Visionary Calculations: Inventing the Mathematical Economy in Nineteenth-Century America

RACHEL KNECHT

In June 1805, Nathaniel Bowditch wrote to a friend that "any writing except mercantile business or mathematical subjects is a task to me."[1] At the time, Bowditch had recently joined the Essex Fire and Marine Insurance Company in Salem, Massachusetts. He had no previous insurance experience, but he had authored *The American Practical Navigator*, a book of updated calculations used by American sailors.[2] Bowditch would eventually become nationally recognized as the father of American mathematics, but his real pride was in combining his twin passions for business and mathematics to create a busy and comfortable life for himself and his family.

In the intervening centuries, most Americans have become accustomed to a mathematical economy. Linking this world and Nathaniel Bowditch's has been the goal across a wide variety of scholarship. Historians, sociologists, science studies scholars, and even economists have sought the processes by which the economy came into being during the crucial decades of the 1930s and 1940s.[3] My dissertation aims to disrupt this conversation by turning attention to the longer history of mathematical commerce. Rather than ask what mathematics did to modern economics, it asks why anyone, at the outset of the twentieth century, would have considered mathematics useful for understanding economic life at all.

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Rachel Knecht received her doctorate in history from Brown University in 2018. She is currently a senior admissions consultant for Spark Admissions in Chestnut Hill, MA. E-mail: rknecht4@gmail.com

1. Nathaniel Bowditch to Caroline Plummer, June 30, 1805, Series I, Box 1, Folder 1, Bowditch Family Papers, 1726–1942, Phillips Library, Peabody Essex Museum, Salem, MA.

2. Bowditch, *American Practical Navigator*.

3. The most cited text on this matter is Mitchell, "Fixing the Economy." See also Breslau, "Economics Invents the Economy; MacKenzie, Muniesa, and Lucia Siu, *Do Economists Make Markets?*; Morgan, *History of Econometric Ideas*; Slobodian, "How to See the World Economy"; Yonay, *Struggle Over the Soul of Economics*.

"Visionary Calculations" posits that the proliferation of numbers did not magically make the world mathematical, when "mathematics" had long been an unstable category.[4] Instead, nineteenth-century Americans argued over what mathematics could do for their political projects. They made choices about which mathematics were best for participating in and understanding economic life—concrete arithmetic, spatial geometry, abstract analytics, and, eventually, dynamic time-oriented calculus. In those contests, my dissertation finds a tension between democratic accountability and expert mystification, both based in claims to mathematical reasoning. Mathematics did not tip the scales to the latter; the people who won these conflicts, with their claims to a particular economic expertise, mystified both economic life and mathematics itself. The invention of mathematical economy was therefore a process, not an event. Only after a hundred years of contestation over mathematical knowledge would universally rational economics appear so self-evident, so inevitable, that some could assume it had been there all along.

My project also argues that disaggregating mathematics and studying its historical form provides a potential avenue to historicize rationality itself. Economic rationality has long been loosely tied to calculation, but in such a way that presumes that there is only one way of making economic calculations.[5] Once mathematics is seen not as a homogenous, unchanging standard but as a heterogeneous knowledge grouping, it can be explored for interactions between types of mathematical reasoning and the economic ideas and applications in which they were used. The individuals who apply mathematics to economic life have a realm of options to choose from, each with its own cultural and intellectual variances. Once these many ways of calculating are understood, rational calculation becomes a meaningless phrase. Understanding how historical actors came to use their numbers therefore belies the ahistorical economic man. By unearthing the entwined histories of these two insistently timeless disciplines, mathematics and economics, I hope to illuminate the instability of some of the most basic modern assumptions.[6]

The founding of the United States attempted, among other things, to weave disparate ideals into a modern state: a classless society, an educated populace, a modern economy, a scientific government, and an illustrious future. Most of the initial leadership believed that

4. Knecht, "Visionary Calculations."
5. Stinchcombe, "Reason and Rationality," 160.
6. On the role of numbers in the "new" history of capitalism, see Cook, *Pricing of Progress*; Mihm, *Nation of Counterfeiters*; Oz, *States of Inquiry*; Bouk, *How Our Days Became Numbered*; Levy, *Freaks of Fortune*. On numbers in slavery, see Beckert and Rockman, *Slavery's Capitalism*.

