was not included by Dupuit, but it is calculated here for convenience. The section "Utility," which is segmented into three columns, shows the marginal rate of lost utility caused by rate increases, along with a column of total utility lost by a given rate, as well as a column for the total utility yielded by a given toll. This latter column (column 6) is net benefit, (actually gross benefit, since, as yet there are no costs of production), that is, the sum of consumers' and producers' surplus (revenue). Column 7 Dupuit called "the yield of the toll," and is, in more modern terminology, total revenue receipts. It should be observed that Dupuit did not include a provision for costs at the outset. The information of Table 5-1 is solely in the province of demand.

**TABLE 5-1**

**DUPUIT'S BRIDGE C**

<table>
<thead>
<tr>
<th>Toll Rate</th>
<th>Number of Crossings</th>
<th>Reduction of crossings due to rate inc.</th>
<th>Utility lost by rate increase</th>
<th>Utility lost by toll</th>
<th>Yield of toll</th>
<th>Consumers' Surpluses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>445</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>425</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>63</td>
<td>17</td>
<td>34</td>
<td>54</td>
<td>391</td>
<td>126</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>13</td>
<td>39</td>
<td>93</td>
<td>352</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>41</td>
<td>9</td>
<td>36</td>
<td>129</td>
<td>316</td>
<td>164</td>
</tr>
<tr>
<td>5</td>
<td>33</td>
<td>8</td>
<td>40</td>
<td>169</td>
<td>276</td>
<td>165a</td>
</tr>
<tr>
<td>6</td>
<td>26</td>
<td>7</td>
<td>42</td>
<td>211</td>
<td>234</td>
<td>156</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
<td>6</td>
<td>42</td>
<td>253</td>
<td>192</td>
<td>140</td>
</tr>
<tr>
<td>8</td>
<td>14</td>
<td>6</td>
<td>48</td>
<td>301</td>
<td>144</td>
<td>112</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>5</td>
<td>45</td>
<td>346</td>
<td>99</td>
<td>81</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>3</td>
<td>30</td>
<td>376</td>
<td>69</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>3</td>
<td>33</td>
<td>409</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
<td>3</td>
<td>36</td>
<td>445</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Totals** 100 445

*a* Maximum yield.
The utility produced, evidently, is divided between the monopolist and his consumers. In order to determine consumers' surplus produced by any rate, total receipts must be subtracted from the "total utility produced" corresponding to that rate. It is apparent that consumers' surplus varies inversely with the toll. Producers' surplus or total receipts (in the absence of costs) increase up to the rate 5 and diminish thereafter. Dupuit, referring to this example, noted that "the distribution of utility is very different . . . " with different rates.19 Again, however, the effect of rates (prices) on the total utility produced (absolute utility) concerned him.

Dupuit made it clear that the total utility of the bridge would depend on where ownership resided. "If the road or bridge or canal is private property, the owner company has only one aim, and that is to get the largest possible income from the toll," as Dupuit pointed out. With Bridge C in Table 5-1, the income (profit) maximizing rate would be 5, producing a total utility of 276 and a "utilite perdue" of 169. The total utility produced of

276 would be partitioned into 111 of consumers' surplus and 165 of producers' surplus.

In discussing the alternative to the private ownership of Bridge C, Dupuit invoked a "marginal cost" argument. In Dupuit's own words:

If . . . the bridge is public property, the government will want to recover from the toll merely a fixed sum representing interest on the capital spent for construction, maintenance cost and perhaps amortization. Suppose, for example, that bridge C cost 150,000 francs to build and that the relative figures shown in the table for crossings are one-hundredth of the real traffic figures; the government will rest content with toll rate 1, because the proceeds of 8000 are enough to cover interest at 4 per cent and leave over 2000 francs for upkeep and amortization. The company would charge 5, the government only 1 . . . Surely, the extra 8500 francs to be paid by the consumers /under private monopoly/ are reason enough to declare for public operation, yet this is a secondary consideration in the light of a comparison of the utility of the bridge in the two cases.20

This last statement crystallizes Dupuit's opinion on distribution. He would not be so opposed to tariffs if they had no other effect than to change the distribution of utility. But tariffs (or taxes or prices) did positive harm if they diminished the total utility which commodities were capable of producing above costs which were necessary to recoup.

20 Dupuit, "On Tolls and Transport Charges," p. 11.
But it is not yet clear where marginal cost pricing emerges from these statements. With reference to the last quotation, a rather liberal interpretation of Dupuit's statement concerning costs would be required. Dupuit there indicated that the government would require a fixed sum which included interest on the original investment, maintenance cost and "perhaps" amortization. Can these costs be interpreted as "variable or marginal" somehow, and if they are to be so considered, did Dupuit believe them to be of constant, increasing or decreasing character? If they are not marginal costs, then how can Dupuit be credited as the originator of marginal cost pricing? This, then, is a problem which deserves close consideration.

**The Issue of Costs**

A clear analysis of costs was one of Dupuit's most serious weaknesses. Interest and amortization, as in the above example, cannot be easily construed as short-run marginal costs with respect to the number of travelers who cross the bridge. Maintenance costs have perhaps a better claim. In an example of the Parisian Pont des Arts bridge, which followed closely on the heels of Dupuit's "theoretical" bridges, he indicated that when
a private company could double the number of crossings by cutting its rate in half, and at the same time, "... still earn enough extra to cover the slight increase in maintenance expenses and the costs of collection," that it should do so. This would suggest that maintenance expense is indeed marginal with respect to quantity. But the statement, taken by itself, is not especially convincing, particularly in view of Dupuit's prior insistence that the government recover a "fixed sum" from the bridge users. Dupuit seems to have intended for this fixed sum to be independent of quantity, a situation not particularly evocative of an incremental cost, either constant or changing with quantity. Rather this implies a cost with no relation whatsoever to quantity.  

Other references in his writings shed some light on this important issue. In his 1844 article, Dupuit made several interesting statements concerning costs of production. Dupuit presented his utility argument in yet an earlier bridge example, concluding, that with a high enough tariff, it was possible to render the bridge useless. He then queried whether this means "that there

22Excluding, for the moment, his treatment of costs under price discrimination.
should only be very low tolls or even that there should be none at all?"  

He answered the rhetorical question in the negative and cited the need to study tariffs "... according to rational principles, in order to produce the greatest possible utility and at the same time a revenue sufficient to cover the cost of upkeep and interest on capital."  

If Dupuit were using a short-run marginal cost argument, his answer to the question would have possibly been 'yes.' The short-run marginal costs of traversing the bridge would certainly be negligible, and quite possibly zero.

Another statement in the same article is a bit more telling in that it involves the pricing of goods other than bridges. Dupuit generalized the "bridge concept" in the following statement:

Loss of utility resulting from a rise in price is not peculiar to tolls and taxes; it applies to the very price, representing costs of production, which could be considered as a kind of tax upon natural resources. This calculation of lost utility... is one which we have already performed above for the case of a bridge which it cost nothing to cross. Instead of a charge for crossing a bridge we can consider the price of some object or other and arrive at exactly the same result. This loss of utility due to a price which is not a payment

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for labour expended plays in political economy the part which friction plays in mechanics.\textsuperscript{25}

(Emphasis supplied)

Here Dupuit departed from a discussion of the bridge, and in doing so, gave a better statement of his intent on the matter of costs. Whether "labour expended" is to be considered a "marginal" cost or not, it is certainly a variable expense. Thus, Dupuit's intent becomes clearer. He looked upon the monopolist's price above "labour expended" as the primary cause of "utilite perdue." Any price, then, above "marginal" or "variable" expense (Dupuit unfortunately does not add "per-unit") is detrimental to society's total utility or welfare. If this is not a lucid statement of the short-run marginal cost principle, it is, at least, strongly evocative of it.

Another part of the above quotation leaves Dupuit's views on the bridge case uncertain. He indicated that the bridge cost "nothing to cross," implying, at least, that marginal costs were zero. Yet in two statements, just encountered, he advocated the charge of a toll to cover the "fixed expenses" of maintenance and interest on capital expended. It must be noted that these amortization and interest expenses are indeed marginal costs if Dupuit

was considering a long-run market period. But an incongruity emerges if Dupuit's was a short-run concept. At least a partial explanation for this seeming incongruity between short-run marginal cost pricing and Dupuit's recommendation that certain fixed costs be recouped, even by the government, can be offered.

In an earlier discussion, Dupuit quoted a statement by an engineer, M. Navier, who wrote an article appearing in the *Annales* of 1832 (1st half year). Navier was concerned with measuring the "utility" of public works, but, as Dupuit pointed out, he was under the spell of Say's dictum that costs of production equaled price and also equaled the measure of utility. This point was of course criticized by Dupuit, but in the quotation Navier made a separate point. He indicated that in order for government "... operation not to be a burden on the taxpayer, the annual economy effected by the transport must be at least equal to the interest on the capital expended together with the costs of maintenance."²⁶ Navier consequently thought that the public provision should at least bear interest and maintenance expense so as not to burden the taxpayer. Dupuit apparently

accepted this argument, for he took the proposal as his own. The expenditures are not marginal in the strict sense, but they are in the realm of current or operating costs. Thus Dupuit concluded that these "fixed" expenses must be covered by a publicly provided good. Again, while not using the concept of marginal cost, Dupuit's ideas would strongly suggest a "marginal cost argument."

