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Retrospectives
The Origins of Neoclassical Microeconomics

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This feature addresses the history of economic words and ideas. The hope is to deepen the workaday dialogue of economists, while perhaps also casting new light on ongoing questions. If you have suggestions for future topics or authors, please write to Joseph Persky, c/o *Journal of Economic Perspectives*, Department of Economics (M/C 144), University of Illinois at Chicago, 601 South Morgan Street, Room 2103, Chicago, Illinois 60607-7121.

Introduction

Until recently, the standard story line in history of thought textbooks was that a triumvirate of British and Continental writers established demarcation between classical economics and neoclassical economics in the early 1870s. In this legend, neoclassical economics emerged in three more or less parallel forms: Austrian microeconomics, shaped largely by Carl Menger in 1871; Walrasian general equilibrium theory, explicated by Léon Walras in 1874; and the subjective theory of consumer behavior, advanced by William Stanley Jevons in 1871. Then, the legend continues, Alfred Marshall codified these ideas for modern economists in his *Principles of Economics*, first published in 1890.

We raise two objections to this potted history. The first is that the tools of neoclassical economics were invented earlier. Recent work has demonstrated that the tools of neoclassical analysis were widely available across Europe well before

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1870. The notion that neoclassical economics experienced a tripartite immaculate conception around 1870 cannot stand. The second objection is that the method of neoclassical economics was invented later. As it stands, the legend undervalues the key contribution of Alfred Marshall, who put an indelible stamp on neoclassical economics by defining the appropriate method of economic inquiry. When we refer to neoclassical economics today, we usually mean the collection of tools of economic knowledge available to (and invented by) Marshall, channeled and directed into uses dictated by Marshall's view of economic science. To be sure, not every contemporary neoclassical economist follows Marshall's path. Some "high-brow" theorists prefer to adopt Cournot's view of economics as rational mechanics. Others maintain that connection to the real world is unimportant in theoretical research. But the bulk of the profession walks in Marshall's footsteps. Yet as we shall see, Marshall had an eminent predecessor in method as well, in the person of Jules Dupuit.

The Proto-Neoclassicals Before 1870

The essence of neoclassical economics is far from settled in the history of economic thought. Some writers emphasize the increasingly mathematical character of economics after 1870. Others point to marginalism as the hallmark of neoclassical economics (as in Hutchison, 1953, p. 16, or the papers in a special 1972 issue of *History of Political Economy*). Others emphasize the roots of neoclassical economics in the subjectivism of utility theory (di Patti, 2001). Others stress the static analysis of efficient allocation as the distinguishing feature of neoclassical economics (Hennings, 1980).

Each of these claims has some truth. But in all of these ways, the economist's toolkit was remarkably full in the decades before 1870. Many writers of different nationalities contributed to the assemblage of microeconomic principles. For example, in Great Britain (see Table 1), William Whewell applied mathematics to Ricardian economics in 1829 and the ensuing years. He launched his economic studies on the twin beliefs that mathematics could render economics simpler, clearer and more systematic and that it could help avoid the danger of drawing false conclusions from the assumptions that had to be made. William Forster Lloyd gave a series of lectures at Oxford University between 1832 and 1837 in which he articulated a theory of value based on the principle of marginal utility. Mountifort Longfield explicated similar ideas at Trinity College, Dublin. His lectures, published in 1834, established a complete demand and supply theory, supplemented by utility analysis, and he espoused a marginal productivity theory of distribution. John Stuart Mill, who is generally regarded as a classical economist, may also be regarded as an important proto-neoclassical (Stigler, 1955).

One of the most distinctive "neoclassical" contributions of the era was made by Dionysius Lardner, an astronomer and railway engineer. His book *Railway Economy* (1850) brimmed over with suggestions regarding the "neoclassical" theory of the

Table 1
Great Britain

Name	*Profession*	*Writings*	*Contribution(s)*
William Whewell (1799–1866)	Scholar	*Mathematical Exposition of Some Doctrines of Political Economy* (1829–1831)	Developed mathematical analysis of Ricardian economics; developed fixed capital model and one dealing with input substitution between labor and machinery.
Mountifort Longfield (1802–1884)	Scholar, Jurist	*Lectures on Political Economy* (1834)	Established complete demand-supply theory supplemented by elements of utility analysis; marginal productivity theory of distribution.
W. F. Lloyd (1794–1852)	Scholar	*Lectures on Population, Value, Poor Laws and Rent* (1837)	Early statement of marginal utility theory of value.
J. S. Mill (1806–1873)	Scholar	*Principles of Political Economy* (1848)	Developed theory of noncompeting groups, joint products, alternative costs, economics of the firm, supply and demand.
Dionysius Lardner (1793–1859)	Engineer	*Railway Economy* (1850)	Analyzed railroad pricing structures; developed simple and discriminating monopoly analysis; analyzed monopoly firm in terms of total cost and total revenue, both mathematically and graphically (with an implicit demand curve).

firm, especially the pricing of transportation services, the behavior of simple and discriminating monopolies, the location of firms and the theory of profit maximization. Lardner developed a graphical model that implied a demand curve, although he did not explicitly sketch one.