scientific reason, in every aspect of government and society, would guide America to eternal freedom.[7] In Chapter 1, I chart the essential place of mathematics in the political economic culture of antebellum America, what I term "the useful knowledge economy."[8] Mathematics became touted as essential to the new nation's future prosperity: American men would learn both the theory and practice of science so they might lead intellectually fulfilling lives, while still occupying economically productive jobs, thus fulfilling the nation's republican dreams. The useful knowledge economy defined mathematics as a field on which to equate the scientist and laborer. Its advocates linked the new nation's political goals to an explicitly masculine conception of practicality, condemning mathematics seen as too abstract as effeminate and aristocratic. Indeed, throughout the century, the line between useful and useless mathematics was nearly always gendered.

Yet while elite celebration of mathematics in cultural discourse did little to shift the larger social hierarchy for working men, it provided an avenue for men with mathematical ability to claim expertise in commercial matters based on their "scientific attainments."[9] Crucially, these men—like Nathaniel Bowditch—made the mathematical knowledge that working men merely applied. As the decades passed, mathematical knowledge gained increasing importance in American life. In education, politics, and commerce, numbers and calculation became essential knowledge for Americans, though exactly how they should be taught and used remained a subject of fierce debate. Over time, however, one thing became clear time and again: mathematics proved to be a uniquely potent tool to settle political economic nerves and disputes. Its ability to make absolute claims to objectivity, combined with its perceived democratic potential, made mathematics a more and more frequent source of economic authority.[10]

In Chapter 2, I expand on the tension between making mathematics and using it through an exploration of antebellum arithmetic education.[11] Arithmetic became a cultural obsession in the United States

7. See Buck, "People Who Counted"; Cook, *Matters of Exchange*; Daston, "Enlightenment Calculations"; Jonsson, "Rival Ecologies of Global Commerce"; Schabas, *Natural Origins of Economics*; Spary, "Political, Natural and Bodily Economies."

8. Knecht, "Visionary Calculations," 25. On useful knowledge in industrial America, see Watkinson, "Useful Knowledge?"; Oleson and Brown, *Pursuit of Knowledge in the Early American Republic*.

9. F.W. Edmonds to Franklin Pierce, February 28, 1853, Series 1, Box 2: 1811–1854, Robert Patterson Papers, American Philosophical Society, Philadelphia PA.

10. On the use of quantification in the nineteenth century to provide democratic accountability to expert judgment, see Porter, *Trust in Numbers*.

11. Much of this chapter builds directly on Cohen, *Calculating People*.

as a signifier of how well prepared its children were for a "business life."[12] In the 1820s, a pedagogical debate emerged over whether arithmetic should be taught in the old way (through established rules) or through mental arithmetic (a new pedagogy emphasizing children's innate calculative skills). As antebellum arithmetic education became tightly linked to commerce, this debate reflected a larger uncertainty about what a person should expect from a caveat emptor market society. Should a buyer place his trust in his own calculative abilities, as the advocates of mental arithmetic argued? Or would he be safe in assuming that others were playing by common, objective rules? The debate over arithmetic education highlighted a problem with mathematical economic authority; that is, one obscured by the discourse of useful knowledge. Did mathematics locate authority in the reasoned self, or in the common good? Arithmetic naturalized the "calculating people," but it could not eliminate the need for external expertise.[13] As a result, it opened the door for others to establish the rules of mathematical commerce.

The mystification of modern economics was not an inevitable result of its use of mathematics.[14] Rather, over the course of the nineteenth century, mathematics and economics were simultaneously made mysterious by emerging experts whose claims to economic authority rested in their specialized mathematical skills. It is these experts that I refer to as "the numerate elite."[15] These were the groups, later professions, that emerged from the mathematical-commercial stew of the early republic and fashioned themselves into practical and experienced economic experts. Numerate elites did not see themselves as businessmen. Indeed, they achieved their authority by explicitly positioning themselves as disinterested scientists who consulted for capital, but were not part of the system.[16] By consistently reinforcing the interdependence of mathematics and commerce, they encouraged not only trust in numbers but also trust in the mathematical expert.

