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The formation of "Modern" Economics: Engineering and Ideology

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The Formation of "Modern" Economics: Engineering and Ideology

Mary S. Morgan*

Economics has always had two connected 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 reveal its governing laws while the latter was concerned with using that knowledge to fashion economic policy. In the twentieth century these two aspects have more often been contrasted as positive and normative economics. The continuity of these dual interests masks differences in the way that economics has been both constituted and practiced in the twentieth century when these two aspects of economics became integrated in a particular way. Originally a verbally expressed body of scientific law-like doctrines and associated policy arts, in the twentieth century these two wings of economics became conjoined by 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 economic theory change 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.

Economics as engineering

Understanding 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 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, as in the eighteenth century term "art of manufactures", which relies on tacit knowledge and decidedly human input.[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 while the application of quantifying technologies to the world could never be automatic but always involved human judgment. There are certain parallels here to psychology's effort to "control" the individual, though, 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 is subject to different interpretation at different times in the practice of twentieth-century economics. In terms of operating the economy, control engineering notions were explicitly discussed during the 1950s experience of the "managed" economy. The picture of the macroeconomy was constructed in a way that implied 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 controlled by personal feedback loops. More flexibly, in the 1960s, governments were thought to have the economic powers only to "fine-tune" the macroeconomy or to nudge the economy back on path.[2] In the 1920s and 1980s, still less interventionist modes were in favor, and macroeconomic policy was understood as taking fiscal care and following rules of monetary operation, suggesting the idea of maintaining a well-running machine, while at the individual level the issue was rather one of influencing behavior via incentive systems rather than by mechanisms of control.

The engineer as designer and constructor has also been 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. In the post 1950s period, the notions have been more evolutionary and less mechanical, namely to affect the environment within which people act in order to produce adaptive economic behavior. Western economists have been expected to formulate development paths, to design new economic institutions to foster market economies and to map out transition paths for post-Communist economies. Over the whole century, they were asked to carry out technical assessments for economic decisions or 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. They were at the same time 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 accessing phenomena and constructing facts about the economy.

Around 1900, there was relatively little mathematics, statistics or modeling in any economic work: economics was a verbal tradition. In the first half of the 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 argument. In 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 both in theoretical work 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 claims to

such a title had less to do with any success in using mathematics to formulate general laws or using statistics to predict events in the economy, the criteria often applied to the physical sciences, and more to do with turning economics into a discipline where 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 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 in the second part of the century.

Economics from the nineteenth to the twentieth centuries.

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 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 sub-fields, 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.

In the late nineteenth and early part of the twentieth centuries, economics was characterized by a considerable pluralism of beliefs, theories and methods. It is difficult to see any one school of economics dominant and, 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 consumers' feelings 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) unit consumed, the least valuable in terms of utility gained, provided the measure of exchange with other goods and thus the price paid for all units. There were four variants of this new theory. The English economist, William Stanley Jevons (1835-82), 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 those 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 over 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 front 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 research front continued as an important one through the first half of the twentieth century,

when the characteristics of what became fully-fledged neoclassical economics in 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 only became widely adopted to the exclusion of other approaches, however, during the second half of the twentieth century.[8]

One of the reasons for the slow acceptance of the neoclassical research front, 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 an American historical economist like Richard T. Ely (1854-1943) could find the concepts and analysis useful for discussing individual consuming behavior without being committed to the utilitarianism and differential calculus of Jevons. Similarly in the 1930s, Joan V. Robinson (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 like 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 into 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 every possible attention to externally adduced evidence, the Austrian school of Menger began with economic individualism, favored abstraction in theory and 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 capital accumulation. American Institutionalists, 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 level and the evolutionary change these experienced.

Thus, between 1870 and 1940, Western economics can not 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 whole twentieth century, can we see how the various strands of marginalism fully 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 agenda to form the mainstream in Western economics, other streams, namely the historical and Marxist traditions, were pushed to the margins.[10]

The outline story for these events advanced inside economics faculties usually make theory change, 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 outline story have no convincing dynamic, so other historical factors need to be considered. The standard treatment also downplays the more obvious change over the century in the way economics is 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 industry of the late nineteenth century, required the collection of data from many different firms and deciding on appropriate methods of aggregating these to form one series of measurements. The more complex problem of measuring "the price level", that is, the general level of prices, needed for applied studies in monetary economics, led to the development of index-number theory. This 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.

