16

ECONOMICS

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Economics has always had two related faces in its Western tradition. In Adam Smith's eighteenth century, as in John Stuart Mill's nineteenth, these might be described as the science of political economy and the art of economic governance. The former aimed to describe the workings of the economy and to reveal its governing laws, while the latter was concerned with using that knowledge to fashion economic policy. In the twentieth century, these two aspects were more often contrasted as positive and normative economics. The continuity of these dual interests masked differences in the way economics was both constituted and practiced during the twentieth century, when these two aspects of economics became integrated in a particular way. These two wings of economics, originally a verbally expressed body of scientific lawlike doctrines and associated policy arts, in the twentieth century became more firmly joined together by the use of a set of technologies routinely and widely used within the practice of economics in both its scientific and policy domains.

In the twentieth-century history of economics, tool development and changes in economic theory need to be set alongside demands for advice generated by overwhelming events in the economic history of the times and strong economic ideologies in the political arena. These processes interacted to generate a Western technocratic economics very different in style and content from the economics of previous centuries, one we might characterize as an engineering science.

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ECONOMICS AS ENGINEERING

To understand twentieth-century economics as a science in the mold of engineering is to see that the economics profession came to rely on a certain precision of representation of the economic world, along with techniques of quantitative investigation and exact analysis that were alien to the experience of nineteenth-century economics, when the extent of such technologies of representation, analysis, and intervention were extremely limited. The engineering metaphor also suggests that twentieth-century economics is best characterized as a science of applications and implies a technical art, one that relies on tacit knowledge and decidedly human input as in the eighteenth-century term "art of manufactures."[1] Because of inherent limitations on the field's ability to access and control its subject matter, even economists' most exact theories had to be explored on a case-by-case basis, and the practical application of quantifying technologies could never be automatic, but always involved human judgment. There are certain parallels here to psychology's effort to "control" the individual, although, perhaps because of the presence of centrally planned Eastern economies for most of the century, Western economics fought shy of the view that direct control is the aim of economic science, either as a way of validating scientific explanation or as a program of social action.

From the point of view of economic policy, the engineering notion embodies elements of both the operation and design of systems, and it is subject to different interpretations at different times in the practice of twentieth-century economics. In terms of operating the economy, notions of control engineering were explicitly discussed during the 1950s experience of the "managed" economy. The way the macroeconomy was pictured implied that the economy was subject to governmental control. At the same time, under the influence of cybernetic thinking, the economic behavior of each individual was pictured as being controlled by personal feedback loops. More flexibly, in the 1960s, governments were thought to have the economic power only to "fine tune" the macroeconomy or to nudge the economy back on course.[2] In the 1920s and 1980s, still less interventionist modes were in favor, and macroeconomic policy was understood to be taking fiscal care and following rules of monetary operation, suggesting the idea of maintaining a smooth-running machine, while at the individual level the issue was one of influencing behavior via incentive systems rather than by mechanisms of control.

[1] This contingent and decidedly human element is characterized by Eugene S. Ferguson as an essential part of the engineering mode in his *Engineering and the Mind's Eye* (Cambridge, Mass.: MIT Press, 1992).

[2] An interesting study of these contrasting beliefs can be found in Craufurd D. Goodwin, *Exhortation and Controls: The Search for a Wage-Price Policy* (Washington, D.C.: Brookings Institution, 1975). For a broader picture of the relation between state and economy, see Alain Desrosières's chapter in this volume.

The engineer as designer and constructor was also prevalent in twentieth-century economics. In the 1930s, when it seemed the economic machine was seriously malfunctioning, some economists suggested planning a whole new economy. During the post-1950s period, the goal was more evolutionary and less mechanical, namely, to affect the environment within which people act in order to produce adaptive economic behavior. Western economists were expected to formulate development paths, to design new economic institutions to foster market economies, and to map out transition paths for postcommunist economies. Throughout the century, they were asked to carry out technical assessments of economic decisions and to tinker with, or design anew, incentive structures for all sorts of everyday cases.

Economic technologies were not only policy tools for designing and justifying interventions in the world but also scientific tools, forged for theory development and to find out about the world. These tools were not independent of high theory; rather, they supported its development. They were also critically involved in new ways of making sense of phenomena and constructing facts about the economy.

Around 1900, there was relatively little mathematics, statistics, or modeling contained in any economic work: Economics was a verbal tradition. In the first half of the twentieth century, a massive growth in the collection of economic data and associated empirical investigations built a detailed knowledge base in economics, leading to the development of specialized statistical tools under the label of econometrics. Concurrently, but more slowly, mathematics was adopted, both to express economic theories and to formalize arguments. During the 1930s, the technology of modeling was introduced into theoretical and econometric work. The full dominance of these technologies – measurement methods, mathematics, statistics, and modeling – occurred only after 1940, but by the end of the century economics had become a modeling science in both theoretical and applied work. Economics became, in effect, a tool-based discipline.

These quantitative techniques gave economics the aura of scientific modernity. But while economics portrayed itself as the most scientific of the social sciences, its claim to such a title had less to do with any success in using mathematics to formulate general laws or using statistics to predict economic events – the criteria often applied to the physical sciences – and more to do with turning economics into a discipline whose methodology relies on technical tools to buttress claims for economic knowledge.

This account of twentieth-century Western economics begins with a picture of the economics discipline around 1900, and then analyzes how the tools that economists fashioned, the theories they developed, and the economies they tended mutually shaped one other and changed the discipline. A further important element in this mix was the role of economic ideology, which was critical to the development of tool-based economics and

to the increasing dominance of American styles and ideas within Western economics during the latter part of the century.

ECONOMICS FROM THE NINETEENTH TO THE TWENTIETH CENTURY

Considered as a field of study, economics had already gathered sufficient academic respectability to have chairs in many universities by the mid nineteenth century. By 1900, it had its own separate academic societies and journals, and its subject matter had become to a large extent separate from its older ancestors, moral philosophy and politics, and from newer siblings such as sociology. Nevertheless, the creation of separate university departments of economics, the growth of professional positions both inside and outside academia, and the advent of graduate education were subject to considerable national variation in timing and outcomes over the first half of the twentieth century.[3] With independence, economics developed specialized subfields, such as labor economics and international trade, but local demarcation disputes continued as economic history, industrial relations, and business management gained their own disciplinary positions.

During the late nineteenth and early twentieth centuries, economics was characterized by a considerable pluralism of beliefs, theories, and methods. It is difficult to view any one school of economics as being dominant, for while there were clearly national differences – and even some "schools" of economics delineated in national terms, such as Austrianism and American Institutionalism – economics throughout this period remained international in terms of its communication lines.[4]

The earlier nineteenth-century English "classical" emphasis on labor as the source of value and the critical element in the creation of wealth had been challenged by the "marginal revolution" of the 1870s.[5] This new account focused on the consumer as the source of valuation of economic goods: Each consumer experienced an increase in overall satisfaction or utility, but at a declining rate, as they increased their consumption of a good. The marginal (last)

[3] There is no overall treatment of the professionalization of the discipline, but see, for example, on Britain, John Maloney, *Marshall, Orthodoxy and the Professionalisation of Economics* (Cambridge: Cambridge University Press, 1985); on the United States, Dorothy Ross, *The Origins of American Social Science* (Cambridge: Cambridge University Press, 1991), and Mary O. Furner, *Advocacy and Objectivity: A Crisis in the Professionalization of American Social Science, 1865–1905* (Lexington: University Press of Kentucky, 1975).

[4] Most histories of economics give an account of the various "schools" in this period: See Roger E. Backhouse, *A History of Modern Economic Analysis* (Oxford: Blackwell, 1985); and Henry Spiegel, *The Growth of Economic Thought*, 3rd ed. (Durham, N.C.: Duke University Press, 1991), which places each school into its intellectual context. See Mark Blaug's *Economic Theory in Retrospect*, 5th ed. (Cambridge: Cambridge University Press, 1996), for an in-depth treatment of the theoretical developments.

[5] For a consideration of classical economics, see Margaret Schabas's chapter in this volume.

unit consumed, the least valuable in terms of utility gained, provided the measure of exchange with other goods and thus determined the price paid for all units. There were four variants of this new theory. The English economist William Stanley Jevons (1835–1882) drew on the Benthamite picture of pleasures and pains, the physiology of satiation, and the physics of his day to provide a mathematical formulation of the consumer's feelings. The French economist at Lausanne, Leon Walras (1834–1910), outlined in mathematical form a general equilibrium theory of the economy, in which all the individual consumers' exchanges were matched at marginal values but in which the psychology of feelings and motivations was less prominent. John Bates Clark (1847–1938), the American historical economist, outlined a more complicated vision of multiple bundles of different kinds of utility associated with each good or service. Carl Menger (1840–1921), the founder of the Austrian school, analyzed how individuals satisfy different needs with the same good and outlined an account of how needs were ordered and choices made.[6]

Accounts differ regarding how revolutionary this movement was and how quickly it spread through the profession.[7] They agree, however, that by the early twentieth century, "neoclassical" economics had established a new research approach by combining the older classical focus on production or supply with the new insights of marginalism on the demand side, in a mathematical account developed from the work of Jevons and Walras. This approach continued to gain credibility through the first half of the twentieth century, as the characteristics of what was to become the full-fledged neoclassical economics of the third quarter of the century – namely, formal treatments of rational, or optimizing, economic agents joined together in an abstractly conceived free-market, general equilibrium world – were worked out. This abstract account became widely adopted to the exclusion of other approaches, however, only during the second half of the twentieth century.[8]

One of the reasons for the slow acceptance of the new neoclassical approach was its narrow and unrealistic portrait of the individual. Nevertheless, economists who found themselves at odds with the project also found some of its formulations useful. Thus the American historical economist Richard T. Ely (1854–1943) could use the concepts and analysis to discuss individual consuming behavior without being committed to the utilitarianism and differential calculus of Jevons. Similarly, in the 1930s, Joan V. Robinson

[6] Except for Backhouse, *Modern Economic Analysis*, most histories of this "revolution" omit Clark. On differences between the other three variants of marginalism, see William Jaffé, "Menger, Jevons and Walras De-homogenized," *Economic Inquiry*, 14 (1972), 511–24; see also Keith Tribe's chapter in this volume, for an interesting comparison of the historical sequence with regard to Menger and Walras.