Furthermore, the numerate elite did not only theorize that business and commerce operated in a certain way; because they were practical experts, centrally located in some of the biggest economic changes

12. Smith, *Practical and Mental Arithmetic*, vi.

13. James Hall, quoted in Cohen, *Calculating People*, 4.

14. For works that are explicit about this mathematical technocracy, see Noble, *America By Design*; Zakim, "Inventing Industrial Statistics"; Bouk, *How Our Days Became Numbered*. Others gesture to the mystification of economic life in the nineteenth century, though do not dwell on mathematics specifically. See Lepler, *Many Panics of 1837*; Levy, *Freaks of Fortune*; Roy, *Socializing Capital*; Sklansky, *Soul's Economy*.

15. Knecht, "Visionary Calculations," 4–5.

16. On disinterestedness in early American industrial science, see Lucier, "Commercial Interests and Scientific Disinterestedness."

of their time, they were also able to direct and reshape the material course of economic life. Long before the emergence of mathematical financial models in the 1980s, mathematical ideas and informal models created new economic realities. Members of the nineteenth-century numerate elite made concrete decisions about where to put a canal, how to value a company, and with whom to transact business, all based on their mathematical educations and calculative assumptions. In this sense, these mathematical experts did not just imagine the mathematical economy; they invented it.[17]

In Chapter 3, I narrate the rise of the United States' first numerate elite: civil engineers. Having been trained in advanced mathematics in the era of useful knowledge, and encountering a nation eager for infrastructure but conflicted over how (and how much) to pay for it, civil engineers claimed economic authority. They used their extensive mathematical educations and professed scientific disinterestedness to project apolitical expertise in deeply political debates over public works projects. However, although antebellum engineers achieved economic influence by promising to make states and corporations follow the rules, they became increasingly protective over their ability to define those rules through expert judgment. Trained in geometry for surveying and construction, they saw economic life as a rational space, to be managed by experts from above, and themselves as the gatekeepers of truly useful, masculine, productive knowledge. As a result, antebellum civil engineers built a geometrical economy of roads, canals, and railways, and turned fraught political contests over economic life into mathematical problems.

Throughout the nineteenth century, mathematics repeatedly emerged as a tool to settle commercial anxiety, turning mathematical acumen, over time, into a proxy for economic authority. The mathematical economy was never an inevitable tool of obfuscation and mystification; on the contrary, it has most often been a participatory ideal—even, on occasion, a reality. But the privatization of certain aspects, including data, methods, and expertise, undercut that ideal. It convinced mathematical experts that they alone possessed the knowledge and skills to safely manage the increasingly complex commercial systems. In Chapter 4, I illustrate how these ideas about mathematical expertise, public accountability, and commercial authority became privatized through emerging corporations. I focus on the emergence of insurance actuaries during and after the Civil War as new members of the

17. This phenomenon is an early American iteration of what some historians and Science and Technology Studies scholars refer to as "performativity." See MacKenzie, *An Engine, Not a Camera*; MacKenzie, Fabian, and Lucia Siu, *Do Economists Make Markets?*

numerate elite, now with expertise in analytical algebra and statistics that they used to build new financial instruments and markets.

Furthermore, as mathematics' more abstract areas, once seen as ornamental and effeminate, became "useful," the discourse around mathematical knowledge changed. Those men who were able, including engineers, embraced fields of mathematics that allowed them to claim belonging in the emerging algebraic-financial economy. As a result, arithmetic, once a badge of liberal self-ownership, became the task of menial laborers—many of whom were now women. The gender of mathematics had reversed itself; now "Miss Anna Lytical," as one student had called her in the antebellum era, had become the purview of men, while employers increasingly argued that women had a natural affinity for arithmetic.[18] As the status of commercial arithmetic degraded, corporate calculators' privatization of economic mathematics further eroded its always-uneasy promise of accountability.