The above analysis, it must be pointed out, does not apply if Dupuit's concept was one of long-run marginal cost. The "fixed costs" would be marginal if Dupuit were discussing the building of the bridge. His argument could then be interpreted as a long-run marginal cost approach. This does not seem, however, to have been Dupuit's intent since, in discussing Bridge C, he analyzed governmental ownership of the bridge as an alternative to private ownership after the bridge was built. His other examples appear to have been of similar character. From this it seems proper to conclude that

27 The statement of marginal costs relating to a half-filled goods train or one leaving at a fixed hour (as discussed in Chapter IV of this dissertation) is conclusive proof that Dupuit understood the principle. But, as will be remembered, he was not speaking of a single price policy there, but of a policy of price discrimination.
Dupuit's was probably not a long-run conception, and that his discussion is more properly juxtaposed against the principles of short-run marginal cost pricing. But it must be remembered that if reason could be found to impute to Dupuit a long-run market conception, his analysis would be an explicit statement of long-run marginal cost pricing.

The Issue of Taxation

Dupuit's statements on the necessity of recouping losses due to such a pricing arrangement (recovery of "fixed costs") may add weight to the claim that he was the first economist to explicitly state the short-run marginal cost theory, although an alternative interpretation of his "theory of taxation," to be considered later, does not support this position. Such taxation would be necessary with industries of decreasing costs, although there is no evidence that Dupuit thought that the cost functions of any or all public projects were of this character. But it would be totally unnecessary, in this context, to discuss the subsidization of industries or public projects to redress losses if Dupuit did not have some form of pricing below full costs in view. Dupuit may have known that some projects recouping only his "fixed" expenses or costs on "labour expended" would require such subsidization.
A relevant passage is the following:

A tariff reduction does, in fact, involve a far greater risk of loss for a private company than for the government. . . . The decrease in total receipts for the company . . . is a real loss with nothing to compensate for it, but for the government it is only a fiscal loss. The money which escapes the fisc stays in the pockets of the old users, together with all the profit they have made through the rate reduction, and new users have profited in their turn; the government can, therefore, recover its loss by levying in other forms the money it lost by lowering the toll.28

Dupuit was not explicit on the nature of the "other forms," but other statements make it clear that he did not have an income or "lump sum" tax in mind. In connection with tariffs on water, for instance, he said that "the State and towns can give something freely only on the condition of making other services more highly paid . . . whatever the method of taxation to which it has recourse, the water must always be paid for."29


29Jules Dupuit, "Disadvantages of the Method of Intermittent Distribution," translated by Candace Uter and edited by R.B. Ekelund, Jr., from Bernardi collection entitled De Utilite et sa Mesure. In the Introduction to his collection of Dupuit's writings Bernardi noted that this selection is the complete "fourth chapter of the second edition of the Theoretical and Practical Treatise on the Conduction and Distribution of Waters, which appeared in 1865, edited by Dunod in Paris," and added that this "chapter reproduces textually the second chapter of the original edition which appeared in 1854 in Paris, and was edited by De Lacroix-Cornon," "Introduction by Mario de Bernardi," translated by Candace Uter and edited by R.B. Ekelund, Jr., pp. 10-11.
The condition that the State must make other services yield more revenue shows that Dupuit was thinking more in terms of excise taxes to finance losses, a position diametrically opposed to the results of Hotelling's inquiry. But Dupuit urged caution in the levy of such taxes because of their effect on "utilite perdue," as depicted in Figure 5-1. He concluded that "the enormous advantage of spreading taxes out is apparent; instead of putting a tax of 10 francs on one article, taxing 10 articles at 1 franc each may reduce the loss of utility by 90 per cent." Hence, Dupuit was unopposed to using excise taxes, "sensibly" levied, on commodities in order to raise government revenue.

Thus the failure to fully develop a cost theory may have led Dupuit to advocate a violation of the "marginal conditions" in some areas of the economy in order to finance rates below full costs of production in other areas. Had

29 (continued) Both of these translations are available only in the library of Louisiana State University. Page references are to the translations.


31 Dupuit, "On the Measurement," p. 104. The utility lost by the first increment of tax on a commodity is less due to the fact that the first units of the good given up possess little utility. In other words, the marginal utility of these first units given up is low.

32 If other forms of taxation were unavailable, Dupuit's argument concerning the spreading of taxes would represent a "second-best" solution.
Dupuit developed an adequate marginal theory of costs, he would have possibly been able to posit the advantages of a lump sum tax over commodity excises with respect to utility lost. Theoretically the true lump sum tax leaves the marginal cost curve unaffected and, therefore, does not affect "utilite perdue" (in the short-run at least). Dupuit's obscurity in this important area of costs is lamentable since it leaves many questions unanswered. An analysis of the welfare effects of various types of taxes, which may have emerged with a full-blown cost theory, would have been a fitting complement to his formidable contributions to the theory of demand.

There is yet another interpretation of Dupuit's attitude towards taxation which must be considered. It is that Dupuit was entirely opposed to the use of general taxation to finance losses in specific public projects. This view can be supported by numerous textual references to his writings, such as in the piece on water distribution, in the railroad rate example, and in his article,

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33Commodity excise taxes on goods absolutely fixed in supply would also have no effect on marginal costs of production. See Hotelling, "General Welfare," p. 257.
34Dupuit, "Disadvantages of the Method."
35Supra, Chapter IV, pp. 159-160.
"Ways of Communication" which appeared in the Dictionnaire. 36

Dupuit made it clear, in the case of water distribution, that water should not be made free and that differential subscription should be designed so as to exactly cover full costs. 37 In the case of railroad rates, considered in Chapter IV of this dissertation, the conclusion was identical. In his "Ways of Communication," Dupuit defended government operation of the railroads, pointing out that, as far as possible, the direct beneficiaries should be made to pay for the services received. 38 In these and other cases, Dupuit expressed a marked distaste for general taxation to finance specific projects. It could be concluded, therefore, that Dupuit was of similar mind in the case of the bridge. The quotation presented above to the effect that the government should recover in other forms the


38Dupuit, "Ways of Communication," pp. 6-7 et passim.
revenue it lost by "lowering the toll" itself could be taken to mean that the profit maximizing revenue would "escape the fisc" and that the government should price to cover full costs. This interpretation of Dupuit's attitude towards taxation would necessitate the conclusion that he could not be termed an advocate of marginal cost pricing in decreasing cost industries, for in this case, full costs would not be covered. Dupuit could still have advocated marginal cost pricing in increasing cost industries along with his refusal to finance losses out of taxation, since total costs would be covered (and economic profits might even exist). This reluctance to tax which led to the conclusion that projects bear full costs may then be closest to Dupuit's real intent in the bridge example.

Some Conclusions

Dupuit can rightly be regarded as a most important precursor of marginal cost theorists, although, in this area, as in the theory of price discrimination, the starring role is given by Dupuit to utility and demand. But this does not mean that a total and utter lack of appreciation for the role of cost extrudes from his discussion. Although he desired to cover certain elements of costs (interest and maintenance) in the case of bridges
in order that an undue burden on the taxpayer could be avoided, he clearly knew that marginal costs were zero. Moreover, there are some statements, for example the "labour expended" quotation, which convey the flavor of a true marginal cost argument. There is, however, no rigorous treatment of marginal costs in his writings, although Professor Stigler may have gone too far in boldly stating that Dupuit "did not devise a coherent theory of costs."\(^{39}\) As has been shown in Chapter IV of this dissertation, Dupuit made accurate statements on the nature of monopoly price maximization. Although he reasoned in terms of "net revenue" instead of the marginal cost - marginal revenue conditions, his approach was essentially correct. He also distinguished between fixed cost and "traction" costs, the latter of which could be viewed as marginal.\(^{40}\) In this context, it will be remembered, he treated "traction" costs as constant, possibly for simplicity. This, together with the fact that, in regard to "marginal cost arguments" he made no

\(^{39}\) Stigler, "The Development of Utility Theory," in Essays, p. 81. See Appendix III of this dissertation for a comment on Stigler's evaluation of Dupuit.

\(^{40}\) Supra, Chapter IV, pp. 129-130, et passim.
assumptions concerning the direction of "marginal costs," leads to the conclusion that a constant marginal cost, as depicted in Figure 5-1, was probably closest to Dupuit's intent. But whether one regards Dupuit's conception of costs as "interest and maintenance" expense or traction costs, variable or marginal, constant, increasing or decreasing, the apparatus for the analysis of the welfare effects of marginal cost pricing was stated in his work with force. The theoretical background for an analysis of public utility pricing, the welfare effects of taxes, and the adverse welfare effects in monopoly pricing, must be credited to him.