[7] See R. D. Collison Black, A. W. Coats, and Craufurd D. W. Goodwin, *The Marginal Revolution in Economics* (*History of Political Economy*, Supplement) (Durham, N.C.: Duke University Press, 1973).

[8] See, for example, the accounts in Mary S. Morgan and Malcolm Rutherford, *From Interwar Pluralism to Postwar Neoclassicism* (*History of Political Economy*, Volume 30 Supplement) (Durham, N.C.: Duke University Press, 1998); and Yuval P. Yonay, *The Struggle over the Soul of Economics* (Princeton, N.J.: Princeton University Press, 1998).

(1903–1983) could use the neoclassical supply-demand graphic framework of Alfred Marshall (1842–1924) to analyze the various elements of labor exploitation, a Marxian concept, inherent in monopoly power.

Perhaps a more important reason was that neoclassical economics at that time had little to say about aggregate questions – that is, about money, growth, technological change, business cycles, or institutions. In these respects we should look rather to individuals such as J. G. Knut Wicksell (1851–1926) in Stockholm and his account of the cumulative process in economics, or to the monetary theories and measurements of Irving Fisher (1867–1947) in America, or to the strongly competing "schools" of economics of the time.

Historical economics remained the economics of choice for the German academy, and the late nineteenth century saw them locked in a bitter *Methodenstreit* with their Austrian neighbors. Whereas the German historical school, associated with Gustav von Schmoller (1838–1917), favored a holism centered on the national level, posited a clear role for the state, and paid close attention to externally adduced evidence, the Austrian school of Menger began with economic individualism, favored abstraction in theory, and advocated introspection as a source of evidence. Both Marxist and American Institutionalist approaches involved historical elements as a matter of method. Both were interested in the nature of the institutions of capitalism. Karl Marx's (1818–1883) economics drew heavily on the earlier classical tradition in its commitment to the labor theory of value and in its desire to provide an account of growth and stagnation as well as of capital accumulation. American Institutionalism, whose most well-known exponent was Thorstein Veblen (1857–1929), focused on the development of habits of economic thought and behavior at both the individual and social levels and on the evolutionary change these experienced.

Thus, between 1870 and 1940, Western economics cannot be easily characterized, since a number of vibrant intellectual approaches coexisted and neither beliefs nor methods fit easily under one label. Only if we look at the entire twentieth century can we see how the various strands of marginalism played out and how the elements of neoclassical economics developed to form a strong paradigm by the 1950s.[9] When, in the last quarter of the century, these essentially micro accounts became formally linked to the aggregate, or macro, level of economics and to certain elements of the institutionalist

[9] See Backhouse, *Modern Economic Analysis*. On the development of three American versions of neoclassical ideas during the period 1930–60, see Philip Mirowski and D. Wade Hands, "A Paradox of Budgets: The Postwar Stabilization of American Neoclassical Demand Theory," in *Interwar Pluralism*, ed. Morgan and Rutherford, pp. 260–92. For the two French traditions, and over a longer period, see Robert B. Ekelund, Jr., and Robert F. Hébert, *The Secret Origins of Modern Microeconomics* (Chicago: University of Chicago Press, 1999); and Bruna Ingrao and Giorgio Israel, *The Invisible Hand: Economic Theory in the History of Science* (Cambridge, Mass.: MIT Press, 1990), which also covers Italian thinking. On British neoclassicism over the longer run, see Maloney, *Marshall, Orthodoxy and the Professionalization of Economics*; and Blaug, *Economic Theory*, which also deals with the broader picture of neoclassical theorizing.

agenda to produce "the mainstream" in Western economics, other accounts, namely the historical and Marxist traditions, were pushed to the margins.[10]

The story of these events advanced inside economics faculties usually makes changes in theory, or theoretical debate, the main focus of the narrative.[11] Thus, the history of twentieth-century economics has usually been portrayed as the early domination and inexorable growth of neoclassical microeconomics. If we suspend belief in the inherent progressiveness of that paradigm, however, the changes portrayed in that story have no convincing dynamic, so that other historical factors need to be considered. The standard treatment also downplays the more obvious changes over the century in the way economics was practiced. This account therefore begins with tools for measuring the economy and for developing theories. Such a beginning enables us to show how the history of economics is intimately linked to the histories of economies and their political contexts, as well as to integrate the history of economic methods with the history of economic theories.

MEASURING THE ECONOMY

The drive to measure economic phenomena can best be understood as a movement dating from the late nineteenth to the mid twentieth century.[12] Despite the fact that many economic elements come ready-numbered, the concepts and entities appearing in economic theories present problems of aggregation and combination of the numbers, or of their representative power. Measuring the output of iron, a basic product of the late nineteenth century, required collecting data from many different firms and deciding on appropriate methods of aggregating them to form one series of measurements. The more complex problem of measuring "the price level," that is, the general level of prices, a measurement needed for applied studies in monetary economics, led to the development of index-number theory. This theory dealt with appropriate ways to combine the data collected on prices and quantities of many different goods into consistent sets of numbers from which a price-level series could be calculated.

[10] Few texts go beyond 1945 in their coverage; one introductory text that does is Harry Landreth and David C. Colander, *History of Economic Thought*, 3rd ed. (Boston: Houghton Mifflin, 1994); Backhouse's *Modern Economic Analysis* develops a more detailed account. A wealth of biographical material, and some useful subject histories, are contained in John Eatwell, Murray Milgate, and Peter Newman, eds, *The New Palgrave: A Dictionary of Economics* (London: Macmillan, 1987).

[11] One of the few recent texts to eschew such an approach is R. E. Backhouse, *Economists and the Economy*, 2nd ed. (New Brunswick, N.J.: Transaction, 1994); Backhouse follows an earlier tradition of relating the history of economics to economic history.

[12] There is no overall history of the modern measurement movement, but see Judy L. Klein and Mary S. Morgan, *The Age of Economic Measurement* (*History of Political Economy*, Volume 33 Supplement) (Durham, N.C.: Duke University Press, 2001) for a recent set of essays. See also Paul Studenski, *The Income of Nations: Theory, Measurement, and Analysis: Past and Present* (New York: New York University Press, 1958), for an exhaustive account of one important strand – the history of national income and wealth measurement until the 1950s.

The problem of choosing an appropriate index-number formula turned out to be a generic one for much economic measurement, spawning monographs on measurement formulas and debates over the relevant criteria that continue as a highly specialized part of the economics literature.[13] The arguments are technical and abstruse, but the topic is one with considerable practical relevance. A change in the measurement formula may be equivalent to wiping out the measured inflation or growth of an economy for a year, as happened in the United States during the 1990s.[14] There are also profound philosophical implications, for the choice of weighting schemes depends on different assumptions regarding equality among people.

Arguments also arose about the conditions for measurability of unobservable elements, such as "utilities," and about the appropriateness of measurement formulas for various economic concepts that are not already numbered, such as "capital." One particularly important example was the measurement of business cycles.[15] Most economists agreed that the cycle was a genuine phenomenon, but there was no agreed concept of it, let alone a definition or causal account. The cycle might be sought in data on output, prices, or other elements; its periodic length was unclear, as was its shape and regularity. The measurement procedures, concepts, and causal accounts were constructed hand in hand, in different business cycle institutes ranging from Cambridge, Massachusetts, to Moscow, from Vienna to Berlin, from the 1910s to the 1930s. Measurement was not an end in itself, but a necessary prerequisite for predicting the turning points of the cycles in economic activity that beset all economies, an ability much in demand during the interwar period.

The surge of interest in measurement thus had roots in both professional research and political demands. For economic scientists, it began in the strong institutionalist, historical, and empiricist traditions popular around the end of the nineteenth century. Academic economists, like other social scientists, often initiated and collected their own data sets in order to answer specific research questions. The Progressive movement in America and liberal and welfarist movements in Europe were committed to reforms that often relied on social science research and data, and in the face of these movements, governments increased their collection of economic information. But it was the requirements of war economies, and interwar problems, particularly the Great Depression, that massively increased the collection of data by the state and its agencies. By the 1950s, economists in the Western world had access

[13] There is no one history of index number measurement, but a glance at Irving Fisher's classic *The Making of Index Numbers* (Boston: Houghton Mifflin, 1922), which includes a huge number of different formulas, will give some insight into the topic.

[14] See the discussion of the Boskin report in "Symposium on Measuring the CPI," *Journal of Economic Perspectives*, 12:1 (1998), 3–78.