These isolated and scattered contributions do not constitute a "school" in the usual sense, but they demonstrate that certain building blocks were being put into place in Great Britain not long after Adam Smith's death. Outwardly, the overlap with the "classical" school was minimal, yet in the first half of the nineteenth century, British writers were already prominently featuring certain elements of economic theory, like mathematical models and marginal analysis, that were to become part of the corpus of neoclassical economics. The process of inventing and collecting tools had begun, but the guiding force that would direct those tools to their most effective use did not materialize until later.

The subjectivist tradition in German economics began with Hufeland (1807) and was continued by practically every important German writer before Menger. Rau (1826), a leading textbook author of the first half of the nineteenth century, insisted that *all* prices be treated within the same demand-supply framework, and he drew demand and supply curves from 1841 on. Hermann (1832) eschewed marginal utility analysis, but used an opportunity-cost approach to demand, and he anticipated the input-valuation procedure later introduced by Menger. Schüz

Table 2
Germany

Name	*Profession*	*Writings*	*Contribution(s)*
Claus Kröncke (1771–1843)	Engineer	*Versuch einer Theorie des Fuhrwerks, mit Answendung auf den Strassenbau* (1802)	Early "cost-benefit" calculations of roads and canals. Benefits associated with cost and price reductions of improved transport.
G. Graf von Buquoy (1781–1851)	Engineer	*Die Theorie der Nationalwirthschaft* (1815)	Used differential calculus to choose optimum technique in agriculture; grasped decreasing returns and increasing (marginal) cost, but failed to understand the "benefits" side of the calculation.
Gottlieb Hufeland (1783–1850)	Jurist	*Neue Grundlegung der Staatswirthschafskunst, durch Prüfung und Berichtigung ihrer Hauptegriffe von Gut, Werth, Preis, Geld and Volksvermögen mit ununterbrochener Rucksicht auf die bisherigen Systeme* (1807)	Provided early subjective theory of value and elements of a productivity theory of distribution, based not merely on physical productivity but on value productivity as well, which emerged in the process of price formation.
J. H. von Thünen (1792–1870)	Agronomist	*Der isolierte Staat in Beziehung aut Landwirtschaft und Nationalökonomie* (1826–1850)	Developed theory of rent, location and resource allocation based on principle of marginal productivity, along lines of comparative statics.
K. H. Rau (1792–1870)	Scholar	*Grundsätze der Volkwirthschaftslehre* (1826; 1841)	Developed marginal productivity theory of value simultaneously with Thünen. Treated all prices in the same demand-supply framework; saw distribution as part of price theory. Drew supply and demand curves after 1840.
F. B. W. Hermann (1795–1868)	Scholar, Statistician	*Staatwirthschaftliche Untersuchungen* (1832)	Recognized, contra Ricardo, that production costs are demand dependent and used "opportunity cost" approach to demand, but without marginal utility as basis for evaluation. Anticipated later Austrian approach to output and input valuation.
C. W. C. Schüz (18??–18??)	Scholar	*Grundsätze der National-Oekonomie* (1843)	Developed theory of marginal-product pricing of factors (VMP) suggested by Hermann.

Table 2—continued

Name	*Profession*	*Writings*	*Contribution(s)*
H. H. Gossen (1810–1858)	Law clerk, Businessman	*Entwicklung der Gesetze des menschlichen Verkehrs, und der daraus fliessenden Regeln fur menschliches Handeln* (1854)*	Developed utility functions related to time, not quantity. Optimal allocation of resources made dependent on equalization of marginal utilities. Moved constrained optimization into the center of value and allocation theory.
W. G. F. Roscher (1817–1894)	Scholar	*Die Grundlagen der Nationalökonomie: Ein Hand und Lesebuch für Geschäftsmanner und Studierende* (1854)*	Proposed subjective theory of value and theory of noncompetitive pricing; wrote standard textbook for generation of German economists nurtured on Rau.
H. K. E. von Mangoldt (1824–1868)	Scholar	*Die Lehre vom Unternehmergewinn* (1855)* *Grundriss der Volkwirthschaftslehre* (1863)*	Developed partial-equilibrium, mathematical theory of prices that extended beyond Cournot; used comparative-statics to analyze multiple equilibria, as well as joint-supply and demand; derived demand curves from underlying utilities in cases of variable quantities.
K. G. A. Knies (1821–1864)	Scholar, Statistician	"Die nationalökoenomische Lehre vom Werth" (1855)	Put principle of diminishing marginal utility at core of value theory; rejected Marx's theory of value because it denied utility.
Peter Mischler (1824–1864)	Scholar	*Grundsätze der National-Oekonomie* (1857)	Menger's teacher. Used utility to measure aggregate welfare; prices to measure individual utility; anticipated Gossen on key points.
A. E. F. Schäffle (1831–1903)	Scholar	*Das gesellschaftliche System der menschlichen Wirthschaft* (1867)	Advanced subjective theory of value; emphasized purpose and causal relationship of goods typical of Menger, but did not recognize Thunen's marginalism. Menger's predecessor at University of Vienna.