But, it must be added, unless Dupuit's was a long-run market period, it is difficult to ascribe to him a clear statement of the marginal cost principles. Additionally, if one chooses to adhere to the argument that Dupuit disallowed taxation to finance specific projects, any statement of the marginal cost pricing principle to be found in his writings, regardless of the market period

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41Again one can only speculate on the benefits Dupuit could have derived from a close reading of Cournot, who presented a formulation of marginal costs. Dupuit's somewhat loose statements in regard to costs are but additional proof for the allegation that their paths never crossed.
chosen, would apply only to increasing cost industries. And this is a limitation which ordinarily would not be imposed on the tool.

The conclusion must be drawn, then, that Dupuit was an important anticipator of the doctrine, providing as he did the welfare backdrop for an explicit formulation of the principle. In addition, as the following section will show, Dupuit was the inspiration of important marginal cost theorists. But an explicit statement of the short-run marginal cost pricing principle is not to be found in his writings.

The Development of Welfare Theory, Marginal Cost Pricing and Dupuit's Contribution—A Brief Discussion

Dupuit's tacit use of the demand curve as a utility measure has, as one might guess, been a most serious weakness in his "formulation" of marginal cost pricing. In short, all of the criticisms relating to the use of the demand curve to measure utility and consumers' surplus, as outlined in Chapter III, apply with equal force to this argument. But before this weakness made the theory of cardinal utility moribund, Marshall had occasion to use the frame of Dupuit's analysis to justify the subsidization
of decreasing cost industries and the taxation of increasing cost industries.42 This argument, radical in its implications, gave rise to a celebrated controversy over whether "boxes," containing information as to the nature of costs in specific industries, would be "empty" or not.43 The arguments over whether one could identify increasing, decreasing or constant cost industries in fact, though interesting, are not of concern here. The interesting point is that the polemics, at this juncture, were not particularly directed against Marshall's utility measurement, which was part and parcel of the subsidization solution.

But, by 1938, due in part to the Hicks-Allen rehabilitation of value theory, the wicked chimera of cardinal utility measurement had been cast from positive economics. Harold Hotelling, in that year, attempted to refurbish an argument he attributed to Dupuit. The argument concerned

42Marshall, Principles, Chapter XIII, Book V.

the welfare effects of marginal cost pricing, but in non-cardinal dress. Hotelling originally overstated the role that Dupuit assigned to marginal cost pricing, if Dupuit's concept is to be considered that. He maintained that Dupuit's argument was "that the optimum of the general welfare corresponds to the sale of everything at marginal cost." If this were true, it would be difficult to explain Dupuit's strong emphasis on price discrimination. Burnham P. Beckwith in his *Marginal-Cost Price-Output Control* has shed some light on this issue.

Beckwith points out:

... that the attribution of this theory to Dupuit has little basis. Dupuit was a pioneer in the use of marginal analysis and consumers' surplus, but no one except Hotelling has ever attributed the theory of marginal-cost control to him, and in a June, 1949, letter to the author he qualified his attribution as follows: 'Dupuit mentions ... the idea of a zero toll for which I argued in my 1938 paper. However, he fails to endorse it explicitly as he carried along at this point the common idea that maintenance costs and interest should be paid out of tolls. Thus, the writers to whom you allude are correct in so far as they imply that Dupuit does this.'

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47 Beckwith, p. 83.
This writer is in substantial agreement with Hotelling's qualification. But, while it is true that Dupuit eschewed a "pure" statement of short-run marginal cost pricing in favor of recovering "fixed expenses," Hotelling did fail to mention Dupuit's justification, which was the avoidance of an undue burden on the taxpayer. In short, while not providing an explicit formulation of marginal cost theory, Dupuit's writings are but a short step away, and he must be given credit for having suggested the principle in the frame of his analysis. Actually, there is no evidence that Hotelling does not acknowledge this, and on his point that Dupuit did not explicitly endorse sales at marginal cost, there can be no argument.

Hotelling thus began with Dupuit's argument (or rather with his interpretation of it), and generalized the analysis using an ordinal preference function, and sought to apply it. He thought the argument to be particularly applicable to certain public utilities, such as "electric power plants, waterworks, railroads, and other industries in which fixed costs are large."48 Hotelling analyzed Dupuit's "utilite perdue," utilizing, however, an upward sloping marginal cost curve which, as has been shown, was

not particularly in the spirit of Dupuit's whole presentation. Moving from the "classic" argument to the one based only on the necessity of ordinal calculation, Hotelling mathematically arrived at several important conclusions: (1) that the general welfare function would be maximized by the institution of ubiquitous marginal cost pricing; (2) that losses attending marginal cost pricing in decreasing cost industries could be made up by certain "lump-sum" taxes, such as on "income, inheritances, and the site value of land;" (3) that, given a fixed amount of revenue desired by government, the decrease in welfare corresponding to obtaining this fixed amount by an excise or sales tax would be greater than the loss due to obtaining this revenue by an income tax. Although Hotelling thought that his argument had special applicability to

\[^{49}\text{Hotelling, p. 242. Hotelling also advocated taxes on other goods "whose quantity is nearly or quite unresponsive to changes in price, and which is not available in such quantities as to satisfy all demands," p. 257. Hotelling's examples along these lines were holiday travel which caused overcrowding in railroad passenger cars. Here, in a manner quite analogous to Dupuit }^{supra}\text{, Chapter IV, pp. 128-129}^{supra}\text{, Hotelling argued for the increase in fares due to the increase in marginal cost. Another interesting example which he provided is a tax on advertising, due to the unlimited demands it forced on the limited "attention supply" of people.}\]
public utilities and transportation, his analysis was
generalized to all industries and services. In brief,
Hotelling thought that if all industries, those of
increasing and decreasing costs, engaged in marginal cost
pricing, net social benefit or welfare could be improved.
Losses were to be financed by his menu of lump-sum taxes.
R. H. Montgomery, in several articles, presented a similar
argument respecting public utilities and the railroads,
in the end recommending government ownership as the most
viable alternative. Montgomery's arguments possessed
none of the rigor and precision of Hotelling's, however,
and it was Hotelling's treatment which elicited the "first-
rate" criticism.

Ragnar Frisch, writing on the "Dupuit Taxation
Theorem," was one of the earliest critics of Hotelling's
position. His two most important observations were:
(1) that price did not have to be equal to marginal cost,

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50 R. H. Montgomery, "Government Ownership and Oper-
atation of the Railroads," Annals of the American Academy
of Political and Social Science (January, 1939). Also see
his "Government Ownership and Operation of the Electric
Industry," in the same issue.

51 Ragnar Frisch, "The Dupuit Taxation Theorem,"
Econometrica, VII (1939); also see Hotelling's rejoinder,
"The Relation of Prices to Marginal Costs in an Optimum
System," and Frisch's reply, "A Further Note on the Dupuit
Taxation Theorem" all in the same issue.
but could be proportional to it with the same result, and; (2) that in any move from one welfare situation to another, where there are both losers and gainers involved, an illegitimate interpersonal comparison is made. Hotelling in his rejoinder agreed with the first criticism and ignored the second on interpersonal comparisons. Although the situation where prices are proportional to marginal costs would eliminate the need for subsidies in decreasing cost industries, it has been found to be theoretically unacceptable.

E. W. Clemens proposed something close to perfect discrimination as an alternative to marginal cost pricing, but with the "block rates" necessary to implement such a proposal, price would not equal marginal costs for some units to all consumers, and the marginal conditions would consequently be violated. It should be noted that output, under such a scheme, would be carried to the point where price - marginal cost in the last market. The great advantage would be that revenues would cover costs

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52 Frisch, "Dupuit Taxation Theorem," p. 145.
53 Frisch, "Dupuit Taxation Theorem," p. 150.
54 Both Hotelling and Frisch were proved wrong on this point by Samuelson in the Foundations, especially pp. 241-243.
and the necessity for interpersonal comparisons would be avoided (Frisch's second criticism). But in the final analysis this is not really marginal cost pricing as it is more commonly accepted.

One of the most important qualifications of Hotelling's proposal is the one surrounding the nature of the "lump sum" income tax. Professor Meade pointed out that the income tax may not be a true "lump sum" tax since a tax on income disturbs the marginal rate of substitution between income (work) and leisure, and is therefore unacceptable as a means for providing revenue in Hotelling's system.