[15] See Mary S. Morgan, *The History of Econometric Ideas* (Cambridge: Cambridge University Press, 1990), pt. I.

to a bewildering variety of "official" data. Rarely since then have economists set out to take their own measurements.

Economists' ambitions in the realm of measurement soon led them, along with other social scientists, to develop mathematical statistics. Measurements that had been valued earlier for their own sake, as sufficient evidence in tables and graphs, were now asked to contribute to causal explanation. The methods of correlation and regression, originally designed for biometric data, were immediately adapted and developed by statisticians operating in the social science community.[16] The first multiple regression analysis ever done is reputed to be that of George Udny Yule (1871–1951), an English statistician cum social scientist, in 1899, on the determinants of why different poor law authorities gave out different amounts of relief payments. Beginning in the early twentieth century, economists used such statistical methods to measure parameters in simple relations. Understanding the law of demand, for example, required statistical analysis of the relations between data on the prices and quantities of a good. Methods of statistical analysis were thus welcomed into economics by those with different theoretical backgrounds and methodological approaches: Both historical and neoclassical economists developed faith in statistical evidence and methods.[17]

MATHEMATIZING ECONOMICS

The use of mathematics in economics began at roughly the same time as the drive to measurement, and, though its adoption was in many ways more gradual, it just as inexorably altered the way in which economics was practiced.[18] The introduction of mathematics was particularly associated with marginal utility economics. While it might seem that mathematics was a natural way to deal with the marginalists' account of utility, only two of the four variants of this thesis adopted mathematics: Jevons's account of individual feelings expressed with the differential calculus and Walras's equations for his general equilibrium exchange economy. Though Clark came to adopt

[16] For the general role of social scientists in statistical thinking around the turn of the century, see Donald MacKenzie, *Statistics in Britain, 1865–1930* (Edinburgh: Edinburgh University Press, 1981); Theodore M. Porter, *The Rise of Statistical Thinking* (Princeton, N.J.: Princeton University Press, 1986); Stephen Stigler, *The History of Statistics: The Measurement of Uncertainty before 1900* (Cambridge, Mass: Harvard University Press, 1986). For more specialist material on economics, see Judy L. Klein, *Statistical Visions in Time* (Cambridge: Cambridge University Press, 1997); Mary S. Morgan, "Searching for Causal Relations in Economic Statistics: Reflections from History," in *Causality in Crisis: The New Debate about Causal Structures*, ed. Vaughn McKim and Stephen P. Turner (Notre Dame, Ind.: University of Notre Dame Press, 1997), pp. 47–80.

[17] For the history of early developments in statistical economics up until the 1940s, see Morgan, *History of Econometric Ideas.*

[18] The best account of the range of attitudes toward mathematics and quantification held by late-nineteenth-century economists is Theodore M. Porter's "Rigor and Practicality: Rival Ideals of Quantification in Nineteenth-Century Economics," in *Natural Images in Economic Thought*, ed. Philip Mirowski (Cambridge: Cambridge University Press, 1994), pp. 128–70.

the mathematical formulation, Menger and the later Austrian school stood firmly against the use of mathematics in economics.

The development of marginal economics into neoclassical economics in the following generation began along the joint mathematical trajectories set by Jevons and Walras. It is traditional to understand Jevons's project as being concerned with decisions concerning the marginal utilities of the individual, or of individuals in exchange situations, a project most notably taken up by the Irish economist Francis Ysidro Edgeworth (1845–1926), who excelled in mathematics and statistics. The general equilibrium approach of Walras focused on the combination of all of the individual sellers and buyers, a project of interest to the American economist Irving Fisher, a student of the American physicist Willard Gibbs, who provided mathematical proofs of the equilibrium account in several domains. Vilfredo Pareto (1848–1923), the Italian economist who succeeded Walras in Lausanne, looked closely at the problem of the path to equilibrium. The English economist Alfred Marshall railed against the excessive use of mathematics in economics and stressed the notion of economics as a "moral" science. Nevertheless, the direction Marshall took was at least as important as that of Walras and Pareto for the history of neoclassical thinking, since he incorporated classical insights on the nature of production to explore the partial equilibrium of each market, good by good, and over time .

Questions of welfare, equity, and distribution, such as those raised by Henry George's (1839–1897) single tax movement or by Fabian socialists, were now treated with the new marginal and neoclassical tools. Clark replaced his earlier historical and institutional analyses of fair exchange with a mathematical account of the return paid to each factor of production in equilibrium. Pareto developed his criteria of overall welfare based on possible compensation from gainers to losers from any change in circumstances. Arthur Cecil Pigou (1877–1959) used marginal analysis to understand the divergence between private and social interests and Marshall's neoclassical concepts provided the basis for later tool-based analyses of equity and distributive questions arising from governmental actions. Some of these forms of social engineering based on mathematical formulation and calculation had been developed by French engineers during the nineteenth century, but only became general in public economic decision making during the middle and late twentieth century.[19]

By the early twentieth century, although the mathematizing project still had far to go, some key elements of the wider neoclassical picture had been worked out. The introduction of mathematics not only changed the way

[19] The importance of engineers in developing and applying these tools as active economists in France in the nineteenth century and in America in the twentieth century has been treated in Ekelund and Hebert, *The Secret Origins*; and in Theodore M. Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life* (Princeton, N.J.: Princeton University Press, 1995).

that theorizing was carried out and concepts were defined, but also altered the questions considered relevant for study and the way in which they were formulated. For example, the older classical and verbally descriptive account of "free" competition had depicted a state in which firms were free to enter and leave the marketplace and actively competed within it. Early-twentieth-century inquiries into the nature of competition within the neoclassical framework developed the mathematically described concept of "perfect competition," an abstract situation in which no active competition took place between firms.[20] Replacing Adam Smith's famous "invisible hand" description of how order arose in the real economic world, a small group led by the French and American economists Gerard Debreu (b. 1921) and Kenneth J. Arrow (b. 1921) studied the mathematical questions of the existence and stability of the Walrasian "general equilibrium" economy, an ivory-tower speculation about a highly idealized, complex, and formally abstract economy.[21] Welfare economics, which seemed to have foundered on the impossibility of interpersonal welfare comparisons, found a new lease on life with Arrow's formalizing of theorems about social welfare functions and social choice theory. Mathematical theorizing radically changed the objects of study in economics and the kind of truth economists sought.

The proponents of mathematics in economics originally understood mathematics to be the most truthful way to express economic realities. As the twentieth century proceeded, mathematics became a more common, though still contested, form of expression for theory building in economics, until the 1950s, when neoclassical economics became the dominant paradigm. This growing commitment to the effectiveness of mathematics in economic reasoning was accompanied by a gradual weakening of the view that such mathematical representations could be understood to be, or empirically validated as, descriptively accurate.[22] With the retreat from realism, mathematical form took precedence over economic content, and mathematics was seen primarily as a language or tool for the exact expression of abstract theories. However, as the century wore on, the abstraction and formalism associated with mathematization were tempered by the practice of modeling.

[20] For a history of this transformation of the concept of competition, see K. G. Dennis, *"Competition" in the History of Economic Thought* (New York: Arno, 1977). For additional material on the relation to evolutionary thinking at that time, see Mary S. Morgan, "Competing Notions of Competition in Late-Nineteenth Century American Economics," *History of Political Economy*, 25:4 (1993), 563–604.

[21] See Ingrao and Israel, *The Invisible Hand*, for an account of this work. The formalist revolution, as it has sometimes been called, is also treated by Mark Blaug in "The Formalist Revolution or What Happened to Orthodox Economics after World War II," in *From Classical Economics to the Theory of the Firm: Essays in Honour of D. P. O'Brien*, ed. Roger E. Backhouse and John Creedy (Cheltenham: Edward Elgar, 1999), pp. 257–80. See also E. Roy Weinbraub, *How Economics Became a Mathematical Science* (Durham, N. C.: Duke University Press, forthcoming).

[22] See Ingrao and Israel, *The Invisible Hand*; Weintraub, *How Economics.*

MODELING AND TOOL-BASED ECONOMICS

The mathematization or formalization typical of neoclassical economics has been interpreted as the replacement of words by geometry and algebra or by other mathematical languages. But historians of the discipline have hardly noticed that, during the 1930s, mathematics became attached to another tool – namely, "modeling" – to create a new style of scientific argument in economics.[23]

The term "model" seems to have migrated into economics with Jan Tinbergen (1903–1994), who used his experience in physics to develop econometric models during the 1930s. His models were special: They provided a simple and mathematical representation of the complexity of the real economy, and at the same time they formed the basis for a statistical description of the actual historical and structural relations embedded in the data of the real economy. Tinbergen was one of the leaders of the econometrics movement, an international movement of the interwar period committed to both statistical and mathematical methods and to their union with economics, so that economic relations could be expressed in a rigorous form and measured. To some extent, we can see this movement paralleled in other social sciences: Psychometrics and sociometrics developed their own particular version of statistical methods at the same time that econometrics emerged in economics. Nevertheless, these parallel movements did not take on the econometricians' commitment to mathematical representations (models) and mathematical methods.