Note: * denotes existence of English translation.

(1843) extended Hermann's analysis by developing the theory of factor pricing based on the value of marginal product. Roscher (1854) discussed the theory of noncompetitive pricing and advocated a subjective theory of value in his textbook, which eventually supplanted Rau's textbook. Knies (1855) put the principle of diminishing marginal utility at the core of value theory. Mangoldt (1855; 1863) elaborated the utility foundations of demand and developed a partial equilibrium, mathematical theory of prices that surpassed Cournot. Mischler (1857), Menger's teacher, defended utility as a measure of economic welfare and anticipated the equi-marginal principle of utility. Finally, Albert Schäffle (1867), Menger's prede-

cessor at the University of Vienna, emphasized subjective evaluations and causal relationships in much the same manner as Menger.

Peak performances in Germany, however, belong to Johann Thünen and Hermann Heinrich Gossen. Thünen practically invented location theory and eventually established a workable microeconomic theory in which economic decisions and economic evaluations are made at the margin in a constrained optimization model. He borrowed from the physical sciences, especially in the use of differential calculus to solve economic problems, and he stands today as the "father" of the comparative statics model.

Gossen did for the theory of consumption what Thünen did for the theory of production. He was one of the earliest writers to work out the formal theory of consumer behavior based on the principle of marginal utility. He also borrowed from the physical sciences in order to remove "the confusion in which economics finds itself today" (Gossen, 1854 [1983], pp. cxlvii–cxlviii). Gossen's utility functions relate to time rather than quantity, which puts them outside the strict neoclassical mold, but his originality in using mathematics and diagrams to explain the principles of constrained maximization was nevertheless striking. Taken together, the contributions of Thünen and Gossen provide a fairly complete neoclassical theory of optimal allocation.

In France, the econo-engineering tradition came to fruition in the works of Jules Dupuit (Ekelund and Hébert, 1999). But French contributions to "neoclassical economics" can be traced back to the eighteenth century. Condillac established the subjective theory of value as early as 1776. Isnard (1781) anticipated Walras on many essential points, including general equilibrium and the mathematics of exchange, production and equilibrium (Jaffé, 1969). Demand theory progressed at the hands of Germain Garnier (1796) and J. B. Say (1828), who developed an "income-stratified" notion of demand that Dupuit later extended and elaborated. From his classroom at the Ecole des Ponts et Chaussées in the early 1830s, Charles Minard (1850) demonstrated the richness of economic inquiry and its anchor in the concept of utility. Cournot, of course, practically invented the modern theory of the firm in 1838. In lasting tribute, Marshall (1925, p. 360) wrote: "Cournot was a gymnastic master who directed the form of my thought."

Italy produced four major economists in the eighteenth century who probed the themes of what would come to be called neoclassical economics. The father figure of Italian neoclassicism was Galiani (1751), who based value theory on utility and scarcity, established economic equilibrium as a result of interdependence between price and quantity and resolved the paradox of value before Smith even posed it. Beccaria (1751; 1771) also embraced utility as the principle of economic action, anticipated modern indifference analysis and championed the mathematical method in economic investigation. Genovesi (1765) put forth a comprehensive program of utilitarian welfare economics and derived value from demand, which he based on the concept, if not the name, of marginal utility. Verri (1760; 1771) offered a clear conception of economic equilibrium based on the "calculus of