In general, then, Hotelling's presentation, derived from Dupuit's earlier approach, possessed two serious flaws. In the transference of satisfaction from lump-sum tax payers to consumers of the products of decreasing cost industries, an interpersonal utility comparison is, of necessity, involved. In order to say that the change results in a net increase in welfare, one must assume either that the distribution of income is a matter of

56 As noted in Chapter IV of this dissertation, Clemens has renewed his proposal for such discrimination in the multi-product firm.

indifference, or that the resultant change in distribution involves a net gain in satisfaction. For the latter to be the case, either a knowledge of the aggregate welfare function must be assumed, or the gainers must compensate the losers. As Nancy Ruggles, paraphrasing Samuelson, has said:

... The economist cannot say that the change should be made and the compensation paid; he can only say that the change could be made and the compensation could be paid with an increase in welfare. He cannot say that it is better to pay the compensation than not to; he simply cannot say anything at all about the case in which compensation is not paid.58

Thus compensation must be paid in order to say that a change has increased welfare.

Further, in order for distribution to be a matter of indifference, income distribution must either be eliminated from the concern of the economist, as in the manner of Dupuit, or the marginal utility of income must be assumed constant for the economy as a whole. Interestingly, then, this latter assumption may be as important in the "new" welfare economics, as it was in the "old" welfare theory of Dupuit.

The second serious difficulty in marginal cost pricing, a la Hotelling, is the issue of the tax. An income tax

58 Ruggles, "Recent Developments," p. 120.
must be, in effect, a tax on work. This point takes on additional importance in the event that adequate revenues cannot be obtained from true "lump-sum" taxes. One path out of the dilemma would be to place excise taxes (in addition to the income tax) on goods related to leisure, for example, on golf-clubs, sport rifles, etc. But adequately defining the goods would be a problem, since leisure means many things, some of them not involving goods. Additionally, defining an "optimal" levy would be practically impossible.\footnote{It is obviously impossible to cover all of the relevant issues involved in marginal cost pricing in the space of a few pages. The question of what concept of marginal cost, long or short-run, should be used, together with the important issue of investment criteria under marginal cost pricing, for example, have not been touched upon. For a resolution of the former issue see Clemens, "Price Discrimination in Decreasing Cost Industries," and for a discussion on investment criteria see William Vickery, "Some Objections to Marginal Cost Pricing," \textit{Journal of Political Economy}, 56 (1948), and also his "Some Implications of Marginal Cost Pricing for Public Utilities," \textit{American Economic Review}, 45 (May, 1955). Rather, the foregoing has attempted to point out the two major theoretical objections to such a pricing tool. Two of the most comprehensive treatments of the proposal are Ruggles, "Recent Developments," and Samuelson, \textit{Foundations}, Chapter VIII, "Welfare Economics." The first, a bit dated, is non-mathematical; the second is largely so.} A larger problem emerges from these brief considerations. Unless society's welfare function can be determined
and defined, statements about the "optimal" distribution are meaningless. And the problems involved in defining an aggregate welfare function are of Herculean proportions, as contemporary welfare discussions attest. Kenneth Arrow has shown that the political voting process may be an inadequate criterion on which to define such a function. Bergson and Gunnar Myrdal have urged that an explicit value judgement be made on the part of the economist, researcher or perhaps the legislature. But is this not exactly what Dupuit was doing? By his own admission, the distribution of income did not matter and from this he at least pointed the way to the conclusion that if public utilities would price at "marginal costs," and the loss was reimbursed by the public at large through taxation, a net increase in utility could be realized. Why is this not sound practice in the absence of information regarding the welfare effects of distribution and the

60Kenneth J. Arrow, Social Choice and Individual Values.

61Abram Bergson, "A Reformulation of Certain Aspects of Welfare Economics."

social welfare function. Economists would be fossilized if they were forced to wait for such information in order to make recommendations for public policy. Dupuit's solution, although it rests on the theoretically unacceptable cardinal utility measurement, is the solution of contemporary economists in effect.63 To paraphrase Bernard Shaw, "if economists cannot have what they want, they had well better settle for what they can get," adding of course, "until something better is available."

Marginal cost pricing in public utilities still has relevance for the proper allocation of resources and for the public welfare. Dupuit was, without doubt, the precursor of this pricing tool, which has been developed

63 Consider along this line the marginal cost experiments in the Electricite de France, a nationalized industry. If Nelson is correct, this practical side of Dupuit's proposal "has never died in France," Marginal Cost Pricing in Practice, p. viii. Nelson's view is that the French have retained the emphasis which Dupuit originally put on practical applications, allowing "the relationship of pricing to consumers' surplus or the allocation of resources" to assume a supporting role, p. viii. This latter issue, according to Nelson, is controlling in English-speaking countries. But Nelson misinterprets Dupuit's position. Although Dupuit was concerned to a great degree with "practical applications," the welfare argument (consumers' surplus) was a major ingredient in the overall proposal. Indeed, what does marginal cost pricing mean if no reference is made to welfare or the allocation of resources?
and refined over the decades. If value judgements are necessary in the absence of better data, then it is best to make them. Otherwise economics becomes barren in its most important role, which is the implementation of public policy, always with a view towards the maximization of society's well-being.

**Dupuit's Application of Economic Theory To Public Policy**

Some evaluation of Dupuit's overall "system" can now be made. It should be clear that Dupuit cannot be regarded as an advocate of any one single pricing tool. The point which Dupuit made so clear, that there was a marked difference between the pricing principles of the governmentally owned or operated industry and the "private propertied" firm, was missed by Hotelling. Dupuit made no such case for marginal cost pricing in every industry, or, if an explicit formulation of such pricing is required, in any industry. As was earlier indicated, he felt that competition, more or less, guided resources in the private economy, realizing the salutary effects of such competition on public welfare. He did not even advocate his version of "marginal cost pricing" as an exclusive tool in
public utilities. Rather, Dupuit's eclectic contention was that the tool used should best fit the problem. Dupuit saw that price discrimination, as well as other pricing systems, could make important contributions to "public utility."

Perfect price discrimination would apparently eliminate "utilite perdue." As Dupuit said regarding railroad rates, "the foremost principle is to ask the passenger to pay . . . a sum . . . just below the price which would make him give up his journey, provided that this does not involve the company in a loss."64 He obviously did not believe perfect discrimination to be workable, however, and all of his examples involve two and three-class tariffs. But Dupuit thought that price discrimination in the railroad industry would have the same beneficent effect on welfare as "marginal cost pricing." The statement can be interpreted as recommending price discrimination as long as marginal costs are covered. Output would be carried to the point where price equaled marginal cost, although the marginal conditions would not obtain in some markets. It is notable that distribution of utility would

be affected in favor of the producer, but the distribution of welfare was not of great concern to Dupuit. He was interested only that someone appropriate the "utilite perdue." In the case of a privately owned railroad company, profits would be maximized by such a scheme. In the case of a nationalized railroad, Dupuit recommended discrimination sufficient to cover total costs (both traction and fixed costs). In proposing that total net benefit be maximized under the constraint that total costs are covered, Dupuit exhibited a distaste for having to seek out other sources of revenue. In this, it should be noted, he also avoided the need for interpersonal comparisons regarding the tax-subsidy, for no subsidy is necessary. Dupuit would thus advocate, in regard to the railroads, a scaling down of rates, which would provide revenue just sufficient to cover total costs.

Another public utility in which Dupuit used essentially the same tool was in water distribution. In an analysis of water distribution, he applied the same reasoning as he had to governmentally owned or operated railroads. After

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65 *Supra*, Chapter IV, pp. 159-160 *et passim*. Also see Dupuit, "Ways of Communication" in which Dupuit pressed for government ownership of the railroads, p. 19 *et passim*. 
categorically rejecting a single price policy for water distributed in cities, he showed how the consumption of water could be increased with discriminatory pricing. He concluded that "water . . . must be sold by differential subscription, at a price proportional to the utility which the subscriber takes from it." Again the condition that "interest and maintenance costs" be covered is obtrusively present. Roads and canals received the same treatment. Actually, then, Dupuit's rational system of price discrimination was his most important application to policy. The elimination of "utilite perdue" is, again, the most important point.

The "marginal cost pricing proposal" entered Dupuit's analysis due to the difficulties of instituting discrimination on bridges. Although Dupuit acknowledged that price discrimination may be possible in the "worker's frock" case, he noted that universal dishonesty limited

66 Dupuit, "Disadvantages of the Method of Intermittent Distribution," p. 11.

67 Dupuit, "Disadvantages," p. 14. Dupuit added that "the study of the tariff of water sale is, we think, an altogether local study; a tariff successful in one town would not succeed in another," p. 13. Once again Dupuit, the practitioner, acknowledged the variability of the law of consumption from place to place.

its use. Thus he turned to a "marginal cost argument."

It must be noted that he only applied the single price policy specifically to bridges, and then only where price discrimination was not a viable alternative. But his generalization regarding industries where price is greater than "labour expended" could be interpreted to mean that he wished the "marginal cost principle" to be applied in other areas. No statement can be found in Dupuit's writings, however, to the effect that specific industries should be forced to price at marginal cost, whether governmentally owned or regulated. In fact, no explicit statement of the principle can be found in his writings.