The problem of choosing an appropriate index number formula turned out to be a generic one for much economic measurement, spawning monographs on measurement formulae and debates over the relevant criteria, which continue as a highly specialized part of the economics literature.[13] The arguments are technical and abstruse, but the topic is one with a considerable degree of practical relevance. A change in 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 in the 1990s![14] There are also profound philosophical implications, for the choice of weighting schemes depends on different assumptions regarding equality between people.

Arguments also arose about the conditions for measurability of unobservables such as "utilities" and the appropriateness of measurement formulae for various economic concepts which 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 definition or causal account. The cycle might be in output, in prices, in activity or other elements and 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, Mass. to Moscow, from Vienna to Berlin, in the 1910s, 1920s and 1930s. Measurement was not an end in itself, but a necessary prerequisite for predicting the turning points of the cycles in economic activity which beset all economies, an ability much in demand in 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, as other social scientists, often initiated and collected their own data sets 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 increased massively the collection of data by the state and its agencies. By the 1950s, economists in the Western world had access to a bewildering variety of "official" data. Rarely since then have economists set out to take their own measurements.

Economists' ambitions in measurement soon led them, along with other social scientists, to develop mathematical statistics. Measurements which had been valued earlier for their own sake, as sufficient evidence in tables and graphs, became 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 ever done is reputed to be that by 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. From the early twentieth century, economists used such statistical methods to measure parameters in simple relations. Understanding the law of demand, for example, required the 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 feelings, only two of the four variants of this thesis adopted mathematics: Jevons' account of individual feelings expressed with the differential calculus and Walras' equations for his general equilibrium exchange economy. Though Clark came to adopt 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 immediately following generation began along the joint mathematical trajectories set by Jevons and Walras. It is traditional to understand Jevons' project as being concerned with decisions concerning the marginal utilities of the individual or individuals in exchange situations with one another, 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 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 in several domains of

the equilibrium account. 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 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 ,while Marshall's neoclassical concepts provided the basis for later tool-based analysis of equity and distributive questions arising from governmental actions. Some of these forms of social engineering based on mathematical formulation and calculation had earlier been developed by French engineers during the nineteenth century but only became general in public economic decision making in 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 fully worked out. The introduction of mathematics not only changed the way theorizing was carried out and concepts defined, but altered the questions considered relevant for study and the way they were formulated. For example, the older classical and verbally descriptive account of "free" competition had meant a state in which firms were free to enter and leave the market place and actively compete 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] In place of 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 (1921-) and Kenneth J. Arrow (1921-) worked on the mathematical questions of the existence and stability of the Walrasian "general equilibrium" economy, an ivory-tower speculation into 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 of 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 as the most truthful way to express economic realities. As the twentieth century proceeded, the 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 could be empirically validated as, descriptively accurate.[22] Mathematics only became a commonplace, though still contested, form of expression for theory building in economics in the 1950s when neoclassical economics became the dominant paradigm. With the retreat from realism, mathematical form took precedence over economic content and mathematics was primarily seen as a language or tool for the exact expression of abstract theories. As the century wore on, the abstraction and formalism associated with mathematization was tempered in the practice of modeling.

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 other mathematical languages. But historians of the discipline have hardly noticed that, in the 1930s, mathematics became attached to another tool, namely, "modeling" to form 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 physics experience to develop econometric models in 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 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 methods and mathematical methods and 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 as econometrics emerged in economics. Nevertheless, these parallel movements did not take on board the commitment to mathematical representations (models) or mathematical methods as did the econometricians.

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 1940s lead of Trygve Haavelmo (1911-1999), econometrics developed its own branches of theoretical statistics and highly sophisticated, though competing, methodologies of application. Econometric models, ranging 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 (1920-) and more usually constructed for governments, have formed the mainstay of econometrics into the late twentieth century. Perhaps because of the heavy reliance of applied economics on this technology, economists have invested much research effort in the field. Meanwhile, mathematical modeling 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 both for statistical and mathematical reasoning in economics, modeling became, especially after mid-century, a distinctive element of both inductive and deductive economics in both scientific and policy domains. Models were taken as sufficiently good representations of the economic world that they formed the basis for advice to governments and firms and equally formed the basis of normal academic science. Emerging sub-fields of economic study each acquired its own "theoretical" and "applied" economists. To return to the example of business cycles, models such as Tinbergen's gave both mathematical representation to older verbal theories and could be used 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 which bore a family resemblance to those of the 1930s, and when connected to econometric models and data, these theories were "applied".

