NEW DIRECTIONS FOR ESTABLISHMENT SURVEYS

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INTRODUCTION

Clark has rightly pointed out that we establishment survey managers need to rethink the ways in which we conduct our business, manage our resources, and organize our employees as we try to implement the principles of Total Quality Management. This paper, too, is concerned with the changes taking place in establishment survey programs, but my focus will be on dealing with the greater complexity of the data that we need to collect. That is, while Clark's paper is concerned with "how," this paper is concerned with "what" and "why."

The complexity we are encountering in collecting data for establishment surveys mirrors the complexity of society and the economy at large. In all areas, we see old patterns being dissolved and new ones being formed, with the changes taking place so rapidly that we often see no pattern at all, only chaos. These changes are creating a "messiness" in our establishment surveys. To some extent, this messiness is the result of social upheaval and of our growing awareness of the need for a greater sophistication in the conceptual frameworks we use for gathering data. But to large extent, this messiness is due to the rapid technological advances being made, creating a "messiness" in our surveys.

According to W. Brian Arthur -- one of the leading theorists of economic complexity -- modern nonlinear physics provides a better model for looking at today's high-technology societies than do the pre-20th century physical models that underlie conventional economic theory.[1]

***The opinions and conclusions expressed herein are solely those of the author and should not be construed as representing the opinions or policy of any agency of the United States.**

Arthur calls the new economic theory "positive feedback economics" because it is interested in how *increasing returns* determine economic outcomes, in contrast with conventional economics, built on the assumption of *diminishing returns*. Conventional economists see the economy as simple, deterministic, predictable, and mechanistic. In conventional economic theory, any change in an economic system will result in negative feedback, which will lead to further economic changes, until the system eventually returns to a state of equilibrium, representing the most efficient use of resources available. For example, the disruption of oil imports in the 1970's led to higher prices, which led to lower consumption and increased exploration for oil, which led to lower prices, until equilibrium was restored in the 1980's.

In contrast, positive-feedback economists see the economy as complex, process-dependent, organic, and always evolving. In the positive feedback theory, the economy can have many possible equilibrium points, and in times of change, when two or more alternatives exist, the particular economic outcome selected may not be the best one, but simply the one that, due to random economic events, managed to establish itself first. For example, the VHS videocassette recorder won over the Beta recorder though both came on the market at about the same time and sold at about the same price, and even though Beta may have been technically superior. The success of VHS was due to its being able to put more VHS recorders on the market early on, which led to greater demand for prerecorded tapes in VHS formats, which led to video outlets stocking more VHS tapes, which led to consumers in the market for a videocassette recorder choosing the VHS recorder, and so on.

Conventional economics probably still provides the best framework for understanding the parts of the economy that are resource-based, such as agriculture, bulk-goods production, and mining. On the other hand, positive-feedback economics may provide the best framework for understanding modern high-technology economies.

In the same way, the traditional classifications of the *Standard Industrial Classification (SIC) Manual* may still be the most useful ones for gathering data on the resource-based establishments. Using these classifications, we have gathered a great deal of data that has been useful in assessing what is happening in the various sectors of the economy -- including agriculture, construction, mining, government, trade, retail, and wholesale sectors, and to a lesser extent, the service and transportation sectors and some multisector categories -- and for forecasting future trends.

However, the classifications of the *SIC Manual* may be too one-dimensional for today's complex world. (Although the manual is being revised so as to classify industries by the similarity of their production processes, the new classifications may still be too limiting.) We may need to establish new methods for collecting data on knowledge-based establishments. Perhaps we need a radical change in our classification systems and the narrow frameworks within which we collect data in order to capture the "messiness" of today's world.[2]

This paper will discuss some of the exciting changes influencing establishment surveys. It will first consider the complexity we are finding in energy surveys and then the complexity we are finding in the world of energy and in the world at large. This paper will also look at some possible ways of dealing with this complexity.

COMPLEXITY IN CLASSIFYING ENERGY USERS

At the Energy Information Administration (EIA), we collect data on energy use in the commercial, residential, transportation, and manufacturing sectors. We have established certain neat categorizations of energy-using entities in these sectors in an attempt to separate the sectors from one another, and to meaningfully relate energy use to the variety of consumers in each sector. These categorizations seemed to fit reality as we saw it at the time they were created. Many times, though, we have since come to realize that we have been collecting data on energy use by one entity (such as apartment buildings and high-tech industries) in one sector, when that entity might better fit in another sector. Or we find that we have to ignore some phenomena (such as the "virtual office" and the private use of commercial vehicles, and vice versa) because our existing surveys and the conceptual frameworks on which they are based do not facilitate the collection of messy data.