Dupuit, judging from statements made in his treatise on Commercial Freedom and in his other writings, had faith in the welfare effects of competition. Increased absolute utility under conditions of discriminating private monopoly, to Dupuit, would reduce "utilite perdue" and would therefore be desirable. In all those industries where competition prevailed, "utilite perdue" would tend to be minimized. The whole issue of "utilite perdue" would be pointless, however, in a world of pure competition.

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69 Supra, Chapter I, p. 15.
That is the reason why Dupuit's theories necessarily involve imperfect competition.

Dupuit's prescriptions for public policy, therefore, are several. In the vast domain of private property, competition should prevail for the maximum enlargement of welfare. As indicated in Chapter I, Dupuit was a vigorous proponent of anti-monopoly legislation, a policy prescription which is obtrusively compatible with his views on welfare. In this he goes beyond Adam Smith, who noted such tendencies, but stood firmly on the laissez-faire tenet of limited government. But Dupuit's logic is paradoxical in that he would prefer the discriminating monopolist, i.e., one who would maximize discriminatory profits, to the single price monopolist. It was the middle ground between pure competition and monopoly discrimination that Dupuit would not like. In this huge area, "utilite perdue" could be reduced by using price discrimination, where possible, or, as another possible alternative, "marginal cost pricing." But Dupuit was truly a 19th century liberal in this regard, and he never suggested the regulation or nationalization of industries.

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70 Supra, Chapter I, p. 17.

71 Smith, Wealth of Nations, p. 128.
other than those regarded as "public utilities." Public utility pricing was a different matter. Here the full range of his welfare pricing techniques would be in order. His examples all attest to this belief.

Public policy in the area of utilities, then, should aim at increased welfare through the "rational" design of a pricing system. It could be maintained that on a theoretical plane, Dupuit failed to develop an "optimum" system of prices, possibly due to a failure to develop a full-blown theory of costs. One may also allege that his advocacy of various pricing tools was a mark of inconsistency. But on the policy level, Dupuit sagely incorporated the "possible" with his theoretical constructions.

Ruggles' conclusions regarding pricing tools could well have been Dupuit's. As she said:

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\text{... the search for a panacea, for a single simple rule by which to guide all conduct, is, because of ... problems ... a vain search and even a foolish one. A set of tools is available with which to accomplish a complicated job. A better job can be done if each tool is used where it is appropriate, instead of throwing away all but one and expecting it to serve all purposes.}^{72}
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Dupuit's writings reflected this eclecticism with respect to policy. He applied not only one tool, but a boxfull instead.

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\(^{72}\)Ruggles, "Recent Development," p. 126.
Dupuit as an Economic Theorist

Dupuit, as this dissertation has shown, made important and original contributions to economic theory. His development of theoretical tools was, however, less organized (though no less scientific), than, for example, Cournot's compact statements. This difference in approach reflects, to some degree, Dupuit's attitude on the methodology of economics. He believed that economics was a science with a body of principles that should be accepted by all.\footnote{Jules Dupuit, "Is Political Economy a Science or is it a Study?" \textit{Journal des Economistes}, 2nd Ser., XXXVII (1863).}

Unfortunately, thought Dupuit, economists argued far too much over basic precepts, and this had two results: (1) to cause the public to distrust economics as a science,\footnote{Dupuit, "Is Political Economy a Science or is it a Study?" particularly pp. 238-239 and 247.} and; (2) to shift attention from the necessary and fertile field of application.
Dupuit's economic theory was bound up with applications. He drew demand and utility curves, to be sure, but it was not for mere logical exercise. There was always a potential application close at hand, and, more often, the theoretical tool was interwoven with an example. This does not mean that Dupuit was not rigorous. His training as an engineer served him well in economics and his discussions were not without theoretical sophistication. Dupuit's distinctive method of approaching economic problems yielded some tools of great theoretical interest.

The first important statement of the subjective theory of value was made by Dupuit. The statement did not consist in merely showing that satisfaction or utility diminished with quantity. Dupuit went on to elaborate on the doctrine and to show that a complete theory of value must consider utility, as well as costs. The fusion of the demand curve with the marginal utility curve was also performed by Dupuit. This identification, as pointed out in Chapter II,

3 The effect of a tax on "utilite perdue" is a good example of Dupuit's mathematical sophistication. Supra, Chapter V, n. 12.

4 Supra, Chapter II, pp. 29-30.

5 Supra, Chapter IV, pp. 129-13Q.

6 Infra, Appendix II.
was strictly a legitimate procedure only in the case of an assumption of a constant marginal utility of money. Nonetheless, the concept of consumers' surplus emerged in Dupuit's writings from the identification of demand and utility curves. The statement that consumers' surplus (or as Dupuit termed it "utility remaining to consumers") is the difference between the amount that individuals would be willing to pay for a quantity of a commodity and the amount that they must pay for it is Dupuit's. The greatest problem is that the use of the demand curve to measure such a surplus requires some quite restrictive assumptions. The marginal utility of money must be assumed constant for Dupuit's money measure of consumers' surplus under the demand curve to be a valid one (plus a host of other assumptions). Alfred Marshall, who drew inspiration from Dupuit on this issue, encountered similar problems in attempting to enlist a money measure, and the doctrine finally fell into disrepute. Attempts have been made to rehabilitate Dupuit's (and Marshall's) concept of a surplus, notably by J. R. Hicks, and it has been turned into a "compensating" or "equivalent" amount of money income. The actual definition of the surplus is Dupuit's, but his
demand curve measure has been adjudged faulty.\(^7\)

The concept of consumers' surplus played a starring role in several important interpretations of the pricing behavior of firms. The theory of profit maximization under monopoly, although developed earlier by Cournot, was stated (probably independently) by Dupuit. Dupuit reasoned in terms of net revenue, i.e., total receipts less total costs, rather than in terms of the marginal costs - marginal revenue apparatus. Dupuit's approach to monopoly theory was valid, however, although the use of marginal analysis is preferred by most contemporary economists.\(^8\) A distinctive part of Dupuit's contribution was an analysis of the effects of monopoly on the size and distribution of welfare. In this part of his discussion, however, Dupuit's account hinges on the validity of the demand curve as a measure of welfare. But it is interesting to note that Marshall's doctrines of "net benefit" and "compromise benefit" bear striking resemblance to Dupuit's earlier statements on monopoly and welfare.

\(^7\)Dupuit's measure has been found to be acceptable where compensation is not actually paid, or where the Hicksian criteria are inapplicable. Supra, Chapter III, p. 122.

\(^8\)The use of marginal revenue analysis has attained currency only since Joan Robinson revived the concept in her Economics of Imperfect Competition (1933).
A discussion of price discrimination was possibly one of Dupuit's most important theoretical achievements. As late as 1910 Edgeworth found Dupuit to be "... the earliest, and still, I think, the highest authority on the theory of discrimination." Dupuit showed that two prices for one and the same commodity could exist with differences in "buyer estimates," with the ability to segment the market and with some degree of monopoly power. High fixed costs together with the desire to maximize profits provided the motives for such discrimination. Dupuit admirably analyzed the effects of such discrimination on quantity and revenue, but his attention was ultimately focused on the welfare effects of discrimination. The distribution of welfare (or "absolute" utility) was of less concern to him than the size of the "benefit," which the practice of price discrimination could increase. Once again the welfare argument required the identity of utility and demand curves for validity. But the discussion of profit maximizing pricing behavior and the conditions required for price discrimination do not require the utility argument for support. Dupuit's contribution in this area would not

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Marginal cost pricing as a welfare tool finds its origins in Dupuit's writings. Although it is true that the theory is not given explicit treatment, Dupuit did mention the possibility of using such a tool, and, by way of examples, exhibited some understanding of the concept. While Dupuit's statements must be stretched to find an explicit formulation of the principle, his analysis, as is, is sufficient to credit him as the precursor of the marginal cost argument. The welfare basis for marginal cost pricing is certainly present, and this was the point which Hotelling extracted from Dupuit.

All of Dupuit's theoretical contributions are juxtaposed on a matrix of welfare economics. Public utility or "the general welfare" was Dupuit's prime concern. He considered not only individual welfare, but the conglomerate of society's welfare. This is shown clearly by Dupuit's major emphasis on consumers' surplus. As such he was the first modern welfare theorist. The conception of an aggregate welfare function is implicit in Dupuit's writings, and, although welfare theory is often treated as the

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10 It should be noted that both Cournot and Marshall neglected price discrimination in their writings on economic theory.
"adopted child" by economists, it is notable that Dupuit's contribution was the beginning of an entire branch of economic theory. Nor were these beginnings meager in scope. Dupuit knew that the welfare economist must concern himself with the effects of monopoly, taxation and pricing techniques on utility; and he set out to provide a frame adequate to the tasks at hand. And, although Dupuit was unaware of many of the problems associated with modern welfare theory, his contribution was amazing in its time. Additionally, he anticipated some of the problems, such as interpersonal comparisons and the distribution of income, facing welfare theorists today.