Twentieth-century economists viewed their measurement formulae, 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 tool usage 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 specifically tools for economics.[25] In the late nineteenth century, ideas from physics, physiology and psycho-physics were used in the accounts of the marginalists, and from biometrics and social statistics in statistical economics.[26] In the middle century, information science and artificial intelligence, the so-

called "cyborg sciences", were another resource.[27] Very often tools were carried by scientists themselves migrating between fields: Tinbergen brought physics tools and concepts with him in the 1930s; Herbert A. Simon (1916-2001) brought information theory tools and concepts with him 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 the mid-century. On a 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 during the period before the 1930s. Demands from the policy domain for economic expertise, and especially for a "usable" economics in the period 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 in the late 1930s as part of their attempts to solve the international and domestic problems of the Great Depression. Both the timing and the nature of policy demands affected the character of the economic science that resulted.

Economists had laid claims to a special public policy expertise throughout the nineteenth century, but the range of economic policy considered the responsibility of the state, and thus which might require 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 economy 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 hold a general economic responsibility towards their citizens.

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 in combination 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 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, the degree of economic response required to fight the war necessitated economic planning and controls on a hitherto unmatched basis, perhaps since the days of the Roman Empire. The experience of economic planning in the first war was somewhat more ad hoc and piecemeal, the second war more organized and coherent. Regardless, the state's share in the economy grew rapidly in the first war, declined in the interwar period, rose again in the second war and did not decline much thereafter. The difference between the wars, of course, was the Great Depression. All countries experienced a considerable postwar collapse soon after the recovery from the first war and severe collapses in the 1929-33 period unmatched by anything after 1950. In the United States, aggregate consumption and income fell by 25% with similar or greater falls in most European and under-developed economies. International trade and international financial institutions collapsed and the world economy moved towards autarky.[29]

The Great Depression had a profound effect on both the psyche 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 were 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] In contrast, the American New 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 peopled 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 depression and optimistic 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 in the post-war period and became largely redundant in the 1990s. This came to be seen as a critical distinction because of the importance attached to explanations of the Great Depression. The mathematical neoclassical economics of the first half of the century provided a micro-level analysis at the level of firms or 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 the individuals' different roles in the economy were aggregated, nor the behavior of that aggregate economy, the issues which 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 Friedrich von Hayek (1899-1992), who was thriving, after the exodus from Vienna of the early 1930s, at the London School of Economics and later at 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 like Irving Fisher; and the Cambridge, England, school 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 because 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 in 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 was not in his solution, but 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 towards market-clearing equilibrium, assumed in the older orthodox aggregate economics and in much of the then

newer business cycle economics. In Keynes' account, the failure 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 story, 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 analysis shared Keynes' 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] 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 1920s-1950s saw a vehement theoretical debate between the Marxist tradition represented notably by 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 old traditional manner in words, combined a strong belief in the principle of methodological individualism in their scientific accounts and in the efficacy of the free-market system to solve all economic ills, advice which became increasingly untenable as the Depression continued.

Keynes' book 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 most long-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 by 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 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 "common sense" 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, usable ones for governments wanting policy action and scientists seeking adequate explanations of events.

The exact historical claims about when, where and from what sources Keynesian economics was put into place, is 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 like regulation of natural monopolies and monetary policy to newer problems like creation of stabilization schemes and 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 hyperinflations, with new policy prescriptions that experienced 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 contingency constantly interact, producing new economics, technologies and expertise. In this interactive context, macro and micro economics became formally joined. Keynesian ideas appeared to be reasonably successful in the 1950s and 1960s when the analysis was used to design fiscal policy and "manage" the economy, perhaps the high period of the economist as engineer, who advised the government 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 rather 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 blunt 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 was an actor whose own spending and saving was itself another control lever. Such economic engineering was not one of external control over an object, but of conscious action by one of the major components within the machine.

Governments' ability to manage or control their economies suffered a severe breakdown in 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 and economists gradually concluded that stagflation resulted from changes on the supply side of the economy, 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 (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 (1937-) and built on earlier versions of the same insight, was a further 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 and they represented this in an aggregate supply-demand analysis which 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 policy failure at the aggregate level.