Until 1950 or so, the union was maintained and practiced in economics by a small but enthusiastic band of econometricians. Since then, the fields have split; the term "econometrics" now refers only to the statistical side of tool-based economics.[24] Following the lead of Trygve Haavelmo (1911–1999) in the 1940s, econometrics has developed its own branches of theoretical statistics and several highly sophisticated, competing methodologies of application. Econometric models ranged from those describing time patterns to those picturing underlying behavioral mechanisms, from single equations to large models of several hundred equations, as developed by Lawrence R. Klein (b. 1920) and were often constructed for governments; they have formed the mainstay of econometrics into the late twentieth century. Perhaps because of the heavy reliance on this technology in applied economics, economists have invested much research effort in the area. Meanwhile, mathematical modeling

[23] Robert M. Solow's "How Did Economics Get That Way and What Way Did It Get?," *Daedalus*, 129:1 (2000), 39–58, offers a similar characterization of late-twentieth-century economics as a modeling science (in an essay that came out as this chapter was being drafted).

[24] For the history of econometrics before 1950, see Morgan, *The History of Econometric Ideas* (containing chapters on Tinbergen and Haavelmo); for the post-1940 period, see Duo Qin, *The Formation of Econometrics* (Oxford: Clarendon Press, 1993); Roy J. Epstein, *A History of Econometrics* (Amsterdam: North-Holland, 1987).

has provided economists with a tool for building and exploring theory, enabling them to build simple mathematical representations of the complex economy or of particular types of behavior and to analyze the theoretical implications by manipulations of the model. The adoption of the modeling style was indeed the primary way in which economics became a mathematized discipline.

Adopted for both statistical and mathematical reasoning in economics, modeling became, especially after midcentury, a distinctive element of both inductive and deductive economics, in both scientific and policy domains. Models were taken as sufficiently accurate representations of the economic world that they formed the basis for both advice to governments and firms and for normal academic science. Each emerging subfield of economic study acquired its own "theoretical" and "applied" economists. To return to the example of business cycles, models such as Tinbergen's both gave mathematical representation to older verbal theories and served as the basis for attaching data to provide measurements of the parameters involved in the relationships. As a consequence, business cycle work suddenly gained a high degree of specificity and exactitude in its claims. Later, with the sudden deepening of economic cycles in the 1970s and 1980s, new mathematical models, labeled "theories," were developed that bore a family resemblance to those of the 1930s; when connected to econometric models and data, these theories were "applied."

Twentieth-century economists viewed their measurement formulas, mathematical and statistical methods, and modeling tools as more "advanced," more properly scientific, than the words and verbal arguments of the nineteenth century, and regarded them as essential to the scientific claims of twentieth-century economics. Economists at the time, and historians since, have linked the use of such tools with the desire to ape natural science. Some notions were indeed imported from other sciences, although these ideas and methods were first adapted to fit economics and then further developed to become tools for economics specifically.[25] During the late nineteenth century, ideas from physics, physiology, and psychophysics were used in the accounts of the marginalists, and ideas from biometrics and social statistics in statistical economics.[26] In the mid twentieth century, information science and artificial intelligence, the so-called cyborg sciences, were another

[25] For example, see Marcel Boumans, "Paul Ehrenfest and Jan Tinbergen: A Case of Limited Physics Transfer," in *Non-Natural Social Science: Reflections on the Enterprise of More Heat than Light*, ed. Neil De Marchi (*History of Political Economy*, Volume 25 Supplement) (Durham, N.C.: Duke University Press, 1993), pp. 131–56.

[26] The physics analogy has been vividly discussed by Philip Mirowski in *More Heat than Light* (Cambridge: Cambridge University Press, 1989), and his account critiqued in De Marchi, *Non-Natural Social Science.* For the concern with psychology, see Margaret Schabas, "Victorian Economics and the Science of the Mind," in *Victorian Science in Context*, ed. Bernard Lightman (Chicago: University of Chicago Press, 1990), pp 72–93.

resource.[27] Very often, tools were carried by scientists themselves migrating between fields: Tinbergen brought the tools and concepts of physics with him in the 1930s; Herbert A. Simon (1916–2001) brought tools and concepts from information theory in the 1940s and 1950s. But larger historical factors were also at work in the adoption of tool-based economics: the historicist concern with evidence in the late nineteenth century, the "modernist" movement's focus on abstraction and formalism in early-twentieth-century science and culture, and the positivist philosophy of midcentury. On an historical scale, between these specific impulses and broad cultural factors, events in politics and in the economies themselves significantly reshaped economics.

THE CONTINGENCIES OF ECONOMIC HISTORY AND ECONOMIC RESPONSIBILITY

One of the things that needs to be explained about the adoption of tool-based economics is its timing. With the exception of measurement methods, these tools spread rather gradually before the 1930s. Demands from the policy domain for economic expertise, and especially for a "usable" economics during the period from 1930 to 1950, were critical for the full-scale adoption of tool-based economics that occurred after the 1950s. It is no accident, for example, that the League of Nations supported Tinbergen's econometric research during the late 1930s as part of its attempt to solve the national and international problems of the Great Depression. Both the historical timing and the nature of policy demands affected the character of the economic science that resulted.

Economists had laid claim to a special public policy expertise throughout the nineteenth century; but at that time the range of economic policy considered to be the responsibility of the state, and thus perhaps requiring economic expertise, was somewhat limited. While this range varied by nation, governments generally were taken to be responsible for trade policy, for keeping their own spending within budget, and for monetary and exchange rate policy. In this last case, the late-nineteenth-century view was that the gold standard, by then widely adopted in the Western world, was the ultimate "governor" maintaining the health of the national and international economies and making monetary/exchange rate policy automatic and self-stabilizing. Governments sometimes initiated legislation to protect vulnerable economic groups, but did not consider themselves to have any general economic responsibility for their citizens.

[27] See the papers in pt. 1 (by Mirowski, Sent, and Boumans) of John Davis, ed., *New Economics and Its History* (*History of Political Economy*, Volume 29 Supplement) (Durham, N.C.: Duke University Press, 1997); Philip Mirowski, *Machine Dreams: Economics Becomes a Cyborg Science* (Cambridge: Cambridge University Press, 2001).

The events of the twentieth century radically altered the balance of economic responsibility between the state and individuals across most Western economies. The economic policy experience of the interwar period, combined with that of two world wars, created the view that governments were responsible for intervening to maintain the health of the domestic economy, and thus for the economic security of their own people, as well as for the health of the international economy.[28]

In the case of the two world wars, economic planning and control were required on a hitherto unmatched scale, perhaps since the days of the Roman empire. The experience of economic planning during the First World War was somewhat more ad hoc and piecemeal, during the Second World War more organized and coherent. Regardless, the state's share in the economy grew rapidly during World War I, declined during the interwar period, rose again during World War II, and did not decline much thereafter. The difference between the wars, of course, was the Great Depression. All countries, developed and underdeveloped, experienced a considerable postwar downturn soon after World War I and severe collapses during the 1929–33 period, unmatched by anything after 1950. In the United States, among the most affected in that second depression, aggregate consumption and income fell by 25 percent. International trade and international financial institutions broke down, and the world economy moved towards autarky.[29]

The Great Depression had a profound effect on both the outlook of economists and on the economic responsibilities assumed by governments in the Western world. In the 1920s, most economists believed that business cycles were a regular and natural phenomenon of the capitalist economic system. But the severity of the Great Depression and its unusual length forced them to reexamine their beliefs about how the aggregate economy worked and forced governments to become proactive in economic affairs, with or without the blessing of their economic advisors.

In 1933, for example, Germany and America instituted wholesale economic interventions to end the Great Depression. In Germany, where one-third of the labor force was unemployed in 1933, massive government spending and investment combined with considerable levels of state control, though not central planning, created virtually full employment by 1936, before the full- scale move towards a war economy.[30] By contrast, the American New

[28] Mary O. Furner and Barry Supple, eds., *The State and Economic Knowledge: The American and British Experiences* (Cambridge: Cambridge University Press, 1990); A.W. Coats, ed., *Economists in Government* (*History of Political Economy*, Volume 13 Supplement) (Durham, N.C.: Duke University Press, 1981); Neil De Marchi, "League of Nations Economists and the Ideal of Peaceful Change in the Decade of the Thirties," in *Economics and National Security* (*History of Political Economy*, Volume 23 Supplement), ed. Craufurd Goodwin (Durham, N.C.: Duke University Press, 1991).

[29] James Foreman-Peck, *A History of the World Economy* (Hemel-Hempstead: Harvester-Wheatsheaf, 1995).

[30] Avraham Barkai, *Nazi Economics: Ideology, Theory and Policy*, trans. Ruth Hadass-Vashitz (New Haven, Conn.: Yale University Press, 1990).

Deal is counted a failure by economic historians. State controls were many but incomplete; federal government spending was high, but more or less canceled out by state governments' savings. The policy experiments of the New Deal failed because each agency was staffed by a mixture of economists and bureaucrats holding divergent views about both economic aims and means of intervention.[31]

Despite their only partial success, the generation of economists who were in their prime at the end of the Second World War felt both committed to prevention of further depressions and optimistic that they had the tools.[32] To understand why, we need to look more closely at the developments within economics during the 1930s and their relation to the arts of economic engineering.