For the economist who rejects welfare economics out of hand, there are still important theoretical tools to be found in Dupuit. The definition of consumers' surplus and the analysis of profit maximization under pure monopoly are "objective" contributions. The most important theoretical contribution to "positive" economics, however, is Dupuit's enlightening discussion of price discrimination. He discussed not only the mechanics of discrimination, but the motives, possibilities and problems associated with it as well. This discussion represented the best nineteenth century formulation of the tool.
Dupuit's contributions to economic theory were not without flaws. He was infatuated with the analysis of demand, almost to the exclusion of the cost side of value theory. He was, of course, aware of the necessary participation of costs in value theory, but he gave no clear and consistent theoretical presentation of a cost theory. One must ferret the cost theory from his works, and the results are by no means clear-cut. But it should be remembered that Dupuit was a pioneer in utility and demand theory, and that, as a pioneer in this area, his natural tendency was to neglect the study of concepts which he was initially obliged to attack. There is, retrospectively, some benefit in having given the leading role to demand at this time, for, to achieve the necessary balance in value theory, the "pendulum" had to swing far from costs of production. These considerations do not exonerate Dupuit with regard to his neglect of costs, however.

Dupuit's theoretical performance, when all is considered, was one of genuine importance and originality. The attempt to build a welfare concept from value theory was without parallel in Dupuit's time. The development of purely microeconomic tools, such as those of price discrimination, monopoly, and marginal cost pricing, were part of
this larger plan; and the theories of marginal utility and consumers' surplus were basic ingredients in the approach. A more sophisticated contemporary economic theory uses some of the tools forged by Dupuit; and, although the results are much better, the questions Dupuit raised and the problems he encountered are much the same.

**Dupuit and Economic Policy**

Dupuit was not a theorist for theory's sake, although he thought that economics was a science and that economic theory was of paramount importance in the development of the science. The protracted battle over the subjective theory of value, in which his theoretical successors found so much pleasure, would have probably been looked upon by Dupuit as a waste of valuable effort and time.\(^\text{11}\) His tack

\(^{11}\)Not that Dupuit was above this sort of intellectual warfare himself. His seething reply to Bordas is a case in point. Although he deplored the quibbling over issues of principle (see Dupuit, "Is Political Economy a Science or is it a Study?") M. Henri Baudrillart in a dissenting reply to that article, "Observations on Mr. Dupuit's Article," *Journal des Économistes*, 2nd Ser., XXXVII (1863), pointed out that there was a gulf between Dupuit's opinions and his actual behavior. Baudrillart said that "... we ask if our honorable colleague himself, who loves discussion so much, and who has reason, for he succeeds at it, would be content /to follow his own advice../..." p. 253. Dupuit would not be moved by Baudrillart's jibe, however, and in his response entitled "Mr. Dupuit's Answer to Mr. Baudrillart
was to use the best theoretical knowledge available to
attack economic problems. Theoretical constructs for their
own sake were not for Dupuit. His firm belief in the
validity of the welfare tools he had developed led to
advocate their adoption at a policy level.\textsuperscript{12} Dupuit
eclectically favored the use of tools to fit particular
problems. The desire to maximize absolute utility (or
minimize "utilite perdue") under the constraint of covering

\textsuperscript{11}(continued) on the Subject of the Article 'Is
Political Economy a Science or is it a Study?', "\textit{Journal
des Economistes}, 2nd Ser., XXXVII (1863), Dupuit reasserted
his position that political economy was a science. He
defended "demonstrations of basic principles," and again
cited the need for fundamental agreement on them to elim­
inate some of the public hostility thrust on the science.

\textsuperscript{12}See in particular his article entitled "On Present
Transport Legislation," \textit{Journal des Economistes}, 1st Ser.,
XXIII (1849), in which he urged the legislative adoption
of "rational" principles, i.e., those tending to maximize
utility, in the establishment and operation of public
projects. In another interesting piece, Dupuit attacked
the granting of privilege by the State. In his "About the
Tax Paid to Postmasters by Owners of Public Vehicles,"
\textit{Journal des Economistes}, 1st Ser., XXVII (1851), Dupuit
attacked an ancient institution which had economic effects
on the direction and establishment of railroad traffic.
Postmasters, because of their establishment, demanded an
"indemnity" of 25 centimes on railroad travel where rail­
road routes were parallel. Dupuit noted that it was
ridiculous for the state to "preserve these relays on
routes parallel to the railroads," adding that "it should
let die those who cannot live with their receipts,"
p. 151.
some "fixed costs" of production was the basis of such recommendations for public policy. Those industries which were to be considered public should be regulated or operated according to "rational" principles. The criterion was the contribution to aggregate welfare.

The application of "rational" principles to public projects, according to Dupuit, required great study and care since the law of consumption varied from project to project and since each industry possessed distinctive peculiarities. He knew that the development of sound economic policy was no mean task and that such development was a slow process. In these matters a strain of good common sense runs through his writings. He wanted his ideas on "public utility" to be accepted, to be sure, but he foresaw resistance and the problems of application.

Dupuit deplored the outmoded laws regulating transportation in France. He attacked legislators who granted privilege or who acted on the "caprice of the moment" in the development of the French transport system.\(^{13}\) Instead he proposed a rational, objective course of action and the adoption of policies designed to maximize the utility of

projects. His boldness in the approach to policy is proof that Dupuit desired to implement his theoretical ideas and see them through to application. His tome on water distribution carried specific policy recommendations,\textsuperscript{14} as did most of his other work.

Dupuit, then, was the complete economist, beginning with the development of economic theory derived from observation, all the way to policy prescription based on his theoretical findings. In short, Dupuit did not divorce the tool-making function from the tool-using function. This is a quality not to be taken lightly in any assessment of Dupuit's achievement. His insistence that the functions of the economist should not be dichotomized, as well as the example he set in attempting to apply the tools of economic analysis to economic problems are points on which modern economists could seek inspiration. Except for purposes of exposition, then, there was no "Dupuit the theorist" or "Dupuit the implementor of policy." The two were happily combined in the writings of one man.

\textsuperscript{14}See Dupuit, "Disadvantages of the Method of Intermittent Distribution," and \textit{supra}, Chapter V, pp. 200-201.
The judgement tendered above, that Dupuit consistently and arduously combined his theoretical findings with his policy pronouncements, is not invalidated when one examines his views on pressing issues of the day. In this vein Dupuit authored several contributions (of lesser importance from a theoretical standpoint) in the *Journal des Economistes*. These contributions, although consisting primarily of polemics on Malthusianism, free trade, the nature of property, etc., deserve some consideration, especially insofar as they illuminate the nature of Dupuit's total contribution.

As noted in Chapter I, Dupuit was a Malthusian. He forcefully exhibited his beliefs on this issue in a statistical study of the cause of the fecundity of populations.\(^{15}\) The study had special relevance for France, the population of which Dupuit examined by provincial incidence. Additionally, Dupuit compared the rate of increase in the population of various countries, noting that the United States had the fastest rate of growth (4.40%);\(^{16}\) and, in the Malthusian

\(^{15}\)Jules Dupuit, "Causes Influencing the Length of the Average Life-Span of Populations," *Journal des Economistes*, 2nd Ser., XLVII (1865), pp. 5-36.

\(^{16}\)Dupuit, "Causes Influencing," Table 4, p. 22.
frame, he related population trends to the cultivation of the soil, (extensive cultivation in the U.S. case), and to the progress of technology. In the end Dupuit concluded that "... the most recent figures from official statistics confirm completely the doctrine of Malthus ..." An amusing incident will serve to illustrate the tenacity with which Dupuit held to the Malthusian theory. In his article on "Is Political Economy a Science or a Study?" Dupuit pointed out that the questioning of the population theory by the American economist Carey would lead to no good end, and, most importantly, would rightly cause the layman to question the scientific character of political economy. Dupuit was attacked for this stand by a contemporary economist, M. de Fontenay. Dupuit replied to this attack, and in his reply, still maintained that Carey's quibbling could lead only to socialism. Dupuit implied, moreover, that Carey was not as wise as the founders and masters of the science. Dupuit asked indignantly, "What does M. de Fontenay reply to this? That Mr. Carey is a dignified


18Dupuit, "Causes Influencing," p. 25.

19Jules Dupuit, "In Response to a Letter from Mr. de Fontenay, on the Malthusian Question," Journal des Economistes, 2nd Ser., XXXVII (1863), pp. 283-284.
old man, inoffensive, a perfect gentleman." In short, Dupuit implied that Fontenay had missed the point entirely, and that he ludicrously assumed that Dupuit's was a personal attack on Carey. In any case, Dupuit's mind remained unchanged on the Malthusian question.