Apartment Buildings

For example, the methods EIA uses to collect information on energy use in residential buildings differ from the methods it uses to collect information on energy use in commercial buildings. For residential buildings, we collect information on the energy-related characteristics of the *household* and the housing unit; for commercial buildings, we collect information on the energy-related characteristics of the *building* and the energy-related activities taking place within the building.

Since EIA defines "residential building" to include apartment buildings and defines "commercial building" to exclude buildings that are more than 50-percent residential, EIA gathers information on energy use in apartment buildings in the same way as it gathers information on energy use in single-family homes. EIA does this because we are interested in the energy-use patterns of households in many different housing units. However, this method obscures the fact that energy use in apartment buildings may be more closely related to energy use in certain types of commercial buildings than to energy use in single-family homes.

We might better capture how large buildings use energy by re-defining "residential" and "commercial" so as to include apartment buildings in the latter category. Better yet, we could collect data on apartment buildings in both sectoral surveys. However, such double counting would create even more confusion than currently exists for economic modelers and buildings analysts. Furthermore, any change in method would create a discontinuity between the new survey data and any other data series, or even with existing time series data for either the residential or commercial sectors, which would be difficult to bridge. Yet, double counting would, in fact, best reflect the complexity that actually exists in how these buildings are used in the residential sector and how they operate in the commercial sector.

The "Virtual Office"

The activities of households are another example of economic complexity, or the next frontier of messiness. The traditional distinction between the economic activities occurring in the commercial and industrial sectors and the activities occurring in households is becoming obsolete. In our residential surveys, we have found that an increasing number of people are working at home in a "virtual office," rather than at the establishment site.

We became aware of this phenomenon during the Residential Energy Consumption Survey when we discovered the plethora of energy-consuming office equipment being used in the home -- not just the personal computer, but also the fax and often the copy machine. Again, we should probably be dealing with this phenomenon through double counting -- that is, by purposely creating messiness.

High-Tech Industries

As a final example of the intersection of sectors, we recently discovered that certain manufacturers -- namely those in such areas as computer software and hardware and medical equipment -- use energy in a way that is more typical of establishments in the commercial sector than of manufacturing establishments. That is, most of the energy these manufacturers used was for heating and cooling rather than for manufacturing processes.

In the commercial sector, EIA traditionally collects data on the heating, cooling, lighting, and other facility-related uses of energy because those uses account for most of the energy used in commercial buildings. In the manufacturing sector, EIA has traditionally emphasized data collection for major process industries (such as iron and steel, chemicals, and pulp and paper), generally ignoring the energy used for heating, cooling, and ventilation in buildings -- because these processes account for most of the energy used in manufacturing establishments.

When the DOE offices responsible for establishing efficiency programs for buildings asked us to collect data on heating and cooling in manufacturing buildings for 1991, our initial reaction was that this information for manufacturing would be essentially "noise" and generally unknown or not worth the effort it would take to collect it. As the figures at right show, however, the

Figure 1. Distribution of Electricity Consumption by Manufacturers in High-Tech Industries

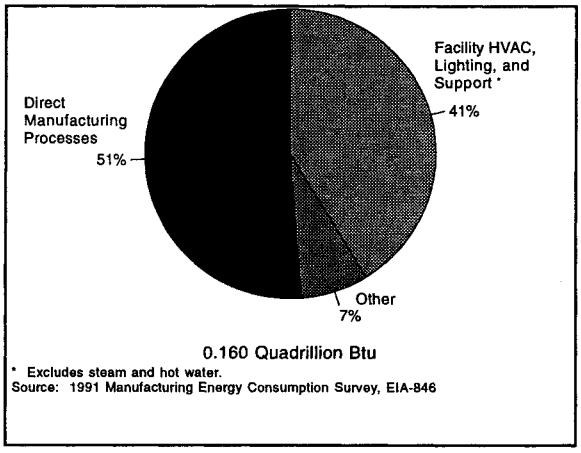
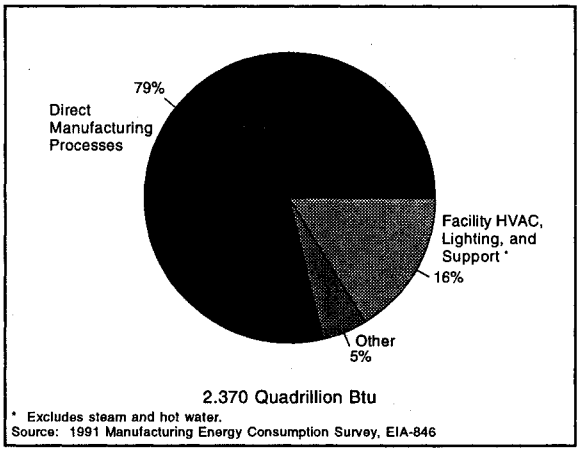