Table 3
France

Name	*Profession*	*Writings*	*Contribution(s)*
E. B. de Condillac (1714–1780)	Philosopher, Cleric	*Le commerce et le gouvernement considérés relativement l'un à l'autre* (1776)*	Established subjective theory of value. Roscher's pet source for notions on utility.
A. N. Isnard (1749–1803)	Engineer	*Traité des richesses* (1781)	Established mathematics of exchange equilibrium, production, capital, interest, and foreign exchange; anticipated general equilibrium approach of Walras.
Germain Garnier (1754–1821)	Aristocrat	*Abrégé élémentaire des principes de l'économie politique* (1796)	Established income stratification of demand (i.e., the pyramid of wealth).
J. B. Say (1767–1832)	Industrialist, Scholar	*Traité d'économie politique politique pratique* (1803)*	Related utility to demand; Dupuit was inspired by Say's confusion to establish marginal utility theory of demand.
		Cours complet d'économie politique pratique (1828)	Pyramid of wealth; launching pad for Dupuit's theory of demand.
Charles Minard (1781–1870)	Engineer	"Notions élémentaire d'économie politique appliquée aux travaux publics" (1830–1850)	Developed cost-benefit analysis based on discounted value of time; influential teacher at Ecole National des Ponts et Chaussées.
A. A. Cournot (1801–1877)	Mathematician, Philosopher	*Recherches sur les principes mathématiques de la théorie des richesses* (1838)*	Mathematical theory of demand and supply; applied marginal analysis to the theory of the firm, under monopoly and competitive conditions; developed theory of duopoly based on quantity conjectures; based demand curves on "observation"; adopted a rational and mechanical theory of markets.
A. E. J. Dupuit (1804–1866)	Engineer	"De la mesure de l'utilité des travaux publics" (1844)*	Advanced utility-based analysis of demand; first modern cost-benefit approach to markets; calculation of net benefit under alternative market conditions and pricing structures (e.g., competition, monopoly, price discrimination); identified time period of adjustments in market model; established economics as theoretical and empirical science with a "Marshallian" methodology; analyzed impact of property rights assignments and interest groups, public-choice models; graphical treatment of price-quantity and price-quality determination.
		"De l'influence des péages sur l'utilite des voies communication" (1849)*	
		"De l'utilité et de sa mesure: "De l'utilité publics" (1853)	

Note: * denotes existence of English translation.

Table 4
Italy

Name	*Profession*	*Writings*	*Contribution(s)*
Ferdinando Galiani (1728–1787)	Scholar, Statesman	*Della Moneta* (1751)*	Established value theory based on utility and scarcity; equilibrium as a result of interdependence between price and quantity; resolved paradox of value.
C. B. Beccaria (1712–1769)	Scholar, Administrator	*Dei delitti e delle pene* (1764)* *Elementi de economia publica* (1771)*	Embraced utility as principle of economic action; discovered idea that underlies modern indifference analysis; established mathematical method in economics; influenced Bentham.
Antonio Genovesi (1712–1794)	Scholar, Cleric	*Lezioni de Commercio ossia di Economia Civile* (1765)	Comprehensive presentation of utilitarian welfare economics; derived value from demand, based on utility; linked quality to value.
Pietro Verri (1728–1797)	Scholar, Administrator	*Elementi del commercio* (1760) *Meditazioni sull' economia politica* (1771)*	Clear conception of economic equilibrium based on the "calculus of pleasure and pain"; developed a constant outlay demand curve; argued that supply and demand determine all prices, including interest.
L. M. Valeriani (1758–1828)	Scholar	*Del prezzo delle cose tutte mercantili* (1806)	Astute use of demand and supply functions.
Francesco Fuoco (1774–1841)	Scholar	*Saggi economici* (1825–1827)	Subjective theory of value; idea of "public happiness" as a state of equilibrium.
Pellegrino Rossi (1787–1848)	Scholar, Statesman	*Cours d'économie politique* (1840)	Subjective theory of value. Successor to Say at Collège de France.
Gerolamo Boccardo (1829–1904)	Scholar, Statesman	*Trattato teorico-pratico di economia politica* (1853)	Treated value as exchange ratio and market price as outcome of demand and supply; argued that reduction in price uncovers lower levels of demand (i.e., anticipated elasticity).
Francesco Ferrara (1810–1900)	Scholar, Statesman	*Lezioni di economia politica* (1856–1858)	Developed a sophisticated theory of value based on subjective factors, i.e., a psychological cost-benefit analysis of alternative choices; anticipated the "marginal revolution."

Note: * denotes existence of English translation.

Table 5
The United States

Name	*Profession*	*Writings*	*Contribution(s)*
Charles Ellet Jr. (1810–1862)	Engineer	*An Essay on the Laws of Trade in Reference to the Works of Internal Improvement in the United States* (1839)	Developed elaborate mathematical models of monopoly and price discriminating firms; invented duopoly theory in same year as Cournot; developed theory of optimal input selection and joint inputs.

pleasure and pain." He developed a constant-outlay demand curve and asserted that demand and supply determine *all* prices, including interest.

In the nineteenth century, Valeriani, Fuoco, Rossi, Boccardo and Ferrara continued this Italian tradition. Schumpeter (1954, p. 511) said of Valeriani (1806) that "he could have taught Senior and Mill how to handle supply and demand functions." Fuoco (1825–1827) advocated a subjective theory of value and advanced the idea that "public happiness" is a state of equilibrium. Rossi (1840) propounded a subjective theory of value at the Collège de France in Paris, where he succeeded Say and influenced Dupuit. Boccardo (1853) explained market price as an exchange ratio—the outcome of demand and supply—and in his arguments about the effect of lower prices on quantity demanded he anticipated the principle of elasticity that Marshall later popularized. Finally, Ferrara (1856–1858) developed a sophisticated theory of value based on psychological "cost-benefit" considerations.