"SOLVING" THE GREAT DEPRESSION: NEW ECONOMICS, NEW EXPERTISE, AND NEW TECHNOLOGIES

Beginning in the 1930s, economists worked with a general distinction between microeconomics (the behavior of the individual or firm) and macroeconomics (the behavior of the aggregate economy), though the labels themselves emerged only during the postwar period and became largely redundant in the 1990s. Because of the importance attached to explanations of the Great Depression, this came to be seen as a critical distinction. The mathematical neoclassical economics of the first half of the century provided a micro-level analysis at the level of firms and consumers on both sides of the market and dealt with a combination of such markets in a general equilibrium account. But it had nothing much to say about how individuals' different roles in the economy were *aggregated*, or about the behavior of that aggregate economy, the macro-level issues that seemed to be relevant for the dislocations of the 1920s and the Depression.

The problems of the aggregate domain were interpreted as questions of monetary theory and business cycles and were broadly debated within the extant "schools" of the period: the Austrian tradition, carried on by Joseph A. Schumpeter (1883–1950) at Harvard and by Friedrich von Hayek (1899–1992), who after the exodus from Vienna of the early 1930s, was thriving at the London School of Economics and later at the University of

[31] William J. Barber, *Designs within Disorder: Franklin D. Roosevelt, the Economists and the Shaping of American Economic Policy, 1933–1945* (Cambridge: Cambridge University Press, 1996) and his *From New Era to New Deal: Herbert Hoover, the Economists and American Economic Policy, 1921–1933* (Cambridge: Cambridge University Press, 1985); Michael D. Bordo, Claudia Goldin, and Eugene N. White, eds, *The Defining Moment: The Great Depression and the American Economy in the Twentieth Century* (Chicago: University of Chicago Press, 1998).

[32] See the conversations with James Tobin, Franco Modigliani, and Robert Solow in Arjo Klamer, *The New Classical Macroeconomics: Conversations with New Classical Economists and Their Opponents* (Boulder, Colo.: Westview Press, 1984).

Chicago; the Swedish tradition, derived from Knut Wicksell and centered in Stockholm; the Americans, both Institutionalists such as Wesley Clair Mitchell (1874–1948) and orthodox economists such as Irving Fisher; and the Cambridge school in England led by John Maynard Keynes (1883–1946). All were aggregate theorists who assumed some particular beliefs and behavior of individuals, but the precise links between individuals and the aggregate remained unformalized in their accounts. And while they shared the questions posed by events in their economies, they worked with different methods of analysis and proposed different solutions.

In the stereotyped story of policy economics, the category of macroeconomics was put on the map by of the work of one Western economist – John Maynard Keynes. In that story, the importance of Keynes is that his work persuaded governments that they could keep their economies out of depression by adjusting their own spending: By their own actions, they could "manage" the economy. His ideas, which in the main came too late to be responsible for influencing policy during the Depression, were widely adopted after the war.[33]

For the economics profession, the stereotyped story is a different one: The importance of Keynes' work lay not in his solution, but in his analysis of the problem.[34] Keynes suggested that the aggregate level of activity depended on the level of effective demand, which could get stuck at a point at which unemployment remained because markets did not clear. This contrasted with the self-correcting mechanisms, or tendency toward market-clearing equilibrium, assumed in the older orthodox aggregate economics and in much of the newer business cycle economics. In Keynes's account, failures arose because of the ways that, in the aggregate, individuals, firms, and the government – whether as savers, investors or consumers – reacted to current events in the economy in the face of uncertainty about the future.

An adequate history, however, needs to explain why Keynesian economics won out over alternative accounts of the Great Depression, both in the academic domain and as a policy tool. The Stockholm School's analysis shared Keynes's assumption that the world was a disequilibrium world, but their theories involved a much more detailed analysis of the problem of incompatibility of individuals' plans taken together and within each time period.[35]

[33] But see the series of papers on "pump-priming" in *History of Political Economy*, 10:4 (1978), 507–48, for an example of tool-based Keynesian style engineering in the 1930s; for later Keynesian influence, see Peter A. Hall, ed., *The Political Power of Economic Ideas: Keynesianism across Nations* (Princeton, N.J.: Princeton University Press, 1989).

[34] Peter Clarke, *The Keynesian Revolution in the Making, 1924–1936* (Oxford: Clarendon Press, 1988), centers on the development of Cambridge analysis; David Laidler, *Fabricating the Keynesian Revolution* (Cambridge: Cambridge University Press, 1999), reviews the debates in aggregate economics and other issues discussed here.

[35] Lars Jonung, ed., *The Stockholm School of Economics Revisited* (Cambridge: Cambridge University Press, 1991); Bjorn A. Hansson, *The Stockholm School and the Development of the Dynamic Method* (London: Croom Helm, 1982); Bo Sanderlin, ed., *The History of Swedish Economic Thought* (London: Routledge, 1991).

Though in many ways attractive as an explanation of what happened at the aggregate level, because it paid full attention to micro behaviors and how these fitted together, it remained largely theoretical and incomplete. The statistical information and mathematical analysis required to make the Stockholm School's approach operational, either as a fully articulated aggregate level theory or as a guide for general advice or government action, did not seem feasible in the 1930s. Ragnar K. Frisch (1895–1973), a Norwegian econometrician of the period, did try to develop a planning model based on consumption requests, with some family resemblances to the Stockholm ideas, and quantified the calculations required. They were of a similar order to those required under socialist planning, another alternative solution to the Depression available in the Marxist tradition. Following the work of Italian economist Enrico Barone (1859–1924), the period from 1920 to 1960 saw a vehement theoretical debate between the Marxist tradition, represented notably by the Polish econometrician Oskar Lange (1904–1965), and the Austrian tradition, represented by Ludwig von Mises (1881–1973) and Hayek. The issue was whether markets were necessary for economic efficiency. It turned out that the socialist planned economy could reach as good an outcome as the free market economy in terms of optimal production and welfare for all individuals, for a given technology and distribution of income – the "Pareto optimum." The information assumed for the necessary calculations did not exist, however, in the absence of a market.[36] "Austrians," who eschewed data and calculations and made their arguments in the traditional manner in words, used the principle of methodological individualism in their scientific accounts and held to a strong belief in the efficacy of the free-market system to solve all economic ills, a stance that became increasingly untenable as the Depression continued.

Keynes's book, *The General Theory of Employment, Interest and Money* (1936), was difficult; like contemporary analyses of business cycles, it was written in the old style, yet with some attempt at formal analysis. But his ideas were very quickly translated by economists in Britain and the United States into simple mathematical models of the macro economy; the longest-lived and flexible, the "IS-LM model," came from John R. Hicks (1904–1989), who was at that time developing a general equilibrium account at a miniature level.[37] These macro models were manipulated to give specific answers to concrete and real policy questions, using the comparative static method, well known among economists and understood from Marshall's microeconomics of the early century. The Keynesian analysis did demand new aggregate data, such as aggregate income and consumption, but once assembled the data could be used to measure parameters of the Keynesian relationships using

[36] Don Lavoie, *Rivalry and Central Planning: The Socialist Calculation Debate Reconsidered* (Cambridge: Cambridge University Press, 1985).

[37] William Darity, Jr., and Warren Young, "IS-LM: An Inquest," *History of Political Economy*, 27: 1 (1995), 1–42.

statistical models and methods.[38] The resulting model-based analysis, if not Keynes' book, produced answers that could be explained to governments, and it was deemed more scientifically advanced than the older "commonsense" analysis. The element of surprise in its advice – that governments should spend their way out of depression, not save because times were bad – was also important in making it acceptable in the political domain; in the 1940s and 1950s, politicians wanted new solutions to the old economic problems. Thus, whereas the alternative economic accounts of aggregate economics available in the 1930s relied on general verbal advice or analytical and planning tools that were too complex or too demanding of data or calculation to be feasible, the Keynesian account generated what might be called intermediate technologies, that is, practical ones for governments in need of policy prescriptions and scientists seeking adequate explanations of events.

The exact historical claims about when, where, and from what sources Keynesian economics was put in place are subject to debate.[39] The more important point is that economic expertise and usable technologies were developed together. After 1950, with the aid of new data, new statistical methods, and simple mathematical models of the economy and economic behavior, economists made their advice effective across a wider range of fields – from older domains, such as regulation of natural monopolies and monetary policy, to newer problems, such as the creation of stabilization schemes and the control of war economies and finance. The profession demonstrated its ability to respond to a range of regular problems, such as the design of subsidies for farmers, and to economic emergencies, such as hyperinflation, with new policy prescriptions that turned out to have varying degrees of success and failure. The failures were, perhaps, a more important dynamic for the history of economics than the successes.

THE FEEDBACK FROM ECONOMIC ENGINEERING TO HISTORICAL EVENTS

Economists' engineering and historical contingencies constantly interact, producing new economics, technologies, and expertise. In this interactive context, macro- and microeconomics became formally joined. Keynesian ideas appeared to be reasonably successful during the 1950s and 1960s, when

[38] Studenski, *The Income*; national income accounting also provided a considerable stimulus for such data collection and usage. On the work of the Russian-born Simon Kuznets in the United States, see Carol S. Carson, "The History of the United States National Income and Product Accounts: The Development of an Analytical Tool," *The Review of Income and Wealth*, 21:2 (1975), 153–82; Mark Perlman, "Political Purpose and the National Accounts," in *The Politics of Numbers*, ed. William Alonso and Paul Starr (New York: Russell Sage, 1987); on the work of John Richard N. Stone in the United Kingdom, see the entry on him by Angus Deaton in *The New Palgrave*, ed. Eatwell, Milgate, and Newman, vol. 4, pp. 509–12. See also Ellen O'Brien, "How the 'G' got into the GNP," in *Perspectives in the History of Economic Thought: Method, Competition, Conflict and Measurement in the Twentieth Century*, ed. Karen I. Vaughn (Aldershot: Edward Elgar, 1994).

