In Memoriam

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William J. Baumol
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William Jack Baumol passed away on May 4, 2017, at the age of 95. Called “one of the great economists of his generation” by Nobelist Joseph Stiglitz (as quoted in Cohen 2017, p. B14) Baumol was enormously productive and highly influential. He wrote hundreds of articles and dozens of books. His curriculum vitae is over 100 pages long. Baumol made a major impact not only on the economics profession but also on policy makers in

In preparing this paper I have benefited from the availability of two excellent summaries of Baumol’s work. The first is the thorough appraisal done by Elizabeth E. Bailey and Robert D. Willig in 1992. The second is a retrospective interview with Baumol conducted by Alan B. Krueger that appeared in 2001.

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business, the arts, and government. He influenced generations of students and colleagues during his many years of teaching at both Princeton and New York University. He served as president of the American Economic Association in 1981 and of the International Atlantic Economic Society in 1985–86.

In a brief article, it will be impossible to do full justice to all of Baumol's scholarly contributions, but here I will try to highlight some of his most important publications, as well as the broader significance of his work.

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Baumol's Disease

Baumol is best known for his contributions emphasizing the inexorable relative increase in the costs facing the service sectors of the economy. Known as the eponymous ailment "Baumol's Disease," his insight has wide applicability to both micro-economic and macroeconomic phenomena.

Baumol developed the cost-disease model in a series of writings published during the 1960s, most notably his book with William G. Bowen on the economics of the performing arts (e.g., Baumol and Bowen 1966 and Baumol 1967). As he pointed out, different sectors of the economy have experienced significant differences in their ability to realize productivity gains. In both the agricultural and manufacturing sectors, new technologies, investments in labor-saving capital, and economies of scale have resulted in persistent gains in productivity, i.e., in increases in output per labor-hour worked. The cumulative gains in productivity have offset the tendency for wages to rise over time, and the prices of goods in the technologically progressive sectors have tended to rise more slowly than the overall rate of inflation. In some cases, such as the production of computers and mobile phones, productivity gains have been sufficiently large, enough that the prices of these goods have actually fallen over time.

In other sectors of the economy, notably the service sectors, productivity gains are much harder to achieve. The classic example offered by Baumol and Bowen (1966) is the preparation, practicing, and performance of a string quartet. It still takes four musicians to perform a string quartet, exactly the same number that it took during Mozart's time. While some service industries have benefited from important productivity enhancements, it remains true that in the so-called "handicraft" services, it is more difficult to achieve productivity gains. Hence in fields such as the performed arts (Baumol fought a losing battle with his publisher to retile his book with Bowen since the arts were performed—not performing), education, healthcare, and productivity gains are likely to be smaller than in the manufacturing industries.

With wages rising throughout the economy, it follows that the relative costs of providing services in the sectors experiencing slower productivity growth will rise relative to those sectors enjoying rapid productivity growth. Thus, the relative costs of services such as theatre tickets, concert performances, and education will tend to rise faster than the general level of inflation. The problem is not restricted to education and the arts. Computers have gotten cheaper, but healthcare has not.

The insight has important macroeconomic implications. In an economy where rising incomes increase the demand for services, the share of economic output devoted to the service sectors tends to rise. In the developed countries of the world, including the United States, Japan, and Western Europe, services account for about three-quarters of each country's gross domestic product (GDP). Baumol et al. (1989) predicted these changes during the late 1980s. Another implication of Baumol's research is that the overall rate of productivity growth will become smaller over time. The current slowdown in productivity growth throughout the developed world, where services have increased in importance, is entirely consistent with the Baumol cost-disease model.

Baumol's Disease also has profound implications for urban finance and what he called "the crisis of the larger cities" (Baumol 1967). Many of the services provided by municipal government are afflicted by cost disease. Consider police protection, education, health and welfare services, and garbage removal. While some productivity enhancements have proved feasible, most of the services provided by cities are in areas where technological change is likely to be slower than in the provision of manufactured products. Thus, Baumol argued, "The upward trend in the real costs of municipal services cannot be expected to halt" (Baumol 1967, p. 423). The inexorable rise in municipal government budgets should not be ascribed to malfeasance or mismanagement. "This is a trend for which no man and no group should be blamed, for there is nothing that can be done to stop it" (Baumol 1967, p. 423).

In an interview with Alan Krueger in the *Journal of Economic Perspectives* (2001), Baumol was passionate in his defense of service sector activities. He noted the public outcry over the terribly high price of a college education, even though it cost fewer labor hours than it did 50 years prior. The public focuses on the fact that a college education costs twice as many automobiles as it did then. "The danger is that we will deny ourselves education, that we will deny ourselves a lot of the activities or the products whose costs are determined by the cost disease," Baumol said (Krueger 2001, p. 217), "You can think of all sorts of horrible things that can happen". Garbage removal and police protection could become less effective and the arts and education could suffer substantially. Baumol was a lifelong champion of public support of the arts and education.