Dupuit was an avid free-trader and his only full-length study, Commercial Freedom, was as much an anti-protectionist plea as it was a clear enunciation of the benefits of competition. He reaffirmed this view in his "Answer to Mr. Dunoyer in Regard to his Report on the Work Entitled 'Commercial Freedom,'" He also took this opportunity to reassert his belief that "the exact sciences are an excellent preparation for political economy," and that this "pure" political economy is "a science whose principles are susceptible to a rigorous demonstration."  

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20Dupuit, "In Response," p. 284.

21Fleury in his "Life and Works of Mr. Dupuit," described the volume as constituting ". . . the very advanced kernel of a veritable treatise on pure political economics, with developed application of the scientific principles to international commerce," p. 32.


23Dupuit, "Answer to Mr. Dunoyer," p. 111.
Dupuit's classical liberalism is further illustrated by his hostility to labor unions and to the activities of the government in redressing the evils of food shortages. Dupuit took the classical position that unions cannot increase wages and that through "accidental unemployment, they diminish society's products and, consequently, the part of these products which return to the workers." In his article on "Food Crises and Means Used to Remedy Them," Dupuit showed, in "classical" fashion, that the charitable instincts which motivated government during food crises merely aggravated the problem. Specifically Dupuit opposed the "ceiling price" on food because of the effect on demand and future supply. As he said, "a system of

24 Dupuit quoted in Fleury, p. 20. The quotation is from The French Economist (January 21 and February 18, 1864), pp. 20 and 50. Also see Dupuit's "Questions of Political Economy and of Public Law by Mr. G. de Molinari," Journal des Economistes, 2nd Ser., XXXVII (1863). In this article Dupuit examined Molinari's views on a number of issues, including labor unions. Molinari thought that laborers had a natural right to associate, as did employers. Dupuit dissented and found that the "... great moving force of work is the private, individual interest," p. 116. Dupuit concluded that "one may not always take the advice of this author, but one is always obliged to render homage to the purity of his doctrines, to his talent and to his sincere faith," p. 119.

maximum prices rests on the same sophism as the use of average prices, which is that it does not take account of the relation which exists between price and consumption.\(^{26}\)

After dispensing with the "charitable" policies of government, Dupuit arrived at "le grand principe: Laissez faire! laissez passer!," noting that it is only "necessary to know the most elementary principles in order to resolve the most difficult problems."\(^{27}\)

Dupuit also engaged in a debate, with Joseph Garnier (editor of the Journal des Economistes) and other members of the Society of Political Economists, on the nature of property.\(^{28}\) Dupuit's views on property explain, to a degree, the nature of Dupuit's contribution. Dupuit defended the "personal appropriation of the soil" against "communal property" on the grounds that it makes "... society infinitely more productive," and because it is the

\(^{26}\)Dupuit, "Food Crises," p. 351.

\(^{27}\)Dupuit, "Food Crises," p. 365. Again Dupuit slapped at the protectionists, who were so active in times of high grain prices.

\(^{28}\)Jules Dupuit, "About the Property Principle. The Just - The Useful," Journal des Economistes, 2nd Ser., XXIX (1861), pp. 321-347 and XXX (1861), pp. 28-55. Dupuit did not favor, of course, the unlimited right to property. In his "About the Freedom of Experiment," Journal des Economistes, 2nd Ser., XLVII (1865), for example, Dupuit espoused, against the opinion of Mr. Courcelle-Seneuil, limits to inheritance rights.
source "... of an infinite number of intellectual enjoyments which did not exist before that institution." Dupuit questioned the economic progress of society under communal property, noting that inventors, authors, etc., without patents, would have to forego individual reward; and this, Dupuit thought, would stifle initiative.

But the philosophical point of departure for Dupuit's "public utility" is found in Dupuit's amendments to the foregoing liberal ideas. Dupuit warned: "remember the necessity of the law in the measure of the public interest, that it cannot justify abuse," and that "... to ask for a radical, complete and absolute liberty is to ask for the savage state." In his conclusions on property Dupuit underscored the justification for his economic theory by saying that:

... the end of society is the well being of the members composing it. ... It /property/ only exists by virtue of certain laws or conventions.


30 Dupuit, "About the Property Principle," pp. 44-45. He also cited the socialist criticism that a liberal economic system is "materialistic;" Dupuit countered this criticism by arguing that the reason for progress under such a system was "... the great pecuniary rewards for intellectual work," p. 51.

which rule the relations of these members and the usage of certain objects and limit the freedom and the natural rights of each . . . The principle of public utility only gives the solution to all of the numerous problems on the question of property, of wealth and of many other economic questions.  

The different economic principles involved in the industries of navigation, transportation, agriculture and public security called for "... appropriation in a different manner in the public interest," and to this Dupuit added that "... the appropriation must always be made in view of the consumer." Dupuit's ideas on property, then, are not only consistent with his theoretical devices for increasing "public utility," but they represent a philosophical basis for his "system," and are interwoven into his economic theory. As he pointed out, "the exploitation of any industry by the State . . . must always be justified by exceptional circumstances, and the circumstance . . . is monopoly."  

In regard to his "polemical" writings, it is important to note that nowhere did Dupuit contradict, modify or retract his earlier theoretical presentations and

33 Dupuit, "About the Property Principle," p. 54.
pronouncements on public utility and welfare. Rather, they tend to amplify and explain his earlier theoretical beliefs. This does not mean that Dupuit was a thoroughgoing economic liberal, for he clearly envisioned a positive role for the government to play in the expansion of public utility. Dupuit's concept of the role of property in the economic system, together with his utility theory, justified the enriched governmental participation in the area of public policy. But Dupuit was no extremist in this regard, and he saw definite limits to the government's role. He viewed competition as the guiding principle across the broad face of economic activity, and there was enough of the "classical" economist in him to allow him to stubbornly refuse to question the Malthusian and wages-fund doctrines. Yet his investigation of utility theory and pricing techniques caused him to modify the "hard" line, and it is this modification, so suggestive of Marshall's, which stamps his total contribution as one of genuine originality.

Dupuit's Influence on the History of Economic Theory

These important contributions to economic theory and policy did not go entirely unnoticed by later generations of economists. Jevons, Marshall, Edgeworth, Walras
and Pantaleoni, among others, took note of his analysis. These acknowledgments referred only to specific points of Dupuit's work, however, and, with the possible exception of Edgeworth, none of these economists attempted a detailed probe into Dupuit's writings. Marshall, whose intellectual debt to Dupuit was probably greatest of the aforementioned, did little more than acknowledge Dupuit's name. Yet it was from these neo-classical sources that modern theorists were introduced to Dupuit. Almost every modern price theory text, for example, mentions Dupuit's name in reference to utility theory or consumers' surplus. George Stigler has provided a more detailed, if not wholly accurate, explanation of Dupuit's contribution to utility theory. Harold Hotelling was moved in the 1930's to credit Dupuit with the first statement of marginal cost pricing. Hotelling, as his later qualification to Beckwith and Chapter V of this dissertation implies, was possibly unaware of Dupuit's actual position on the issue. The same must be said of the modern French theorists who attribute the "pure" form of the marginal cost theory to Dupuit.

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36 Supra, Chapter V, p. 209.
The problem with all of the above evaluations is that Dupuit's contribution is seen atomistically. A particular theory is attributed to Dupuit with little attempt to justify the attribution. This procedure has fostered the neglect of Dupuit's overall performance. Nowhere, for example, is Dupuit's conception of "public utility" or welfare economics mentioned. Nowhere have his statements on the marginal cost argument, the theory of price discrimination or the theory of marginal utility been quoted and/or analyzed. Edgeworth, who otherwise exhibited more than a cursory understanding of Dupuit, presented his reader with only a few brief quotations on price discrimination from the original source. The result has been to leave uncertain the nature of the total contribution of Jules Dupuit. In consequence, contradictions and outright mis-statements have appeared in the sparse literature on his economic writings. It is hoped that this research has contributed toward setting the record aright as to the real nature of Dupuit's accomplishment.

Perhaps a larger and more important point emerges from the study of Dupuit's writings. It is that there can be positive value in the study of the origins of economic theory. Accretions to the body of economic analysis are
painfully slow, and at every stage in their development, doctrines must be re-examined and thought through again. The study of the origins and development of theory, such as that of marginal cost pricing or of price discrimination, yields new insight into the problems being faced by modern economic theorists. Not that a study of past formulations would necessarily provide solutions to vexing problems at hand. Rather it is that in studying the manner in which earlier theorists justified their theoretical constructions and conclusions one may find a potentially important line of analysis which has not been adequately pursued, or even a "deadend." In this manner contemporary economic theory may possibly be improved.