[39] Hall, *Political Power*.

the analysis was used to design fiscal policy and to "manage" the economy. This was perhaps the high period of the economist as engineer, advising the government on how to set the levers of economic control. Western governments used economists' models and calculations to dampen the economic cycles in their economies and to engineer relatively stable growth, low inflation, low unemployment, and a reasonable balance of payments. In certain open economies, those with a relatively high level of trade compared to their gross national income, there were problems in timing the levers. In retrospect, it appeared that these levers were rather crude tools: They were designed to change incentives for individuals in the system, even though the ultimate aim was to affect the aggregate. In addition, the government itself was an actor, and its own spending and saving was another control lever. Such economic engineering thus did not mean external control over an object, but rather conscious action taken by one of the major components of the machine.

Governments' ability to manage or control their economies suffered a severe breakdown during the 1970s. The most immediate evidence of that failure was the new phenomenon of "stagflation," both high inflation and high unemployment, a combination inconceivable within Keynesian economics, which perceived a trade-off between the two. The problem prompted a number of diagnoses. First, the theory and policy design of Keynesian economics focused on the demand side of the economy, while economists gradually concluded that stagflation resulted from changes on the supply side – in particular, from the large shock given by the 1973 rise in oil prices. A second explanation connected the rising inflation with the neglect of monetary elements in the Keynesian system, a critique led by the monetarist Milton Friedman (b. 1912). Another element in the account was the role of expectations: As people got used to the amount of inflation in the economy, they modified their behavior based on an expected amount of inflation remaining in the system and so exacerbated the stagflation. A fourth element was that the government's actions were being second-guessed, thus invalidating its power to manage the economy while at the same time being an actor in it. This "Lucas critique," named after the Chicago economist Robert E. Lucas (b. 1937) and built on earlier versions of the same insight, was another nail in the coffin of the government as controller of the economy. Economists judged, in effect, that the Keynesian demand management of previous years had helped to create stagflation and that its continuation after the supply-side shock had exacerbated the problem; they represented this in an aggregate supply-demand analysis that became popular at the time. Thus, in a simple domain transfer, a standard neoclassical micro-level tool was applied to the macro context to explain a phenomenon and a policy failure at the aggregate level.

Economists' accounts of stagflation spawned the "rational expectations revolution," an analysis that connected the microeconomics of uncertainty at the individual level with the impact of policy tools at the macro level.

Developed primarily by Lucas, this thesis argued that individuals should be assumed to hold "rational expectations," that is, that they made use of all the information they had and so did not make systematic errors; such expectations might be taken as formally equivalent to those embedded in the economic and econometric model. As a result of the stagflation experience, economists came to hold the view that macroeconomic models should always have adequate micro foundations, that is, that they should be consistent with a set of assumptions, mathematically represented, about the behavior of the individuals in the economy. The technology of new economic models thereby served to underwrite the integration of macroeconomic theory with neoclassical microeconomic theory.[40] The individuals represented in the economy were now also bound tightly into the model by the presumption of rational expectations. Thus the push for micro-macro integration was a result of the practical experience with stagflation, but its particular form was determined by the two postwar disciplinary contexts of an increasing mathematical formalism and, as we will see in the next section, the renewed ideological attraction of individualism.

The most striking case of feedback from economic engineering to economic events and ideas came with the collapse of communism, which Western economists largely blamed on the failures of Eastern block economics. Eastern European economics was the product of firmly held ideologies and strongly based theories of production, along with techniques of central planning; it had delivered growth rates substantially above those of the free capitalist West for much of the early postwar period. When their citizens grew disenchanted with the economic outcomes produced in later years by their own economic experts, they were ready and eager to invite Western economists into their countries to teach them "modern" economics. Western expertise did not prove entirely equal to the task of designing economic institutions for the Eastern countries' transition to capitalism, and that experience challenged Western neoclassical mainstream economists to incorporate the role of institutions into their formal models.

THE IDEOLOGICAL TURN IN AMERICAN ECONOMICS

The day-to-day practice of economics turned technical at midcentury, just as economic ideas became a central and more highly specified element in the ideologies of different world power blocks.[41] Particularly in American economics, the acceleration toward tool-based economics and the

[40] Kevin D. Hoover, *The New Classical Macroeconomics: A Sceptical Enquiry* (Oxford: Blackwell, 1988); Backhouse, *Modern Economic Analysis*.

[41] This section draws particularly on my essay "American Economics: The Character of the Transformation," written jointly with Malcolm Rutherford, in *From Interwar Pluralism,* ed. Morgan and Rutherford, pp. 1–26. I thank Malcolm Rutherford for allowing me to draw on that material here.

development of a full-fledged neoclassical economics were intimately connected with the ideological war. These connections are important to an account of Western economics, for it was during this period that American economics became dominant in the Western discipline, just as the United States gained economic and political dominance.

The thesis that American war and Cold War experience were critical for the turn of American economics to a tool-based discipline in general, and to neoclassical economics in particular, requires amplification. Tool-based economics had been important in the American experience of fighting the war, not only in economic policy terms but in other areas as well, for mathematical and statistical techniques and modeling could be turned to many ends, specifically to direct war aims. Indeed, the economic side of the war effort was partly determined by businessmen rather than by economists, while the economists were employed in tasks like the design of bombing raids. The war experience also produced data and planning experience that were grist for the mill of statistically minded Institutionalists. Research on such matters as linear programming, operations research, game theory, and decision theory, involving concepts and mathematical techniques that became mainstays of later twentieth-century neoclassical economics, were generously funded as defense expenditures, and such research and funding continued into the Cold War years.[42]

The economic values enshrined in the Cold War between East and West are well known. Postwar Western economic values were more clearly defined in opposition to the centrally planned East. The leader of the "free" West, the United States, preached a theory of free markets as the most efficient ones. The Eastern bloc economic ideology began with Marxian production planning and aimed at fairness, not efficiency. Meanwhile, Western European ideals marked a middle way, aiming for reasonably free, and thus moderately efficient, markets and a reasonable level of distributional equity through welfarism and state intervention. The Western economic ideology bore down more strongly on the academic community in the United States than on those in Western Europe, with consequent effects on the views held by economists.

While war work supported tool-based economics, the American political movement against communism in the later 1940s and the McCarthyism of the early 1950s decided the issue in favor of neoclassical economics at the local level. Although the overall picture has yet to be filled in, it is clear that economists had to be careful in expressing their views.[43] One economist

[42] Mirowski, *Machine Dreams*; Robert Leonard, *From Red Vienna to Santa Monica: Von Neumann, Morgenstern and Social Science, 1925–1960* (Cambridge: Cambridge University Press, forthcoming) and his "War as a 'Simple Economic Problem': The Rise of an Economics of Defense," in *Economics and National Security* (*History of Political Economy*, Volume 23 Supplement), ed. Craufurd Goodwin (Durham, N.C.: Duke University Press, 1991).

[43] Ellen W. Schrecker, *No Ivory Tower: McCarthyism and the Universities* (New York: Oxford University Press, 1986); Craufurd Goodwin, "The Patrons of Economics in a Time of Transformation," in *From Interwar Pluralism*, ed. Morgan and Rutherford, pp. 53–84.

writing about this period suggested that moving to tool-based economics was a defensive option against ideological persecution, though this sometimes proved to be an inadequate defense, particularly for those whose values were not aligned with the new ideology. There are examples of American economists of mild left-wing sympathies (including one future Nobel Prize winner, Klein) leaving the United States for the safety of Europe. Others who held such views remained, for the effects of loyalty oaths and McCarthyism were uneven. Nevertheless, economists who preached Keynesianism – viewed by some as close to socialism – or who had advocated postwar socioeconomic planning of the sort associated with Institutionalist positions were particularly at risk from university administrators, local state governments, and research institute trustees, who sought to purge their faculties of "reds" and "pinks" during the late 1940s and early 1950s.

Though neoclassical economics had been slow to spread in the United States during the interwar period, unlike the economics of institutionalism, it was nonetheless one of the forms of economics unambiguous in its support of capitalism. The ideal abstract neoclassical economy takes as its problematic the efficient use of existing resources, and analysis of this model suggests that result is best achieved by minimizing interference in the market. The neoclassical theory of distribution, in part developed by the American economist J. B. Clark around the turn of the century, assumed that the efficient economy would also be characterized by a just distribution for each contributing factor: Labor and capital would earn precisely what was due to them. In this privileging of efficiency and the ideal economy, the important questions of equity arising from the original distribution of wealth in the actual economy are left to one side. The values of neoclassical economics were perfectly aligned with the American position in the ideological war, so that during the postwar years the virtues of free individuals operating in free markets, or "economic democracy," came to seem inseparable from the virtues of political democracy.