Economists' accounts of stagflation spawned the rational expectations "revolution", an analysis which connected the micro economics 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 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 the view that macroeconomic models should always have adequate micro-foundations, that is, be consistent with a set of assumptions, mathematically represented, of the behavior of the individuals in the economy. Thus, the technology of new economic models underwrote 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 post-war disciplinary contexts of 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. East 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 post-war period. When their citizens grew disenchanted with the economic outcomes produced by their own economic experts, they were ready and eager to invite Western economists into their countries to teach them "modern" economics. This 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[41]

The day-to-day practice of economics turned technical in mid-century just as

economic ideas became a central and more highly specified element in the ideologies of different world power blocks. Particularly in American economics, the acceleration towards tool-based economics and the development of a fully 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 American experience of fighting the war, not only in economic policy terms, but in other areas too, for mathematical and statistical techniques and modeling could be turned to many ends, specifically direct war aims. Indeed, the economic side of the war effort was partly determined by business men, rather than economists, while economists were employed in tasks like the design of bombing raids. The war experience also produced data and planning experience that were grist to the mill of statistically minded institutionalists, while research on such matters as linear programming, operations research, game theory and decision theory, involving concepts and mathematical techniques that became the mainstay of later twentieth-century neoclassical economics, were generously funded directly out of the defense budget and continued into the Cold War years.[42]

The economic values enshrined in the cold war between East and West are well-known. Post war, 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 block economic ideology began with Marxian production planning and aimed at fairness not efficiency. Meanwhile Western European ideals marked a middle way, aiming for freeish, 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 political movement of America 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, economists had to be careful in expressing their views.[43] One economist writing about the time suggested that moving to tool-based economics was a defensive option against ideological persecution, though this proved not always an adequate defense, particularly for those whose values were not aligned with the new ideology. There are examples of American economists of mild left-wing sympathy (including one future Nobel Prizewinner, Klein) leaving America for the safety of Europe. Others with such views stayed, 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 socio-economic planning for the post-war world of the sort associated with Institutionalist positions, both popular and socially supported during the New Deal and war years, were particularly at risk from university administrators, local state governments, and research institute trustees, who sought to purge their faculties of reds and pinks in the late 1940s and early 1950s.

Though neoclassical economics had been slow to spread in the United States during the interwar period by contrast with the economics of institutionalism, it was 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 this is best achieved by least 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 privileging 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 in the post-war 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 at war's end found their economic values most closely aligned with those of 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]

Through the postwar period, American neoclassical economists claimed that tool-based analysis provided a mantle of scientific neutrality with respect to all ideological positions. This was a claim that the free market and libertarian "Austrian" tradition, by then largely domiciled and increasingly naturalized in America, could not make, 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 destructive agent and the self-organising 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 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 following the work of Ronald H. Coase (1910-) to economic history with the work of Robert H. Fogel (1926-) and Douglas C. North (1910-). 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 down-grading 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 invoke any particular explanations or laws. Economics was seldom abstract, and the 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 as an applied question 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 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. In America particularly, they also turned away from making claims about motivation and psychology.[47] The postulates 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 (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 mathematical representation, not thought to characterize any real people or their behavior. Neoclassical economics used this model character 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 only had to prefer more goods to less 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 post-war development of the economics of the family, a case where other social scientists resented neoclassical economic work as imperialist. In this sub-field, developed by the American Gary S. Becker (1930-), economists explored the consequences of their general theory of individual behavior for such typical decisions as which parent should go out to work or whether or not to have another child. Modeling suggested the "rational" and "efficient" decision to take in 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.

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 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 in the late twentieth century. First, the dual impact of critiques of the economists' notion of rationality by Herbert Simon and Amartya Sen (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 proved so invasive in economics in 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 independently of other individuals; rather they had to be modeled in situations of interaction. Thirdly, 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 flexible to a wider range of assumptions (and so implicit values) and a greater variety of situations than earlier 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) in 1944 and 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" were placed in situations of interaction, "games", with each other.[49] This placement was 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, similar to those conducted in social psychology.[50] This allowed economists to study the processes of economic interaction and learning in a

"controlled" field. The situations, in both thought and real experiments, were defined in terms of rules of interaction or "institutions": who moves first, how many moves there are, what kinds of moves can take place and so forth. As in the usual modeling method of neoclassical micro-theory, each type of game could be "applied" to concrete situations described in terms of situations in which individuals or firms (the economists' "agents") might find themselves. This enabled game theorists to apply their ideas to specific fields, such as industrial economics, where strategic choice has a natural home 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 economic world was seen as incredibly detailed and complex. Modeling, even the large 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 economic advice ubiquitous and which proved invasive in the political and social sphere.[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, particularly 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 were interventionist and depended on tools. For example, Marshall Aid required that recipient countries had an overall economic policy constraint conceived in Keynesian aggregate terms and this required the local provision of national income accounting systems, based on Richard Stone's design,