U.S. writers on economics lagged behind the Europeans during the nineteenth century, with one noteworthy exception. Charles Ellet Jr. studied at the Ecole des Ponts et Chaussées in Paris—then the world's leading postgraduate institution of engineering instruction—and brought its brand of economic analysis to American shores. In the same year that Cournot burst on the economic scene, Ellet copyrighted the manuscript of his book, *An Essay on the Laws of Trade with Reference to the Works of Internal Improvement in the United States,* which was published the following year. For more than a century, economists on both sides of the Atlantic overlooked the merits of this book, a virtual incubator of "neoclassical" ideas. Its recurrent theme is that business decisions could and should be based on mathematically derived principles. Ellet forged a number of new analytical tools, including mathematical models of monopoly and price-discriminating firms, a theory of optimal input selection and joint inputs and a duopoly model that in certain respects is superior to Cournot's.

Regardless of country of origin, practically all these proto-neoclassical contributions were based on economic rationality formulated in terms of the "marginalism" of downward-sloping demand curves. True, the contributions of many of these writers are fragmented and isolated. But four writers rose above the crowd: Thünen, Gossen, Cournot and Dupuit. In these four writers the fundamental tools of neoclassical analysis—expressed verbally, graphically or mathematically—may be found in clear and original fashion by 1860.

For example, in the area of demand theory, Dupuit, Cournot and Gossen established a downward-sloping demand curve based on economic rationality and costs and benefits. Dupuit and Gossen used marginal utility as the behavioral basis for benefits. Dupuit further investigated the principles of consumers' surplus and welfare evaluations under alternative market structures.

These writers firmly established the importance of maximizing subject to constraints. Gossen found equilibrium for individuals subject to an expenditure constraint where the marginal benefits were equal. Thunen discussed selection of inputs based upon marginal productivity, while Gossen looked at choice of labor inputs based on productivity. Cournot and Dupuit discussed the concept of elasticity, although it had not yet taken that name. Gossen also constructed exchange models based on utility considerations, while Dupuit established a model of international exchange based on Marshallian-like periods of adjustment (that is, short run versus long run).

Cournot, Dupuit and Gossen established a framework of market equilibrium encased in supply and demand analysis. In turn, Cournot and Dupuit showed how this framework established the underlying profit-maximizing principles for monopolists and competitors, and Dupuit further discussed the conditions and consequences of price discrimination. Cournot created a theory of oligopoly and duopoly with mutual interdependence, while Dupuit applied this theory to product differentiation by quality in markets. Thünen and Dupuit introduced economic implications of time, technology, space and property rights.

If the theoretical toolkit that appears in Marshall's *Principles* is taken as a benchmark for the establishment of neoclassical microeconomics, there is very little that cannot be found beforehand in the works of Cournot, Dupuit, Gossen and Thünen. Indeed, in a number of areas, such as duopoly, price discrimination and spatial competition, Marshall's analysis is not as accomplished as that of his predecessors.

Several overall points emerge from a review of early developments in neoclassical economics. First, there was a pronounced continental dominance in the development of the "new" themes. In terms of sheer numbers, Germany and Italy dominated (see Tables 2 and 3), yet the proto-neoclassical tradition in other countries was making serious headway. Until recently, these advances have been mostly overlooked. Streissler (1990) has rendered great service to historians of economic thought by revealing the rich heritage in the neoclassical spirit of German writers who preceded Menger. Ekelund and Hébert (1999) have likewise revealed the obscure origins of French economic theory before Walras. But the Italian contribution remains largely neglected, and in England, the proto-neoclassicals have been overshadowed by the usual major figures of the classical era.

Second, as many, or more, new analytical techniques emerged from practitioners like engineers, agronomists and merchants as from academicians. True, in Great Britain, Germany and Italy, the writers who consistently probed "neoclassical" themes came primarily from within the academy, whereas in France and the United

States, it was chiefly engineers who broke new ground (see Tables 4 and 5). But Germany's most original economists, Thünen and Gossen, did not fit the usual mold. Thünen was an agronomist, while Gossen was a law clerk and businessman.[1] Lardner (Great Britain) was an astronomer and engineer. Whewell (Great Britain) and Cournot (France) were mathematicians. Condillac (France) and Genovesi (Italy) were clerics.

Third, if history is a proper guide, economic theory is not mathematics, and vice versa. Gossen, for example, was a mediocre mathematician, but seems to have invented modern diagrammatic economics (Georgescu-Roegen, 1983, p. lxx; Theocharis, 1993). New insights in economic theory are sometimes expressed in mathematical tools, but they are also often expressed with verbal or graphical tools and only later translated into mathematics.

The final point is that except for Dupuit, none of the proto-neoclassical writers surveyed shared the Marshallian vision of economics as an engine of scientific discovery.