From the outset, numerate elites had most often coped with the disconnect between their supposed accountability and their expert realities by blaming the ignorance of others, whether the politicians or the public. Indeed, the growing import of mathematics to economic life in the United States tracks quite closely with how difficult the subject was seen to be, in its most general sense, and how exclusive its practitioners would be. While differing mathematical approaches meant that claimants to economic authority often conflicted—over the price of a canal, the cause of a panic, the solvency of a corporation, or best practices in commercial education—numerate elites agreed in principle that mathematics was the primary field of knowledge that a person claiming economic authority should have. In periods of anxiety or moments of outright panic or crisis, the apparent steadying hand of mathematics was increasingly called upon to settle economic problems, from the individual to the national.

But the larger cultural consensus that mathematics should rule economic life remained fragile. The more complex the mathematics behind economic life became, and the more protective numerate elites became of their own position, the more critical some outsiders became of their secretive methods. Fraternal collectives in the immediate postbellum years boasted that they employed no actuaries, declaring them "false scientists."[19] The central paradox of the mathematical economy—between its initial democratic ideals and its disappointingly specialized reality—became more and more strained as the century progressed. When the life insurance bubble

18. "Eulogy at the Burial of the Mathematics," c. 1852, Mss 852940.6, Rauner Library, Dartmouth College, Hanover NH.

19. Levy, *Freaks of Fortune*, 194–204.

burst in the early 1870s, actuaries and their defenders insisted that the public was at fault, not their calculations. They drew away from older attempts to explain their mathematics, reinforcing instead the credibility of the calculator. It was in the context of this crisis of faith that a new cadre of university economists emerged at the end of the century.

In the final chapter, I illustrate how the contests and changes of the long nineteenth century made possible, though not inevitable, the invention of the mathematical economy. The earliest American economists using mathematics, primarily associated with the "marginalists" of Britain and Europe, upturned the historical school in their discipline through the apolitical power of mathematical models. At the same time, they muscled out the business interests that had helped define the professionalization of early economics, dismissing corporations as insufficiently disinterested to be true economic experts. The newly hegemonic vision of economic life that these economists invented drew on many of the previous century's ideas about mathematical economic expertise, particularly the need for apolitical experts to interpret economic facts, and the idea that they necessarily acted in the public good. Crucially, however, they used differential calculus, with which they invented a universal economic man—a figure who could only have been imagined after a hundred years of making mathematical reasoning central to economic life. The universalization of *homo economicus* continued into the twentieth century, but, at the time, his invention erased the century of choices, contests, and silences that had made him possible at all.

The history of the economy contains a paradox, in which calculation is expected to lead to a democratic market society, but mathematical knowledge removes the economy from the hands of ordinary people. This tension can be explained only through an understanding of mathematics' historical role in how Americans conceptualized, participated in, and learned about economic life. The more numbers came to define certain aspects of economic relationships, the more crucial mathematical knowledge and the ability to calculate—real or perceived—became. This fact alone did not necessitate that the mathematical economy would become either participatory or mystified, or that it would involve a specific field of mathematics, or that it would expand inexorably into everyday life. Rather, the historical processes by which Americans learned to think economically, to reason, calculate, and trade, defined the realities of mathematical economic life. For many years, the quasi-democratic idea that every man could learn to calculate, as an independent and competent economic actor, existed alongside the notion that business required management by a trustworthy group with specialized calculative skill. The modern

mathematical economy resulted not from the inherent nature of "mathematics" but from social decisions about how to define it.

"Visionary Calculations" argues that nineteenth-century contests over the use and meaning of mathematics made America's modern economy possible. Mathematical reasoning became integral to claiming authority in nineteenth-century commerce; as a result, economic knowledge became tied to mathematics—its definition, its utility, and its cultural meaning. This dissertation aims to explain, through contests over the proper role of mathematics in economic life, how Americans became attracted to a mathematical economy, how commercial mathematics became increasingly specialized, and how people pushed back on this mystification. Long before academic economists adopted calculus, the ability to claim mathematical expertise had become essential in debates over what constituted a legitimate economic actor. It determined how economic knowledge was—or should be—made, and who could be trusted to make it. Rather than see the mathematical economy as originating in twentieth-century economics departments, therefore, this project illustrates that it was instead made by possible by a hundred years of changes in business practices, mathematical pedagogies, social relations, and economic ideas. It was in those spaces, over the long nineteenth century, that Americans invented their mathematical economy.

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