even though at the same time, commitments to open markets were extracted.[53] Western ideologies and tools figured prominently in the relationship between 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, America exported beliefs in the virtues of free competition and an economy free of government direction along with a set of tools 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 learnt to use the tools in order to maximize the aid their economy received. The ideologies of Marxism and communism of the Eastern block 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 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. The basis of much central planning is the Leontief input-output matrix, developed by Wassily W. Leontief (1906-99), 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. They fitted neatly with the economic theory of Eastern block beliefs that it is labor which creates value in production, so growth has to be understood and planned at the level of production. But their usage 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 block countries. Norway, for example, has used these

methods since the second world war as a standard part of its economic information and policy analysis in conjunction with a form of national budgeting accounts. French indicative planning of the post-war period was also based on a version of the method. Leontief constructed such matrices for the US economy as part of an academic research initiative in the 1930s, and they have provided tools for academic research into economic performance. Such tables were used by the US government in the 1940s to trace through the probable economic response to the end of the war within different economic sectors. Thus, although not the main policy tool in Western economies, input-output tables have often been constructed and used for policy analysis in these 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 America rather than somewhere else. Whereas in the late nineteenth century American economists typically undertook training in Europe, mainly in Germany, by the late twentieth century the flow had been reversed, and the preferred place of economics study for Europeans became America. The decline of European imperial power in the postwar period meant that economists who had earlier looked to Britain or France as the educational model, as the place to train graduates students, or 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, having initially also imported Soviet planning ideas and found training opportunities in the Eastern block. New members of America's informal Empire were even better candidates for importing American economics. South Korea soon took to sending its brightest students to the United States for economics graduate training, and they found ready homes in the

university departments and in important positions in government policy on their return.[55] International agencies such as IMF 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 for certain cases in Latin America. Here the record describes specific attempts by a combination of governmental, academic and charitable American institutions to install "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 the import of American economics and those who disapproved, openly interpreted the changes to their academic economics as Americanization, but European academics preferred to see the trend as one of "internationalization", or even "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 adoption of American style graduate training schemes, all of which create 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, making European economists more likely to spend some of their working time outside the ivory tower of universities and inside government or in politics.[57] For example, in Italy and Japan, economics was, for much of the post-war 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 in 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 they represented only a small part of the economics profession in France, which seemed like Germany to remain relatively immune from the internationalist trend. In Britain, while the Keynesian legacy lived 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 economic agenda. 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 as second order values.

Most late nineteenth century Western economists read several languages and often wrote in many. Despite language barriers, communication between members of recognised national schools was effective and active, yet national schools thrived. By contrast, with the domination of American economics in 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 proved an effective scientific export. But the existence of shared tools and language, and the partial autonomy of tools from ideology also provided an easy entry for challenges to the American mainstream. Thus, some of the most interesting developments of late twentieth-century economic analysis came 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 in which "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 and need to be considered against the foreground of local ideologies.

NOTES

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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.: The Brookings Institution, 1975).

3 There is no overall treatment of the professionalization of the discipline, but see, for example, John

Maloney Marshall, Orthodoxy and the Professionalisation of Economics (New York: Cambridge University Press, 1985) on Britain; 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) on the United States.

4 Most historians of economics give an account of the various "schools" in this period: see Roger E. Backhouse, A History of Modern Economic Analysis (Oxford: Blackwells, 1985) or Henry Spiegel The Growth of Economic Thought (Durham: Duke University Press, 3rd edition, 1991) which places each school into its intellectual context. See Mark Blaug's Economic Theory in Retrospect 5th edition (Cambridge: Cambridge University Press, 1996) for an in-depth coverage of the theoretical developments.

5 For a consideration of classical economics, see Backhouse, Modern Economic Analysis or Spiegel, Growth of Economic Thought.

6 Most histories of this "revolution" omit Clark except Backhouse, Modern Economic Analysis; on differences between the other three variants of marginalism, see William Jaffe, "Menger, Jevons and Walras De-homogenized", Economic Inquiry, 14 (1972), 511-24.

7 See R.D. Collison Black, A.W. Coats, and Craufurd D.W. Goodwin, The Marginal Revolution in Economics (Durham: Duke University Press, 1973).

8 See, for example, the accounts in Mary S. Morgan and Malcolm Rutherford, From Interwar Pluralism to Postwar Neoclassicism (Durham: Duke University Press, 1998) and Yuval P.Yonay, The Struggle over the Soul of Economics (Princeton: Princeton University Press, 1998).