What Did Marshall Know and Where Did He Learn It?

It is difficult to know what sources Alfred Marshall drew upon for his *Principles* and how he came to know of them. The most thorough attempt to trace the influences on Marshall's thought to date can be found in Groenewegen (1995, chapter 6). By his own testimony, Marshall read Cournot in 1868; Thünen, Hermann, Roscher, Rau and Mangoldt around 1869–1870; Jenkin in 1870; Jevons in 1871; and Dupuit in 1873 or sometime after. How these influences impinged on his own thinking remains somewhat obscure, however, although on some points connections are clear. For example, Marshall (1920, pp. 55*n*, 432*n*, 788*n*) adopted Hermann's classification of internal and external wants, acknowledged his anticipation of quasi rent and cited his notion of capital. It is even plausible, as Streissler (1990) contends, that Marshall might have gotten the general structure of the *Principles* from earlier German writers, but we do not believe that he got his ideas on demand, marginal utility, consumers' surplus and general competitive equilibrium from them.[2] Marshall (1925, pp. 412–413) told J. B. Clark that Thünen inspired his distribution theory. Furthermore, he said (p. 360) that his opinions derived more substance from Thünen than Cournot.

It is widely recognized that Marshall drew upon earlier sources in codifying the toolkit of neoclassical microeconomics, and we have long known that Marshall did

[1] On the prominence of Thünen in economic theory, see Blaug (1979) and Kurz (1998a). Gossen's preeminence is justifiably proclaimed by Baumol and Goldfeld (1968), Georgescu-Roegen (1983) and Theocharis (1993).

[2] Direct connections between early German writers and Marshall are difficult to substantiate. For example, in our opinion, the case Streissler (1990) makes for the influence of Rau's demand curve on Marshall is weak.

not regard his contributions as revolutionary. What is new in the last few years is the claim that this toolkit existed before Menger, Jevons and Walras and that Marshall had some awareness of the earlier proto-neoclassicals. But discussions of neoclassical economics often underestimate the extent to which it consists of a scientific method, as well as a set of tools, and the extent to which Marshall was instrumental in laying the groundwork for that method. Indeed, there are indications that Marshall considered the lack of a proper scientific basis for economics to be the most pressing problem confronting the discipline.

Marshall affirmed his belief that economic science is a procedure for scientific discovery in book I, chapter 3 of his *Principles.* He noted similarities between economics and all other sciences: "It is the business of economics, as of almost every other science, to collect facts, to arrange and interpret them, and to draw inferences from them" (Marshall, 1920, p. 29). However, economic analysis faces certain limitations that may not apply in other sciences. In sciences like physics or astronomy, the variables used in the theory can include most of the important causes and effects, so that an empirical test can match the theory quite closely. Economic theory often fails in this regard because, by necessity, human sciences often rely on theories that do not include all of the variables that are relevant at a specific time and place.

Although Marshall focused on static equilibrium, a concept borrowed from physics, he denied explicit analogies between the laws of physics, astronomy or mechanics and those of economics. Instead, Marshall (1920, pp. 32–33) compared economics to meteorology.

> The laws of economics are to be compared with the laws of the tides, rather than the simple and exact law of gravitation. For the actions of men are so various and uncertain, that the best statement of tendencies, which we can make in a science of human conduct, must needs be inexact and faulty . . . . And since we must form to ourselves some notions of the tendencies of human action, our choice is between forming those notions carelessly and forming them carefully.

Sutton (2000, p. 4) explains: "The key to Marshall's view lies in his claim that economic mechanisms work out their influences against a messy background of complicated factors, so that the most we can expect of economic analysis is that it captures the 'tendencies' induced by changes in this or that factor." Thus, Marshall accepted mathematical models and static equilibrium theory as helpful organizing principles that can help in understanding the functioning of actual markets. But he insisted that tendencies produced by self-interested, rational human behavior yield predictable results only within the limited confines of "disturbing causes," which must be examined one at a time using the ceteris paribus assumption. Marshall's methodology is one in which not all factors are specified (nor can they be) within a theory, and where some of the unspecified factors may measurably alter predicted results. This latter approach encouraged the development of modern methods of

econometrics to determine, probabilistically, which factors do and which do not alter results.

In the battle over induction from theory versus deduction from evidence, Marshall occupied the middle ground. He told Edgeworth (as quoted in Sutton, 2000, p. 13) that "theory alone was empty, while empirical investigations without theory were suspect; hence only the interweaving of theory and evidence constituted 'economics proper.'" In his evaluation of Marshall's impact, Sutton (pp. 105–106) argues: "[W]hat the birth of the standard paradigm brought into economics was a new insistence on the importance of formulating rival views in the guise of sharply defined theories that could be evaluated by reference to clear empirical tests. It is this, rather than any rigid recipe for research, that remains its enduring legacy."