In sum, it was neoclassical economists, whose mode of analysis had come to rely most heavily on the adoption of statistics, mathematics, and modeling technologies – those same techniques that had proved so efficacious during the war – who found their economic values most closely aligned with those of postwar society at large. In this context, pressures to conform to the newly (re)established American ideal of free markets and individual capitalism boosted the adoption of neoclassical economics at the expense of the previously dominant Institutionalist approach within the economics profession in America.[44]

Throughout the postwar period, American neoclassical economists claimed that tool-based analysis provided a mantle of scientific neutrality

[44] Malcolm Rutherford, "Understanding Institutional Economics: 1918–1929," *Journal of the History of Economic Thought*, 22 (2000), 277–308.

with respect to all ideological positions. This claim could not be made by the free market and libertarian "Austrian" tradition, by then largely domiciled and increasingly naturalized in America, for their methods were old-fashioned words, which no longer held the guarantee of scientific objectivity. Only in the 1980s and 1990s, when the political climate had turned so far to the right as to obscure their ideological tinge, did the Austrian accounts associated with Hayek and Schumpeter of the functioning of free markets, the role of competition as both a creative and a destructive agent, and the self-organizing nature of the market economy feed successfully into American mainstream economics, which then developed their ideas on the role of information and the evolution of competition in formal and technical ways. After the fall of the Eastern communist regimes, some of the ideas and questions associated with the "old" American Institutionalists also found their way back onto the agenda. But these too were now integrated into the mainstream, so it was difficult at first to recognize the congruence between "old" and "new" institutionalists, whose ideas could be found in realms ranging from law and economics, in the work of Ronald H. Coase (b. 1910), to economic history, in the work of Robert H. Fogel (b. 1926) and Douglass C. North (b. 1920). The "old" concerns with economic justice and the inseparability of theory and evidence were lost, but interest in economic habits and institutions reappeared in investigations into the rules and conventions of behavior, the legal and economic arrangements of economic units, and the processes of learning and adaptation.[45]

From this discussion it appears that tools and values cannot be divorced. But in the following sections we will see that tools remained partially independent of values, and that differences in values enabled Western economics as a whole to retain a certain variety. First, however, we need to examine more closely the scientific character and value commitments of tool-based neoclassical economics.

TOOLS AND ECONOMIC SCIENCE

The dependency of later twentieth-century economics on technologies, particularly its concentration on the modeling method, involved a subtle downgrading of economists' scientific ambitions. Published papers and books at the start of the twentieth century tended to treat specific real questions by invoking general claims or laws about how the economy works and discussing them in the context of specific cases. Alternatively, they treated questions empirically, almost as a piece of economic history, rather than invoking any particular explanations or laws. Economics was seldom abstract, and the

[45] Malcolm Rutherford, *Institutions in Economics: The Old and the New Institutionalism* (Cambridge: Cambridge University Press, 1994).

distinction between theoretical and applied economics could not easily be made.[46] A century later, economics papers tended to treat specific questions directly, either in abstract terms, by means of mathematical modeling under the heading "economic theory," or empirically, through econometrics. By the late twentieth century, there were no longer any "laws" of economics and few general theories – only models of concrete, but not necessarily real, cases.

We can see this process at work in the twentieth-century mathematical work characterizing individual behavior. From the 1890s to the 1930s, economists of the neoclassical persuasion retreated from the possibility of measuring individuals' underlying utilities and satisfied themselves with representing the situation of the choice between goods in mathematical form. Particularly in the United States, they also turned away from making claims about motivation and psychology.[47] The postulates used to characterize such individual choice behavior were outlined in Britain in the 1930s by Hicks and Roy D. G. Allen (1906–1983) and axiomatized by the American economist Paul Samuelson (b. 1915) in the 1940s, creating the depersonalized "rational economic agent" of the latter half of the twentieth century. This was a highly idealized and abstract representation, not thought to characterize any real person or actual behavior. Neoclassical economics used this model person to explore not the reasons for action, but the consequences of acting rationally, as defined by those economists, in a specified situation.

To its many critics, this portrait of individual self-interested behavior seemed highly restrictive, yet it did not forbid very much: Rationality was narrowly defined, but to behave rationally, an individual had only to prefer more goods to fewer and to maintain a certain consistency in choice situations. This allowed simplified models of behavior to be invoked in concrete and complicated situations. A good example is the postwar development of the economics of the family, a case where other social scientists resented neoclassical economic work as imperialist. In this subfield, developed by the American Gary S. Becker (b. 1930), economists explored the consequences of their general theory of individual behavior for such typical decisions as which parent should go to work and whether or not to have another child. Modeling suggested the "rational" and "efficient" decision for the specific family situation modeled. Such concrete "theoretical" – that is, mathematical – models became attached to real situations when they were reformulated for statistical work. Econometricians added greater realism and complexity to the model of economic rationality by taking other factors into account and by assessing the fit of the model to real-world data.

[46] Roger E. Backhouse, "The Transformation of U.S. Economics, 1920–1960, Viewed through a Survey of Journal Articles," in *From Interwar Pluralism*, ed. Morgan and Rutherford, pp. 85–107.

[47] A.W. Coats, "Economics and Psychology," in *Method and Appraisal in Economics*, ed. Spiro J. Latsis (Cambridge: Cambridge University Press, 1980), pp. 43–64.

In such neoclassical modeling, it was the restrictive neoclassical assumptions of self-interest depicted as rationality that enabled the reduction to simplicity necessary for the mathematical models, and it was this that non-neoclassical economists found objectionable. For critics, the effect of the program was to erase whatever did not fit the paradigm. But while it may have seemed otherwise, the neoclassical program did not prove immune to such criticisms, and modeling developed in three new directions during the late twentieth century. First, the dual impact of critiques of the economists' notion of rationality by Herbert Simon and Amartya Sen (b. 1933) in the 1970s and the results reported from laboratory experiments in the 1980s broadened the concept and theoretical characterizations of economic rationality. The "rational economic agent," who had become so pervasive in economics during the third quarter of the twentieth century, came, in the final quarter, to be used more as a benchmark for the exploration of behavior patterns that varied from that ideal. Second, it was no longer assumed that each micro-economic individual acted independent of other individuals; rather, they had to be modeled in situations of interaction. Third, economists found a way within their paradigm to take institutions into account. Despite appearances, the tools of neoclassical economics turned out, by the end of the century, to be adaptable to a wider range of assumptions (and so implicit values) and a greater variety of situations than had earlier been conceived.[48]

We can see this flexibility in the field of "game theory." This was a body of investigation, dating from the classic work by John von Neumann (1903–1957) and Oskar Morgenstern (1902–1977) published in 1944, and later developed primarily in America and Germany, that became dominant in late-twentieth-century economics and was exported to evolutionary biology and political science. In game theory, individual "agents" are placed in situations of interaction with each other called "games."[49] This placement is not usually real, but a thought experiment worked through in a model representation in mathematical form. Since the 1980s, such investigations have been one of the main foci of the growing program of laboratory experimentation in economics, using methods similar to those found in social psychology.[50] This has allowed economists to study the processes of economic interaction and learning in a "controlled" field. The "games" in both thought and real experiments, are defined as situations with rules of interaction or "institutions": who moves first, how many moves there are, what kinds of moves can be made, and so forth. As in the usual modeling method of neoclassical micro

[48] For a discussion of the individualistic values imbedded in marginal and neoclassical economics at the turn of the last century that is compatible with the range of commitments discussed here, see Maloney, *Marshall, Orthodoxy, and the Professionalization of Economics*.

[49] E. Roy Weintraub, *Toward a History of Game Theory* (*History of Political Economy*, Volume 24 Supplement) (Durham, N.C.: Duke University Press, 1992).

[50] Vernon L. Smith, "Experiments in Economics," in *New Palgrave*, ed. Eatwell, Milgate, and Newman, vol. 2, pp. 241–9.

theory, each type of game could be "applied" to concrete situations in which individuals or firms (the economists' "agents") might find themselves. This has enabled game theorists to apply their ideas to specific fields, such as industrial economics, where strategic choice has a natural role in the problem of describing and understanding the behavior of competing firms.

The dominant neoclassical economic theory of the postwar period was in many ways rather general; modeling gave it content because economists used the method to explore what the theory would mean in specific, rather simple, circumstances. By contrast, the larger economic world was seen as incredibly detailed and complex. Modeling, even the more elaborate econometric models maintained by economists in government, made the economy seem open to investigation. It was the simplistic quality of such models, particularly the smaller ones, with their effective reduction of complexity and their ability to produce answers explainable in terms of rather simple propositions of economic efficiency and rationality, that made neoclassical advice ubiquitous in the economic sphere and invasive even in the political and social spheres.[51]

THE NEXUS OF TOOLS, SCIENCE, AND IDEOLOGY

Although the values of neoclassical economics were aligned with those of the general market orientation of Western, and particularly of American, economic ideology, tools and ideology were not fully aligned, especially in the policy domain.[52] Even while relying on economic theory to espouse the benefits of free markets and unfettered capitalism, American economic policies in the domestic arena and those exported abroad remained interventionist and depended on tools. For example, the Marshall Plan required that recipient countries have an overall economic policy constraint conceived in Keynesian aggregate terms, (and this in turn required the local provision of national income accounting systems, based on Richard Stone's design), which, at that time of reconstruction, required some strict domestic policies, even though at the same time commitments to open markets were extracted.[53] Western ideologies and tools figured prominently in the relationships among countries, donors, and international agencies. Through its own Foreign Aid Program and its dominance among economists in international agencies, such as the International Monetary Fund and the World Bank, the United States

[51] For a good example, see Jacques J. Polak, "The IMF Model at 40," *Economic Modelling*, 15:3 (1998), 395–410; and for a more general portrait of the insider's view, see William R. Allen, "Economics, Economists, and Economic Policy: Modern American Experiences," *History of Political Economy*, 9:1 (1977), 48–88.