Figure 2. Distribution of Electricity Consumption by Other Manufacturers



Notes: High-tech industries include manufacturers of computer and office equipment, electronic and other electric equipment, and instruments and other related products. "Facility-related uses" include heating, cooling, ventilation, lighting and support and exclude steam and hot water. "Other" includes fuel used in boilers.

Source: 1991 Manufacturing Energy Consumption Survey, EIA-846

suspicions of some DOE analysts about the energy use of the high-growth industries turned out to be right.

Here, again, is another instance of the blurring of sectors, where some buildings in the manufacturing sector use energy in a way that is typical of buildings in the commercial sector.

Residential vs. Commercial Vehicles

We have also found that the distinction between the residential vehicle and commercial vehicle is blurring in a few instances and that we are not yet collecting data in a way that captures this phenomenon. Recently, in the preliminary stages of developing a survey to collect data on commercial fleets, we found indications that a substantial number of households in our residential transportation survey use commercial vehicles for their own personal use -- sometimes reimbursing their companies and sometimes not. They often keep these vehicles at home and are responsible for refueling them, for which they are reimbursed. Recent tax changes are trying to capture this "fringe benefit," but we are not capturing the extent and impact of this phenomenon in our data systems.

On the other hand, experts in business fleets for establishments say that a growing trend is for businesses to divest themselves of their car fleets and to reimburse employees for maintenance and mileage when employees use their own cars on company business. Here again is an intersection between a traditional industrial or commercial establishment activity and another sector -- in this case, the residential sector. We are capturing the trend to some extent, but we are not discriminating between the activities that fall into the traditional sectors that we have defined.

COMPLEXITY IN WORLD OF ENERGY USE

Major changes are today taking place in the world of energy use, as in the larger economic and societal context, that will also complicate our establishment surveys. Four of these changes in the area of energy are the advent of the alternative-fuel vehicle into the marketplace through various regulatory requirements, the deregulation of utilities, the concern with global climate change, and the growth of environmental restoration activities.

Alternative-Fuel Vehicles

The Energy Policy Act of 1992 requires that businesses and governments begin to acquire more and more alternative-fuel vehicles for their fleets each year so that by the year 1999 75 percent of all Federal and State fleet vehicles and 20 percent of all municipal and private fleet vehicles will be alternative-fuel vehicles. Similarly, California legislation relating to air pollution requires these vehicles also to be introduced into the residential sector, primarily in Southern California. In the meantime, manufacturers, refuelers, and the repair industry are working to develop an infrastructure to support these vehicles and their penetration throughout the economy.

At EIA, we are beginning to look at how establishment surveys can be designed (and often redesigned) to assess the impact the introduction of these vehicles will have. We are currently developing a methodology for surveying fleets in the so-called "Clean Cities" so that we have a benchmark that will help us later measure the impact of the introduction of alternative-fuel vehicles into these cities. At present, we are gathering data on commercial fleets in only one Clean City (Atlanta); next year, we will gather data on two more. Since we are not looking at the problems of refueling, reselling, and maintaining alternative-fuel vehicles, we will not be able to capture the disequilibrium these vehicles could cause in various systems in individual geographic areas, sectors, and economic markets.

Deregulation of Utilities

The deregulation of the natural gas and electric utilities will also have an impact on the way in which we collect data for our establishment surveys. Natural gas utilities have already been deregulated. The Federal Energy Regulatory Commission has enabled pipelines and producers to sell directly to end users or brokers. As a result, the local distribution company or utility no longer has a monopoly on the sale of natural gas for ultimate end use.[3]

In the past, collecting data on the sale, use, and price of natural gas was relatively simple: The various distribution companies and utilities were surveyed to determine how much natural gas they had sold by sector and at what price. But, as a result of the deregulation, groups of end users, often from different sectors, are banding together to get the best prices or to insure uninterrupted supply. These developments are so new

and are growing so rapidly that we at EIA are having difficulty in our end-use surveys in gathering data on who is buying this gas, who the ultimate end users are, what prices they are paying, and what are the components of the prices they are paying. The chaos created by these various equilibria is illustrated by the fact that natural gas is being sold under different names; some call it "transportation gas," and others call it "transported gas," "gas delivered for the use of others," or "gas delivered for the account of others." The system is in such a state of flux that we cannot clearly describe it, let alone measure it with any accuracy.