Although Marshall was lavish in his praise of Thünen and Cournot, what he borrowed from these writers was theories, not method. Thünen did not attempt to encase his theory in a strict methodological framework. Niehans (1987) claims that Thünen made the farm his economic paradigm.[3] Cournot, while widely regarded as the precursor of economic statistics, expressly disallowed empiricism when it came to economic science. As discussed in Stigler (1986, p. 197), Cournot took refuge in what Ménard (1980, p. 533) has called "rational mechanics," displaying a curiously ambivalent attitude toward statistics. This view of science is verified throughout Cournot's (1838) *Researches,* where all of the scientific analogies are to "hard" sciences, such as mechanics, physics, astronomy and "motion" (pp. 3, 9, 19, 20). Only once did Cournot admit "empiricism" into his analysis, in the formulation of his demand curve, where he based the inverse relation between price and quantity on common observation. This single insertion is best viewed as a stalking horse for a mechanical and purely mathematical science of economics. Cournot's (p. 17) goal was in fact to fashion economics along the lines of an "abstract science" like hydrostatics. The same was true of Gossen, who believed (as quoted in Theocharis, 1993, p. 198): "[I]t is impossible to present the true system of economics without the aid of mathematics—a fact that has long been recognised in the case of pure astronomy, pure physics, mechanics and so forth." With proper caveats, virtually the same mechanical approach was employed by the rest of the proto-neoclassicals.

The single exception was Jules Dupuit. Dupuit was undaunted by the uncertain or "capricious" nature of utility as a basis for the demand curve, and he explained its negative slope on the basis of diminishing marginal utility, which could be

[3] Groenewegen (1995, p. 152) asserts that Thünen's method gave Marshall "greater awareness of the importance of gathering facts and experimentation for scientific activity," a point we do not dispute. However, we maintain that Thünen's method was of a different order than Marshall's (and Dupuit's). Thünen collected facts with which to verify theory. This constitutes a version of the "scientific method" as we know it. However, Thünen's method seems to be more in the realm of arithmetic, whereas the method that Marshall proposed for economics appears to be "statistical" in the probabilistic sense.

approximated in monetary terms.[4] He envisioned economic science as a combination of both theory and empiricism. From the very beginning of his economic investigations, Dupuit (1844 [1952], p. 104) combined empiricism—hypothetical or actual observation—with demand, producing actual estimations of demand curves and consumer surplus. In addition to his empirically based demand curves, Dupuit proffered other examples of actual or "anecdotal" empirical referents to economic theory, including analysis of bridges (1844 [1952], pp. 104–105), rock quarries and canals (pp. 92–93), population (1865a) and water distribution (1865b). These discussions show the use of a recognizably modern scientific method—a priori theorizing, testing, reformulating "missing" elements in the original theory.

When Dupuit is compared to Marshall, especially on key points of theory and method, he stands out as a harbinger of the "new" approach. Hence, we find Dupuit expounding economic method in 1860 in a fashion exactly analogous to Marshall's exposition 30 years later.[5] In discussing the usefulness of mathematical abstraction in the search for solutions to economic problems, Dupuit cautioned that because of the complexity of economic events, empirical verification is required to enrich and to inform "provisional laws." The following passage makes it clear that Dupuit (1861, p. 138) regarded economics as a process of discovery.

> There are times when throngs of curiosity-seekers flock to the seaside to see a hundred-year tide. Science, which has discovered what causes tides, can tell us that on a certain day the sun and moon will be so aligned as to cause the water level to rise far above normal, nevertheless it may happen that the tide does not behave as predicted. Is this cause to doubt the reigning theory? Does it mean that the influence of the sun and moon on the tides was suspended for a day? No, of course not; this great disappointment simply indicates that the height of the tides depends on regular actions that we know how to calculate and on another action that still eludes science. On the day when the phenomenon was anticipated, an action that could not be predicted, such as a shift in wind direction, could have produced effects contrary to what was calculated. The same is true of economic events.

The parallel between this argument and Marshall's analogy between economics and tides is striking.

Moreover, Dupuit encased his methodological argument in the context of a "periods-of-adjustment" (short-run versus long-run) model of competitive

[4] Marshall's defense of welfare measures in terms of money (1920, book I, chapter 2, pp. 15–22 et passim) is identical to that of Dupuit (1844 [1952], pp. 102–107). Dupuit (1853 [1933], p. 178) always argued that there is no "utility other than what people will pay for," and that "political economy, speculating on wealth and on the sacrifices which we are disposed to make in order to obtain them, must necessarily take into account the energy of the will by its expression in money."