Mathematical Modeling of Business Problems

A salient characteristic of Baumol's research was his ability to state business problems in simplified terms and consequently construct very simple mathematical models that can be used to produce optimal solutions. His contributions are thus grounded in rigorous theory while producing pragmatic solutions. No better illustration can be found than his seminal paper (Baumol 1952b) on the transactions demand for cash, published in 1952.¹

¹ The model is often called the Baumol-Tobin model, as it was independently developed by James Tobin (1956). In fact Baumol and Tobin both credit the original insight to Maurice Allais (1989).

The Transactions Demand for Cash

Baumol suggested that a firm should manage its cash balances in the same way that it should manage any other inventory that it was holding. The problem comes down to managing the balance between the carrying cost of keeping cash balances on hand and the transactions costs of converting other assets into cash. The (opportunity) cost of holding a cash balance is the interest foregone by not investing the cash in short-term marketable interest-bearing securities. Transactions costs are involved whenever marketable securities are sold and converted into cash. Assuming that the firm uses cash at a constant rate through time, Baumol's model has the firm starting with a cash balance of C and spending it evenly until the balance is reduced to zero. At that time a balance of C dollars in cash is reestablished by selling marketable securities. Figure 1 shows the determination of the firm's optimal cash balance. The opportunity holding cost increases as the amount of cash held by the firm increases. But the transactions costs are lower with larger cash balances since fewer sales of securities for cash are required.

According to Baumol's model, the optimum cash level is the amount of cash where the holding costs and transactions costs are equal. Holding cost is measured by the interest foregone had the cash been invested in marketable securities. Transactions cost is the cost involved in getting the marketable securities converted into cash or vice versa. It includes clerical costs, brokerage costs, trading spreads, and other costs. There is an inverse relationship between these two costs. Holding small cash balances will minimize the (opportunity) holding cost of foregone interest, but it will involve high transactions costs as periodic sales of marketable securities will be required to provide the cash needed by the firm. The optimum cash balance is that amount of cash where the holding costs and transactions costs are equal, as shown in Figure 1.

While the model is very simple, the implications are profound. The prevalent view at the time of Baumol's contribution was that the optimal cash balance would be proportional to the money value of the firm's transactions, but Baumol was able to show that economies of scale exist. The optimal cash balance rises in proportion to the square root of the firm's transactions.

Fig. 1 Baumol Model: Transactions Demand for Cash

Models of Revenue Maximization

Baumol was well ahead of his time in a series of writings on the theory of the business firm that substituted revenue maximization for profit maximization as the firm's objective function (Baumol 1959). In some sense, this was one of the first explorations of behavioral economics in developing a more complete theory of the firm. Many large corporations can be assumed to attempt to maximize total sales revenues rather than net profits. As long as profits have reached some satisfactory level, the firm may decide to forego further increases in profits in order to boost total revenues. Sales maximization may be employed because it is believed to be in the short-run interest of business managers or because it will ultimately result in larger long-run profits. In either case, optimization techniques may still be used, although they are likely to produce different business decisions.

Revenue maximization may be explained by the businessman's desire to maintain his competitive position (Baumol 1959, 1962) and his prestige, which are dependent on the size of the enterprise. It may also be in the narrow interest of the executive (as opposed to the stockholders) since management salaries may be related more to the size of the firm's operations than its profits. Baumol strongly believed that the nature of the firm's objectives cannot be assumed in advance. This model has often been advanced as a good description of the behavior of Japanese firms. It is also able to explain what are sometimes puzzling behaviors of large firms, such as their expenditures on advertising or their pursuit of mergers in the face of results that appear inconsistent with profit maximization.

Selected Other Contributions

Baumol made several other influential contributions in the field of applied microeconomics. I mention only a select few here. He worked on the solution to the problem of capital budgeting under conditions where budget levels were constrained (Baumol and Quandt 1965). Using a programming approach, he was able to provide an objective measure of the applicable discount rate by looking at the (dual) prices corresponding to the budget constraints for different periods. Two other papers presented mathematical programming optimization methods and showed the economic interpretation of the dual prices derived in their solution (Baumol and Gomory 1960; Balinski and Baumol 1968). Baumol also made contributions to the field of financial economics in his publications on portfolio theory, capital structure, and the efficiency of our capital markets (Baumol 1970; Baumol and Malkiel 1967; Baumol 1965).