The electric utility industry is also being deregulated.[4] Although the industry is in the early stages of deregulation -- similar to what happened with the American Telephone and Telegraph Company in the 1980s -- a dynamic change is definitely underway. Various policy mechanisms are encouraging industrial manufacturers to use cogeneration to produce electricity for sale. At present, manufactures will likely sell most of their excess power within their company, to another establishment outside their company, or to a local utility. They may also sell some electricity to local governments.

In addition, a whole new industry of nonutility generators has developed, encouraged by legislation to sell wholesale electricity to municipal and other utilities as well as to industrial users of electricity. The next decade will likely bring extraordinary change, and many different equilibrium points, in the generation, marketing, and sale of electricity.[5]

We already know of instances where single-family housing units are joining with apartment complexes in cooperatives to buy electricity at a more competitive rate than the local utility offers to individual customers. California law will soon permit residential users to form cooperatives to buy electricity from these nonutility generators. Obviously, the potential for chaos is dramatic and, again, it may be that many different points of equilibrium are being established.

EIA's traditional supply-side surveys of the generators and end users of electricity will be capturing smaller and smaller sections of the market. Other surveys conducted by EIA of nonutility generators will be enhanced as their share of the market increases. Our surveys of end users will be affected even more dramatically because end users will likely be getting electricity from many different sources -- not necessarily from utilities -- at different periods of time. Since EIA's current end-user surveys are not geared for these situations, we will have to decide how to capture the dynamic changes occurring across sectoral lines.

Global Climate Change

Based on scientific findings of the last several decades, a worldwide concern has developed about the growth in greenhouse gases. Scientists fear that an increase in these gases will affect the Earth's temperature, causing a profound disruption of life as it now exists.[6]

EIA and the U.S. Environmental Protection Agency (EPA) are now trying to quantify the greenhouse gas emissions around the world and to relate them to emissions from manufacturing processes, transportation, landfills, agricultural activities, and other areas. Rudimentary classification systems have been established to quantify these emissions, based primarily on consumption of fossil fuels. Although we can use our traditional systems of establishment classification to track changes in these emissions, we could have difficulties when we try to track the interrelationship of emissions with actions taken to reduce the emissions. [7]

A number of different plans and programs are now underway to reduce greenhouse emissions. For example, communities and private businesses are planting trees to reduce the energy they use for air conditioning. In the near future, corporations will be allowed to report actions they have voluntarily taken to reduce emissions. Since some corporations have facilities in foreign countries, a way will have to be found to classify their voluntary efforts in other countries.

Environmental Restoration

Environmental restoration activities are growing rapidly, spawning an entire new industry as well as new academic specialties. Representatives of various industries have indicated that expenditures for environmental issues now rank with those for health and safety issues in their budgets. The largest area of growth in DOE's budget is environmental restoration around DOE facilities that have been contaminated from the development of nuclear fuel or the storing of spent nuclear fuel or other contaminants. EPA's responsibilities for cleaning up areas contaminated by other pollutants reflect a similar concern.

Although most environmental restoration activities per se yield no profit and produce no additional product, they have a tremendous impact on the way establishments, companies, and communities function. They have also spawned a highly profitable industry of

establishments involved in environmental restoration. Yet, we know little about how environmental restoration activities will affect current establishments or what kinds of new establishments they may lead to. Nor do we know how best to gather information on these activities through our traditional establishment surveys.

COMPLEXITY IN THE WORLD AT LARGE

Chaos in boundaries is replete in the world outside of energy. The most obvious examples are the constant references we hear being made to the global marketplace and global communities and to the North American Free Trade Agreement (NAFTA). Other examples are the communications, consulting, and health care industries.

Communications Industry

Perhaps the communications industry provides the most intriguing example of chaos in establishments. As our communications become "wireless," entire new industries are being created that will cross the boundaries of telephone, cable, TV, cellular communications, electronic mail, handpagers, and new forms that we do not even know about today.[8]

Economic classifications and, therefore, our ability to survey establishments in these industries will be in chaos for some time. It is quite feasible that we will have multiple equilibrium points that are constantly shifting. We are facing an open-ended evolution in communications. Each of these industries is engaged in a dynamic evolution. These new industries, which are developing across global lines, are so new we have difficulty classifying them because of their lack of boundaries.