[52] The classic treatment of the interrelations of values and theory development, rather than tools, is K. Gunnar Myrdal, *The Political Element in the Development of Economic Theory* (New York: Simon and Schuster, 1963).

[53] M. J. Hogan, *The Marshall Plan: America, Britain and the Reconstruction of Western Europe, 1947–1952* (Cambridge: Cambridge University Press, 1987); for discussion of national income accounts, see note 38.

exported beliefs in the virtues of free competition and an economy free of government direction along with a set of tools meant to aid in the design of economic policy, planning, and project assessment. The economics of the "free world" seemed to require an arsenal of economic tools of intervention to make sure that it worked "properly" – that is, according to the donor's design – in new countries. Even economists who had little sympathy with Western economic ideals soon learned to use the tools in order to maximize the aid their economies received. The ideologies of Marxism and communism of the Eastern bloc countries also connected their satellites to economic engineering, for Marxian economies required structural analysis of the economy and high levels of data collection and calculation for purposes of production planning.

Nevertheless, tools were more genuinely autonomous, or detachable, from values in policy usage than is suggested by these observations: Tools were neither totally domiciled nor fully independent in either Western or Eastern ideologies. One tool that was widely thought to represent the task of central planning is the Leontief input-output matrix, developed by Wassily W. Leontief (1906–1999), a Russian economist who emigrated to America. This method uses industry-level data, on inputs into and outputs from each industry, to portray the technical interrelations between the sectors of the economy in matrix form. Such matrices can be used to understand and analyze technical relations and to predict or plan industrial output at various levels, ranging from the industry level to the national economy. This technique fitted neatly with the economic theory of Eastern bloc countries that assume labor creates value in production, so growth has to be understood and planned at the level of production. In fact, however, it was only in the 1960s that the tool was imported from the United States to play a marginal role in Soviet central planning, which had relied on the more practical method of material balances. In any case, the use of such matrices does not necessarily require the theoretical commitment to a labor theory of value, and input–output analysis has been by no means confined to Eastern bloc countries. Norway, for example, has used these methods in conjunction with a form of national budgeting accounts as a standard part of its economic information and policy analysis since the Second World War. French indicative planning of the postwar period was also based on a version of the method. Leontief constructed such matrices for the U.S. economy as part of an academic research initiative during the 1930s, and they have also provided tools for academic research into economic performance. Such tables were used by the U.S. government in the 1940s to predict the probable economic response to the end of the war within different economic sectors. Thus, although not the main policy tool, input-output tables have often been constructed and used for policy analysis in Western countries.

During the second half of the twentieth century, the tool-based style and neoclassical content of American economics became the dominant influence

not only in policy terms but also within Western economic science. The disciplinary background helps to explain how this American economics was exported to other countries.[54] One of the main conduits was through the adoption of American economics education, the development of graduate school training based on American lines, and the preference to send students for training in the United States rather than somewhere else. Whereas during the late nineteenth century American economists had typically undertaken training in Europe, mainly in Germany, by the late twentieth century the flow had been reversed; the preferred place of economics study for Europeans became America. The decline of European imperial power during the postwar period meant that economists who had earlier looked to Britain or France as the educational model, as the place to train graduate students, and for leadership in economic science and expertise, began to look elsewhere. For example, Australia became more American-oriented in its economics and began to see American economics as the new role model. India later followed a similar route, initially having imported Soviet planning ideas and found training opportunities in the Eastern bloc. New members of America's informal empire were even better candidates for importing American economics. South Korea soon began sending its brightest students to the United States for economics graduate training; they found homes in university departments and in important positions in government on their return.[55] International agencies such as the International Monetary Fund and the World Bank contributed to the Americanization process. Early repositories of American economics at a technical level, they also exported these ideas directly, by training other nationals and by specifying in their operational and technical manuals how to evaluate policy regimes, design programs, and assess project proposals.

We know most about this process of Americanization of economic science from certain cases in Latin America. Here the record describes specific attempts by a combination of governmental, academic, and charitable American institutions to instil "good" or "modern" – that is, neoclassical tool-based – economics into the academic and political elites of Latin American economies.[56] Latin Americans, both those who approved of the import of American economics and those who disapproved, openly interpreted the

[54] A.W. Coats, ed., *The Post-1945 Internationalization of Economics* (*History of Political Economy*, Volume 28 Supplement) (Durham, N.C.: Duke University Press, 1996); A.W. Coats, ed., *The Development of Economics in Western Europe since 1945* (London: Routledge, 1999).

[55] Young Back Choi, "The Americanization of Economics in Korea" in *Post-1945 Internationalization*, ed. Coats, pp. 97–122.

[56] Veronica Montecinos, "Economists in Political and Policy Elites in Latin America," and Maria Rita Loureiro, "The Professional and Political Impacts of the Internationalization of Economics in Brazil," in *The Post-1945 Internationalization*, ed. Coats, pp. 279–300, 184–210; J. G. Valdes, *Pinochet's Economists: The Chicago School in Chile* (Cambridge: Cambridge University Press, 1989). For earlier attempts to export "good" social science, see Earlene Craver, "Patronage and the Directions of Research in Economics: The Rockefeller Foundation in Europe, 1924–1938," *Minerva*, 24:2–3 (1986), 205–23; Martin Bulmer and Joan Bulmer, "Philanthropy and Social Science in the 1920s: Beardsley Ruml and the Laura Spelman Rockefeller Memorial, 1922–29," *Minerva*, 19:3 (1981), 347–407.

changes in their academic economics as Americanization; but European academics preferred to see the trend as one of "internationalization" or even of "denationalization," for they were never quite so open to channels of American domination.

European academics gradually became more American in their concern with academic credentials and citations and their adoption of American-style graduate training schemes, all of which created mechanisms for conformity. Yet in many respects European economics retained its individuality. This may be because of the wider range of economies and ideologies that coexisted within European democracies, and the greater public service ethos of European economics, which made European economists more likely to spend some of their working time outside the ivory tower of the university and inside government or in politics.[57] For example, in Italy and Japan economics was, for much of the postwar period, home to active groups of Marxist economists.[58] Despite the American role in reconstruction, many Marxists regained their positions at the end of the war, for they had been active in resisting the fascist war regimes in those countries. Dutch economics remained largely wedded to what is known as the Tinbergen legacy, involving technocratic management of the economy and a practical commitment to social justice in analysis and outcomes. Norwegian economics also remained to some extent concerned with the econometric legacy of Frisch, displaying its own brand of commitment to economic planning and policy design. French economics supported a strong group of modernists of high theory in the mathematical and statistical domains, but such economists represented only a small part of the economics profession in France, which seemed, like Germany, to remain relatively immune to the internationalist trend. In Britain, while the Keynesian legacy continued into the 1970s, academic and policy economists were, from that time, more ready to follow American examples in both disciplinary and theoretical respects. In Europe as a whole, the concern for economic security and a relatively equal economic distribution kept issues of political economy firmly on the scientific and policy agendas. In scientific endeavor, as in the sphere of policy advice, tools proved in part autonomous and applicable in circumstances where the values of rationality and efficiency inherent in American neoclassical economics might be taken to be second-order values.

Most late-nineteenth-century Western economists read several languages and often wrote in many. Despite language barriers, communication between members of recognized national schools was effective and active; yet national schools thrived. By contrast, with the domination of American economics

[57] R. L. Frey and Bruno Frey, eds., "Is There a European Economics," *Kyklos*, 48:2 (1995), 185–311.

[58] Pier Luigi Porta, "Italian Economics through the Postwar Years," and Aiko Ikeo, "The Internationalization of Economics in Japan," in *The Post-1945 Internationalization*, ed. Coats, pp. 165–83, 123–41.

during the late twentieth century, the languages of scientific economics have become unambiguously mathematics, statistics, and English. These shared languages have been advanced as another of the reasons why the tool-based style of American economics has proved an effective scientific export. But the existence of shared tools and language, and the partial autonomy of tools from ideology, have also provided an easy entry for challenges to American mainstream ideas. Thus, some of the most interesting developments of late-twentieth-century economic analysis have come from third world economists operating within the first world community, the most notable example being Sen's analyses of famines and poverty.

CONCLUSION: THE DYNAMICS OF THE ECONOMICS DISCIPLINE

The twentieth-century discipline of economics, its ideas, methods, institutions, "schools," and the shifting of what constitutes the "mainstream," depended not only on the everyday internal dynamics of normal science, but also on the demands of changing historical realities at local, national, and international levels. This is the way "nature" works in economics: The economies throw up unexpected economic events or demands of such magnitude that they exert a strong discipline on the pattern of economics. At the same time, the economic science of the twentieth century has, by means of its engineering interventions in the economy, engendered new economic "events," to be reckoned with by new generations of economists. Thus the use of technological methods of analysis and tools of intervention, a particular feature of Western economics in the twentieth century, created a peculiarly reflexive dynamic for the discipline. The practice of economics over the twentieth century changed from a primarily verbal method to one dependent on mathematics, statistics, and modeling. This move was connected to the growing power of an American-dominated neoclassical economics, but it was also dependent on many other contingencies, generated from inside economics and from outside. The histories of tool-based economic science and of the economies it analyzes cannot easily be separated, nor can they be pulled apart from local ideologies, the foreground within which economics thrives.