The goal of revenue maximization was extended by Baumol into a dynamic analysis in his theory of the expansion of the firm (1962). There, he elaborates his static model of revenue maximization to explain the extraordinary growth record of firms in capitalist economies. In the dynamic setting, adequate profits are a means of obtaining the retained earnings necessary to finance future growth. The optimal profit stream becomes the one that is consistent with maximizing the long-run growth in output over the firm's lifetime. Profits then are no longer a period-by-period constraint, but rather are the requirements to ensure that the firm meets its long-run growth objectives.

Welfare Economics and the Environment

Welfare economics was a lifelong interest of Baumol. Originating with his Ph.D. dissertation, his first book (1952a) was on welfare economics and why externalities justified government intervention in the form of taxation and pricing policies. He returned to the subject in 1972 in “Taxation and the Control of Externalities” (Baumol 1972) and was an early supporter of carbon taxes and their role in reducing environmental pollution.

He published an important book on environmental economics (Baumol and Oates 1975). The book provided thoughtful analyses of various tax and subsidy policies to reduce emissions as well as the role that might be played by selling pollution rights. Some firms using older technologies might find it more efficient to pay for the right to continue to produce carbon pollutants than to make the expenditures necessary to reduce their emissions. When asked about the morality of selling licenses to do harm to the environment, Baumol would answer. “It’s a lot better than giving them away free as we do now” (Baumol 1980, unpublished lecture).

Contestable Markets and Regulation

The theory of contestable markets is primarily associated with Baumol’s work in the field of industrial organization.² He argued that markets exist that are served by a small number of firms, but that nevertheless are characterized by vigorous competition (and therefore desirable welfare outcomes) because of the existence of potential new entrants. The definition (Baumol 1982, pp. 3–4) states:

“We define a perfectly contestable market as one that is accessible to potential entrants and has the following two properties: First, the potential entrants can, without restriction, serve the same market demands and use the same productive techniques as those available to the incumbent firms . . . Second, the potential entrants evaluate the profitability of entry at the incumbent firms’ pre-entry prices.”

A contestable market is one in which entry is completely free and exit is absolutely costless. The market’s crucial characteristic is its vulnerability to hit-and-run entry. The controversy concerning the contestable markets idea concerns the circumstances under which it is plausible for incumbents to believe that new entrants could realistically believe that they could engage in rapid and reversible entry. Only then could the threat of potential entry constrain the behavior of incumbents.

The theory was expanded in Baumol et al. (1982). An entering firm must have the same access to technology as the incumbent firms. High barriers to entry will make an industry less contestable, as will sunk costs that cannot be recovered if the entering firm eventually shuts down. If a new firm is unsuccessful, it must be able to either sell or transfer the capital it has invested to another use. In a perfectly contestable market there

² The theory had deep roots in the work Baumol did a decade earlier with David Bradford (1970) on optimal departures from marginal cost pricing on the part of natural monopolies, such as railroads. The theory was also suggested in Baumol et al. (1977).

must be frictionless reversible entry. An example of a contestable market is the airline industry. Potential entrants can lease aircraft and quickly enter (and, if necessary, later exit) a particular market where it appears that excessive profits are being earned.

The theory of contestable markets has been extremely important in the design of antitrust and deregulatory policy. The prescription for obtaining a more competitive outcome is the opening up of markets to potential entrants. Thus, Baumol argued for the removal of any artificial barriers to entry and exit and he supported the deregulation of certain industries. He also favored requiring incumbents in the telecommunications industry to open up their infrastructure and make it available to potential entrants. He believed that such a requirement would allow potential competition even in cases where the incumbent had significant market power through the control of a costly network.

Baumol frequently testified in both regulatory hearings and in court cases, and he participated in several antitrust cases. He was involved with several industries including railroads, telecommunications, and electric power. His work had considerable influence on public policy.

Baumol also provided important insights with respect to issues involved in the regulation of natural monopolies. His 1970 paper with David Bradford (1970) explored optimal departures from marginal cost pricing for unsubsidized natural monopolies. Recognizing the original contribution of Ramsey (1927), Baumol and Bradford show that “quasi-optimal” prices can exist that maximize consumer welfare (subject to a profit constraint) but systematically deviate from marginal costs. Traditionally, regulators have required that prices be set as equal to costs, product by product, even when there are substantial common costs that must be allocated to different products. Such allocations are essentially arbitrary and depend on the specific accounting methodology imposed. Moreover, no system of allocating costs can reflect the different elasticities of demand for alternative products. Thus, more flexible methods of rate regulation should be employed. For example, the Baumol and Bradford results imply that railroads should allocate proportionally more of the carrier’s overhead costs to coal shipments than to products shipped in boxcars where trucks can provide alternative means of delivery.³

Growth Theory and Entrepreneurship

Baumol continued to be a productive researcher well into his late 80s. The emphasis of his most recent work was in the areas of innovation, entrepreneurship, and economic growth. The titles of two of his books describe the flavor of the work: *The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism* (2004), and *The Microtheory of Innovative Entrepreneurship* (2010).⁴

In Baumol’s view, the productive contribution of entrepreneurship to society depends upon the allocation of such activities between useful innovations and unproductive activities, such as rent-seeking or crime. The allocation is influenced by the payoff society offers such activities. Policies will be more effective if they can influence the

³ See also Baumol et al. (1987).