9 See Backhouse, Modern Economic Analysis. On the development of three American versions of neoclassical ideas in the period 1930-60, see Philip Mirowski and D. Wade Hands, "A Paradox of Budgets: The Postwar Stabilization of American Neoclassical Demand Theory" in Morgan and Rutherford, From Interwar Pluralism. For the two French traditions, over the longer century period, see Ekelund, R. and Hebert, R., Secret Origins of modern microeconomics: Dupuit and the engineers (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 and Blaug Economic Theory, which also deals with a broader picture of neoclassical theorizing.

10 Few texts go beyond 1945 in their coverage; one introductory text which does is Harry Landreth and David C. Colander History of Economic Thought 3rd edition, (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 edition, (New Brunswick: Transaction Publishers, 1994) who follows an earlier tradition of relating the history of economics to economic history.

12 Again there is no overall history of this movement, but see 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.

13 There is no 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 formulae will give an insight into the topic.

14 See the discussion over the Boskin report: "Symposium on Measuring the CPI", Journal of Economic Perspectives, 12:1, 1998, pp. 3-78.

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

16 For the general role of social scientists in statistical thinking around the turn of the nineteenth/twentieth century, see Donald McKenzie, Statistics in Britain: 1865-1930, (Edinburgh: Edinburgh University Press, 1981); Ted Porter The Rise of Statistical Thinking (Princeton: 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 for economics, see and Judy L. Klein Statistical Visions in Time New York: Cambridge University Press, 1997) and Mary S. Morgan, "Searching for Causal Relations in Economic Statistics: Reflections from History" in Causality in Crisis: The New Debate about Causal Structures eds: Vaughn McKim and Stephen P. Turner. (Notre Dame: University of Notre Dame Press, 1997).

17 For the history of early developments in statistical economics through till the 1940s see Morgan, History of Econometric Ideas.

18 The best account of the range of attitudes towards 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 P. Mirowski, (New York: Cambridge University Press, 1994).

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 Theodore M. Porter, Trust in Numbers: The Pursuit of objectivity in Science and Public Life (Princeton: Princeton University Press, 1995).

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 R.E. Backhouse and John Creedy (eds) From Classical Economics to the Theory of the Firm: Essays in Honour of D.P. O'Brien Edward Elgar, 257-280. See also E. Roy Weintraub How Economics Became a Mathematical Science (Duke University Press, forthcoming).

22 See Ingrao and Israel, The Invisible Hand and Weintraub How Economics.

23 Robert M. Solow's "How Did Economics Get That Way and What Way Did It Get?" Daedalus 126:1 (2000), 39-58 offers a similar characterization of late twentieth-century economics as a modeling science in an essay which came out while this one was being drafted!

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

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

26 The physics analogy has been vividly discussed by Philip Mirowski in More Heat than Light (New York: 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 Bernard Lightman (ed) Victorian Science in Context, (University of Chicago Press, 1990, pp 72-93).

27 See the papers in Part I (by Mirowski, Sent and Boumans) of New Economics and its History ed. John Davis, Annual Supplement to Volume 29, History of Political Economy (Durham: Duke University Press, 1997) and Philip Mirowski, Machine Dreams: Economics Becomes a Cyborg Science (Cambridge: Cambridge University Press, forthcoming).

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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:

Westview Press, 1984).

33 But see the series of papers on "pump-priming" in History of Political Economy 10:4 (1978), 507-548 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: 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 in this section.

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) and Bo Sanderlin, ed. The History of Swedish Economic Thought (London: Routledge, 1991).

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.

38 Studenski, The Income; national income accounting also provided a considerable impulse 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), 153-182 and Mark Perlman "Political Purpose and the National Accounts" in William Alonso and Paul Starr eds., The Politics of Numbers (New York: Russell Sage 1987); on the work of John Richard N. Stone in the United Kingdom, see Angus Deaton in Eatwell et al, The New Palgrave , vol 4, pp 509-512. See also Ellen O'Brien "How the 'G' got into the GNP" in Karen I. Vaughn Perspectives in the History of Economic Thought: Method, Competition, Conflict and Measurement in the Twentieth Century (Aldershot: Edward Elgar, 1994).

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40 Kevin D. Hoover The New Classical Macroeconomics: A Sceptical Enquiry (Oxford: Blackwells, 1988) and Backhouse Modern Economic Analysis.

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

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