The wireless industry operates not a single location but within an "environment." It may have a relatively small office where it processes the "paper" or "messages" or "billing charges," but that office will have little relationship to the productive work of the industry. The wireless communications industry is a perfect example of the complexity or chaos occurring in our economy, which will present continuing new challenges to researchers trying to quantify what is happening in these areas.

Consulting Industry

Another good example of the complexity in establishments is the consulting industry -- or, in more general terms, the "support" industry, and in particular, the increasing layers of such industries. A consulting firm can be a group of consultants supporting a survey research firm that is supporting a government agency. Or it can be a temp agency supporting a fleet management firm that is supporting a fleet leasing company that is supplying vehicles to a final vehicle user, which is itself a contract carrier for a manufacturer (or perhaps a distributor supporting a manufacturer). Although the consulting industry is hard to define, it occurs in every discipline. Perhaps we will one day see it as a metaphor for a concept or component that we are at present unable to classify within our existing system.

When dynamic change takes place, existing establishments or individuals are often unable to deal with it. New pathfinders tend to arise -- be they individuals or organizations -- to fill the gap, often becoming part of the existing establishments at a later point. Consultants exist in every area, but they may in fact be more predominant in areas that are going through massive change and are undefined, such as the communications industry.

How the consulting industry should be surveyed and quantified is unclear. Perhaps the consulting industry is its own classification, but, then too, it may be a new industry.

Health Care Industry

Still another example of the complexity of today's society is what is happening in the U.S. health care industry, which is obviously undergoing an open-ended dynamic with many new equilibrium points developing. After the health care legislation is passed, some states may implement the Federal health care system with variations. Some may offer an employer option, for example; some may not. Some states have already established reformed health care systems -- such as Hawaii and Florida.

No one can say what the health care system will look like in the future, but the relationship between individuals and health providers are certain to change dramatically. Quantifying the health care industries and the "health" of individuals as this dynamic chaos is occurring will take enormous creativity.

Although statisticians are bit players in this drama, data is being collected that will be used on all sides of the debate. Perhaps statisticians should be doing more -- such as working on the design of a standardized claim

form. And perhaps we should be thinking about how the changes in the health care system will affect our current health care surveys, but, more importantly, our basic economic establishment surveys, as well as our demographic surveys.

Component Parts Industry

A final example of the complexity in the collection of data on establishments is the component parts industry. In the past, we could point to one site as the place where such products as cars and clothing were made. Today, these products are being made in several different places.

In a recent review of the U.S. statistical system, the Office of Technology Assessment (OTA) briefly touched on the emergence of worldwide production networks. OTA noted that car parts were now being made in some parts of the world, assembled into motors, transmissions, and other vehicle systems in other parts of the world, and subsequently assembled into finished vehicles in still other parts of the world, making it impossible to say where the car is made.[9]

The fashion industry is another example of messiness. Clothes are also often designed in one country, their fabric cut in other countries, and the garments assembled and finished in still another country. Often even different parts of a garment are cut and assembled in several different countries. This arcane system developed to gain convenience and to avoid tariff restrictions and cost. (With the growth of China, the whole industry appears to be rapidly changing and in evolution again.) [10] This dynamic is sure to continue. How it will grow and evolve is unclear but it, again, will have a tremendous impact on how and what data we collect.

DEALING WITH COMPLEXITY IN ESTABLISHMENT SURVEYS

New technologies for collecting data on the exciting changes in the modern world are coming on the market every day. Unfortunately, at the same time, our budgets for buying, experimenting with, and using the new technologies are shrinking. The Federal budget for fiscal year 1995 indicates quite clearly that discretionary spending has been frozen.[11] Limited funds, however, may be a hidden blessing for those doing establishment surveys because they challenge us to rethink how we conceptualize our surveys and the responding units.