⁴ See also Baumol et al. (2007).

allocation by changing the incentives facing innovators so that they are motivated to work in beneficial directions.

The competitive pricing mechanism is often given the credit in capitalist systems for promoting economic growth. Baumol rejects the view that capitalism benefits society mainly through the price competition that makes goods and services less costly for consumers. In his view, the driving force behind economic growth is the innovative activity of business firms who compete by offering more and better products, processes, and services in an attempt to keep ahead of competitors. It is the innovation of enterprise, not price competition, that makes the vital contribution to economic growth and general welfare.

Most research and development is done by large firms. Powerful competitive forces lead them to do this for survival, but most of the truly paradigm-changing innovations have been done by the independent individual innovators. By partnering with large firms, such innovators are able to access the power and capability of the large firm, exploit the innovation, and bring revolutionary changes to the market. Baumol calls this the “David-Goliath Symbiosis.” Moreover, large firms do not wish to risk too much on innovation because it is costly and can be made obsolete by the innovation of rivals. Hence, firms will often partner with other firms through the sale of technology licenses and by participating in technology-sharing contracts. This process, in Baumol’s view, encourages the proliferation of entrepreneurial activity and accounts for the unprecedented growth of modern capitalist economies (Baumol 2004). Friendly technology transfer does not negate the advantage of the firm that produced the innovation. The head start of the first mover still confers an enormous competitive advantage. The dissemination of each new technique is accelerated, and it reduces the time that rivals will be stuck with an obsolete technology.

Simply spending large amounts on R&D is not sufficient to allow an economy to grow. Various planned economies have failed to realize benefits from those investments in terms of economic growth. While there was much invention taking place, innovation was missing, and the dissemination and widespread utilization of the invention never occurred. It is the private economic incentive to exploit and utilize the new technologies that allows the free-market economy to realize the benefits of entrepreneurial activity. Baumol’s work on entrepreneurship (1990) enhances our understanding of its critical role in explaining economic growth and makes an important contribution to policy discussions.

Textbook Writing, Consulting and Artistic Endeavors

Together with Alan Blinder, Baumol is the coauthor of one of the leading textbooks in introductory economics: *Economics: Principles and Policy* (1979). The book is now in its 13th edition. Taking a policy-based approach to the teaching of economic principles, the text is clear, accessible, and highly relevant. Having taught introductory economics myself, I can attest that the exposition in the book is characterized by unusual clarity, and it has been well-liked by generations of students. The book has sold well over a million copies. Considering second-hand sales, it has been used by almost three million students.

Baumol has also authored a more advanced text *Economic Theory and Operations Analyses* (1961). The book, now in its 4th edition, presents a systematic exposition of

received microeconomic analysis and the use of programming techniques in the solution of specific business problems. Baumol shows that business practices can be a fertile source of the analytical toolbox of the microeconomist and that, in turn, the theorist's rigorous tools can contribute to more effective solutions to applied business problems.

Baumol also had a distinguished consulting career, and he testified often before Congress, regulatory agencies, and in corporate litigation cases. He consulted for many industries, most often for railroads, electric power, and telecommunications companies. One of his most effective techniques in testifying was to be sure to bring up for himself the best argument that could be mustered to attack his position and to indicate clearly in what ways he disagreed with his client. Baumol was convinced that, especially in jury trials, this technique would convince the jurors of his integrity and that he was not a "hired gun." One of his favorite stories, (now a legend among lawyers according to Krueger 2001, p. 227), is a quote from a juror. After one of his trials the chief juror was interviewed by a newspaper about how influential Baumol's testimony was. The juror replied, "That kind of guy wouldn't lie to nobody."

The term "Renaissance Man" fits William Baumol particularly well. A noted polymath, his expertise ranged from the history of theatre and music to French wines and cheese to clocks and watches, which he skillfully repaired. He was a noted artist who worked in the mediums of wood sculpture, oil, and computer painting. He taught a woodcarving course at Princeton and had a one-man show of his work in New York City.

Concluding Comment

Let me end on a personal note. Baumol was my mentor and thesis adviser at Princeton. I could not have asked for an adviser who was more caring, more generous with his time, and more willing to help on any issues that I had. His generosity extended to generations of students at Princeton University and New York University, where he was the quintessential university citizen. I was blessed to have him as a mentor and friend.

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