[5] Citations below are to Dupuit's *La Liberté commerciale* published in 1861, however, the same text was published serially in 1860 in the *Revue européenne.*

equilibrium—a hallmark of Marshall's theoretical presentation of competitive markets and a staple of every introductory economics text of the twentieth century. Expounding on the effect of a tariff reduction on the relative prices of English iron and French wine, Dupuit (1861, p. 138) argued:

> Economics might predict that free trade would lower the price of iron in France to 170 francs within a few years; but if the price falls to 120 francs instead, due to improvements in metallurgical processes, or the discovery of more abundant new minerals; or on the contrary, if the price rises to 300 francs because of the influx of gold and silver from California or Australia, these events do not refute basic principles. Of course, doubting Thomases, swayed by mere appearances and overcome by their great disdain [for abstract theory], can marshal facts in opposition to the theory, but surely intelligent people will not be convinced by their attacks.

Likewise, on the efficacy of ceteris paribus, Dupuit anticipated Marshall root and branch. "When an effect depends on many causes," Dupuit (1861, p. 138) wrote, "it can only be calculated exactly if every condition is taken into account simultaneously. Nevertheless, it is defensible for science to isolate each of these causes and to calculate their effects separately; indeed it is the only way for it to investigate and to discover knowledge."

These passages from Dupuit, which are considerably amplified in their original context, present clear and unequivocal evidence that the primary method by which economists study economic phenomena today was explicitly outlined a generation before Marshall. Marshallian neoclassical economics parallels Dupuit's method and not Cournot's, nor Thünen's, nor any of the other proto-neoclassical writers.

Whether this remarkable parallel constitutes evidence of a genuine filiation between Marshall and Dupuit or a mere instance of historical serendipity is not really the issue. Marshall could have formed his views on scientific method, as well as his theoretical insights on utility, demand and consumers' surplus, independently of Dupuit or through other intellectual connections. For example, Marshall was clearly aware of Jevons, who also mentioned tides in his discourse on economic method, although Jevons ultimately adopted a "harder" view of economic science.[6] The issue instead is that both Marshall and Dupuit espoused the same method—the

[6] Marshall was also quite familiar with the work of John Stuart Mill, who elaborated a view of economic method that anticipated Dupuit and Marshall in several key respects. Mill admitted the complexity of economics, recognized the uncertainty introduced to it by disturbing causes, distinguished between social sciences and physical sciences and outlined the necessity of ceteris paribus. Later in the *Logic*, however, Mill (1843, book VI, chapter 2, parts 1 and 2) appeared to argue that ceteris paribus is only a logical convention in reasoning, not a method of discovery to the extent that each causal element is brought in one at a time empirically to explain effects within a theory and possibly to change its nature. For his part, Dupuit asserted that empirical methods are useful for discovering general principles as well as verifying their existence, whereas Mill (1836 [1967], p. 331) rejected the role of a posteriori methods as a discovery mechanism.

method that was practiced for most of the twentieth century and that has progressively stimulated improved econometric and statistical techniques. Hence, Marshall transmitted many of Dupuit's ideas, either wittingly or unwittingly. Marshall's central importance to economics consists not so much in the originality of his ideas, but in his ability to persuade the bulk of the profession of the efficacy of the new paradigm.

Conclusion

A genuine, functioning toolkit for neoclassical microeconomics existed long before Marshall's *Principles* in 1890 and well before the legendary triumvirate of Menger, Jevons and Walras circa 1870. The argument could be made that neoclassical/marginalist ideas that floated about prior to 1870 were merely isolated pieces in a great intellectual puzzle. In some individual cases, that may have been true. It is also true that neoclassical microeconomics does not appear to have evolved in a neat or linear way or in an intellectual battle between "systems" or "schools." But the quantity and quality of the achievement of the proto-neoclassicals is too great for their work as a whole to be set aside as isolated, fragmentary or incomplete.

Jules Dupuit, in particular, managed to assemble a complete paradigm with demand-utility specifications, marginalism with respect to inputs, cost conceptions based on time periods of production, welfare calculations under alternative market structures, graphical and mathematical analysis and illustrations and a well-stated and well-formed method for establishing microeconomic science. Dupuit anticipated Marshall in most of the key ingredients that came together to form neoclassical microeconomics.[7]

Marshall was an accomplished theorist, but more importantly, he was at the center of a "synthesizing community." He shaped his theoretical tools with a single purpose in mind: to make economics an engine of scientific discovery. He channeled the new tools of economic theory into what has become the traditional neoclassical paradigm by specifying its methodological framework. The Marshallian method, which combined inductive theory and deductive empiricism, was ultimately the impetus to the development of econometrics and to the modern practice of economics.

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[7] We leave for future consideration intriguing issues concerning the nature of scientific discovery and sense in which the large coterie of contributors mentioned here should be classified as "successes" or "failures" in the sense of Stigler (1976). But we find it significant, in this regard, that Dupuit's proposed book, one which might have solidified his scientific reputation among contemporaries, did not reach fruition, although he spoke of it as early as 1844.

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