It is important, moreover, and particularly in the social sciences, to be aware of the origins of contemporary thought; for it is in these origins, either by reaction or affirmation, that contemporary thought is formed. In economic theory, as in less esoteric areas of human knowledge, the past is always with us. And, as an oft-forgotten phrase explains, the past is not dead, it is not even past. This dissertation has depicted Dupuit's "past" achievement as a contribution to economic analysis in the Schumpeterian sense, rather than as a contribution to
economic thought,\textsuperscript{37} (although Dupuit's views on free-trade, the Malthusian question, and on economic policy have been given some consideration). It is this writer's opinion that Dupuit, in his effort to understand and present a unified explanation of economic phenomena, placed himself far beyond mere "history of thought" interest; and it is this contribution to economic theory which must surely comprise a great analytic achievement. It is important to acknowledge and understand Dupuit's theoretical performance precisely because his achievement is so obviously still with us.

\textsuperscript{37}Schumpeter defined economic thought as "the sum total of all opinions and desires concerning economic subjects, especially concerning public policy bearing upon these subjects that, at any given time and place, float in the public mind," \textit{History}, p. 38.
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APPENDIX I
A BIBLIOGRAPHY OF THE ECONOMIC WRITINGS OF JULES DUPUIT


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1 This bibliography is in chronological order and it includes both books and articles.


DUPUIT'S DEMAND CURVE AND UTILITY: A NUMERICAL EXAMPLE

The following table from Dupuit's 1853 article illustrates, via a numerical example, the identity he posited between utility and demand curves.

<table>
<thead>
<tr>
<th>TOLL</th>
<th>FREQUENCY</th>
<th>RETURNS</th>
<th>UTILITY CORRESPONDING TO TARIFF</th>
<th>UTILITY LOST BECAUSE OF TARIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>0</td>
<td>445</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>80</td>
<td>80</td>
<td>425</td>
<td>20</td>
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<tr>
<td>2</td>
<td>63</td>
<td>126</td>
<td>391</td>
<td>54</td>
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<td>50</td>
<td>150</td>
<td>352</td>
<td>93</td>
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<td>164</td>
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<td>0</td>
<td>0</td>
<td>445</td>
</tr>
</tbody>
</table>

Dupuit presented a demand curve for some "way of communication," but stated that the same principles applied to all goods. There is an inverse relationship between quantity demanded ("frequentation") and the toll. The third column labeled "returns" is total receipts, and since

Dupuit abstracted from costs in the example, these returns are also profits. It is the fourth column, labeled "utility corresponding to the tariff," which clearly indicates that Dupuit identified the demand curve with a marginal utility function. Column 4 represents the total utility corresponding to any given toll, or what Dupuit called absolute utility.\(^2\) Dupuit arrived at this absolute utility by considering the effect that tolls would have on traffic.

It is perhaps best expressed in his own words:

> One could say, in effect, that the 100 consumers given by the toll zero, can be considered as drawing a utility of 1, since there are only 20 which this tariff causes to disappear, which gives 100 utility; that the remaining 80 can be considered as drawing a utility of 1 over and above, that is 80; that among these 80, 68 \(^{sic}\) draw a utility of 1 over and above the others, that is 63, etc., etc.\(^3\)

Thus the summation of "frequentation" would yield the absolute utility corresponding to a toll of zero. One could say that the marginal utility for 20 of the 100 passengers is represented by (actually just under) 1 franc. The absolute utility corresponding to a toll of 1 franc is the loss (20 X 1) subtracted from absolute utility at the

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\(^2\) *Supra*, Chapter V, pp. 190-191.

\(^3\) Dupuit, "On Utility and Its Measure," (1853), p. 43.
toll of zero, (or 425). Absolute utility corresponding to the other tolls is found in an analogous manner.

Dupuit directed the calculation of the fifth column in the following manner:

To find the lost utility caused by the tariff or the figures in the 5th column, one reasons thus: from tariff zero to tariff one the frequency descends from 100 to 80, there are then 20 consumers who are no longer satisfied and who attached a utility of one to the service rendered; from tariff one to tariff two, a loss of 17 consumers who attached a utility of 2, that is 34, which added to the preceding ones, make a total loss of 54.

This "utilite perdue" increases with the toll, and with a linear demand curve, the loss would be proportionate to the square of the tax or toll.

In the numerical example above Dupuit aggregated the marginal utility (demand) functions of individuals and obtained an "aggregate marginal utility curve." It is also the market demand curve. This identification, as pointed out in Chapter II and Chapter III of this dissertation, would be legitimate only under some quite restrictive assumptions.

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5 Supra, Chapter V, note 12.
6 Supra, Chapter II, pp. 55-56.
7 Supra, Chapter III, pp. 74-76.
APPENDIX III
A COMMENT ON STIGLER'S ASSESSMENT OF DUPUIT

George Stigler in his "Development of Utility Theory," unhesitatingly credited Dupuit with the first non-adventitious discussion of marginal utility. Additionally, he found that "the explicit formulation of the concept of consumer surplus is elegant." But Stigler was not so generous in dealing with Dupuit's cost of production theory (or lack of it). His comment was that "Dupuit could not reach a complete theory of optimum prices because he did not devise a coherent theory of cost," a criticism not without some justification. But this reason for the previous allegation is questionable. Stigler extracted a passage from the Bernardi collection of Dupuit's writings to support his view, and he prefaces the quotation with

1 Supra, Chapter II, p. 46, n. 40.
2 Stigler, "Development," p. 81.
3 Stigler, "Development," P. 81.
4 Supra, Chapter V, pp. 193-194.
5 Apparently Stigler translated the passage himself. The reference is to Bernardi, pp. 52-53. The above version of the quotation is from the International Economic Association, "On the Measurement of the Utility of Public Works." Both translations agree in meaning, however.
the remark that "this failure to devise a coherent theory of cost is illustrated by the following quotation in which price fluctuations are treated as exercises of arbitrary power." The quotation at issue is the following:

For an increase or decrease of utility to take place, there must be, provided there is no change in quality, a decrease or increase in the costs of production. When there is merely a change in the market price, the consumer gains what the producer loses, or vice versa. Thus, when an object costing 20 francs to produce, is sold at 50 francs because of a monopoly or concession, the producer exacts 30 francs' worth of utility from each purchaser. If for some reason or another he is forced to cut his price by 10 francs, his profit falls by 10 francs per article and each purchaser gains by that amount. It is a question of compensation, but no utility has been produced. There would have been an increase of utility if the drop in the market price had been due to a fall in the costs of production, because the gain to consumers would not have been offset by any loss to the producer.

It is clear that Dupuit was illustrating in the quotation the important distinction between the distribution of absolute utility (both consumers' and producers' surplus) and the manner in which absolute utility itself is increased. The statement is perfectly valid given the proper assumptions for Dupuit indicated that quantity was

6 Stigler, "Development," p. 81, n. 36.

to be considered constant. The consideration of a given quantity was legitimate since Dupuit was investigating the distribution of utility with changes in price. The argument can be expressed conveniently in diagrammatic terms, as in Figure III-1 below.

FIGURE III-1
THE DISTRIBUTION OF UTILITY WITH FIXED QUANTITY

The monopolist faces demand curve PZ and he is selling a given amount OM. His costs are constant at AA'. Exacting a price OF for OM quantity will yield the monopolist a "profit" (or producers' surplus) of AFNR. At price OF,

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8 Note that in the quotation Dupuit specified "an object." Stigler's translation used the words "an article."

9 Figure III-1 is similar to Figure 5-1, p.176.
given the constancy of the marginal utility of money, FPN represents consumers' surplus. Absolute utility, then, equals the area APNR. Dupuit's point in the quotation was to show that the price change (say to OG) would not change the amount of absolute utility afforded by quantity OM, but would change the distribution of the benefit. At the lower price OG, consumers would gain FNTG in utility, and the producer would lose exactly that amount. If costs decreased (say to BB'), however, the absolute utility of quantity OM would increase to ARBY, and the immediate effect would be an augmentation of producers' surplus or "profits."

Professor Stigler has possibly interpreted Dupuit's quotation incorrectly. Dupuit, in this case, was merely using a simple example to show the above results. How else, in a monopoly situation involving a fixed quantity, could one show a change in the distribution of utility if not by a change in price? Dupuit was discussing not price determination in this passage, but the principles behind changes in the distribution of utility. It is hardly likely that Dupuit considered price fluctuations as the result of "arbitrary power," since, in his discussion of monopoly price determination, he showed clearly that the
profit maximizing position occurred at the toll rate associated with maximum net revenues. He further pointed out, in the context, that the profit maximizing toll rate would increase with the increase in costs. These price (toll) changes were not the result of "arbitrary power," but were the stated result of the interaction of costs and demand. The example given by Dupuit in the quotation above is no more than a simple illustration, and, given Dupuit's intent, a good one.

It is correct, then, to maintain that Dupuit did not develop an elaborate and consistent theory of costs, but the reason is not that he treated price changes as exercises of "arbitrary power."

^Supra, Chapter IV, p. 128.
VITA

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Candidate: Robert B. Ekelund, Jr.

Major Field: Economics


Approved:

[Signature]
Major Professor and Chairman

[Signature]
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

December 21, 1966