As survey statisticians, we have always prided ourselves in developing predictable and, often, elegant methods of collecting establishment data. We have generally developed surveys that can be replicated in order to produce the time-series data needed to track the economy. Probably by the very nature of the fact that we are statisticians, we are people who like order. Unlike Heraclitus, who saw the world as a constant process of flow and change, most statisticians tend to see the world more as a system whose natural state is one of equilibrium and if the system is out of equilibrium, we believe that forces in the system will push it back into its natural state. I suspect, however, that the disequilibrium we are now seeing in society will last for some time, which means that survey statisticians will have to develop methods of collecting data that will best illuminate what is happening and may have to concentrate on developing methods to collect and present data that will best illuminate the contemporary state of affairs.[12]

At first, I despaired that statisticians could ever learn how to think about periods with multiple equilibrium points or periods without any equilibrium points. But, because I am basically a "Heraclitian," or perhaps just a very messy thinker, the idea occurred to me that we could use the changes themselves and the products of these changes to design new ways of collecting data for establishment surveys. The trick may be to realize that in order to collect time series data, we may have to be constantly changing our methods of collecting data -- because the units we are collecting from and the systems in which they reside are in constant flux.

Statisticians will have to become inventive in their methods of developing establishment surveys, which often lag behind the inventiveness of household or demographic surveys. We are already making substantial progress in using the newest methods of surveying -- computer-assisted telephone and personal interviewing, Touch Tone Data Entry, the fax machine, and the like. However, those methods may still be too static for the changes that are occurring.

We need to become as inventive as those doing demographic surveys. For example, we need to consider whether we can harness the changes taking place in the communications industry to help us collect data. How we could do this is unclear, but I am sure that we can find inventive ways to use the tremendous proliferation of car phones, cellular phones, and handpagers.

We also need to look at voice mail and e-mail systems as another mechanism for working directly with industry groups to see how these systems work and to understand their potential as a mechanism for collecting information. We need to consider to what extent we can use the "Information Highway" of the Internet system. And we need to work with the designers of the new wireless industries to determine ways to use the mechanisms of the industry to collect data both about the establishments or entities that are developing in these industries and also about all the other industries that will be using wireless communications.

The end of the Cold War has had many benefits, even some that may affect how we collect establishment data. In our agency, for example, we are currently exploring the use of satellite imagery to collect information about buildings. It is even being considered for environmental restoration. Initially, we will be linking the data to geographic information systems and using the combined data to list buildings in rural areas, to pinpoint new construction, and potentially even to determine use of buildings. Our present aim is to use the imagery to replace all field listing. We suspect that much more useful data will become available as data from both the U.S. Central Intelligence Agency and the U.S. National Security Agency data becomes declassified. Perhaps even the restriction on the use of this data for domestic surveys will be lifted.

CONCLUSION

This paper has been written from the rather narrow perspective of a statistician working in a rather small government statistical agency, watching very large changes taking place. I am making a plea for greater exploratory, complexity-oriented communication with other statistical agencies, both in this country and others to start thinking very broadly about the future, which is happening right now. We cannot afford to keep undertaking establishment surveys in the traditional way. We really need to think broadly about crossing traditional establishment and agency lines. We need to grapple with how we can best describe the reality of our ever-changing, interlocking, nonlinear, kaleidoscopic world.

END NOTES

1. See "Positive Feedback in the Economy," *Scientific American*, February 1990, pp. 92-99. See also M. Mitchell Waldrop, *Complexity*, New York; Simon and Schuster, 1992, pp. 333-4; and David Berreby, "Murray Gell-Mann," *The New York Times Magazine*, 8 May 1994, pp. 24-27.

2. Jacob Rytend, of Statistics Canada, looked at many of these concerns from an economic perspective in a superb address, "Business Surveys in Ten Years," delivered at the American Statistical Association's 1993 International Conference on Establishment Surveys.

3. For a detailed discussion, see U.S. Department of Energy, Energy Information Administration, *Natural Gas 1992: Issues and Trends*, DOE/EIA-0560 (92), March 1993, pp. 19-28 and 47-70.

4. See pp. 19-32 of U.S. DOE, Energy Information Administration, The Changing Structure of the Electric Power Industry, 1970-1991.

5. For a discussion, see "A Utility Gets Ready to Compete," *New York Times*, 11 May 1994, pp. D1 and D6.

6. An extensive literature exists in this area. See President William J. Clinton, Vice President Albert Gore, Jr. *The Climate Change Action Plan*, October 1993; and Energy Information Administration, U.S. Department of Energy, *Emissions of Greenhouse Gases in the United States, 1985-1990.*

7. For an excellent discussion of energy use and emissions, see *Energy Use and Carbon Emissions: Some International Comparisons*, U.S. Department of Energy, Energy Information Administration, 1994.

8. See "Racing to Build a Wireless World," *Washington Post*, March 25, 1994, pp. B1 and B5.

9. See pp. 23-24 in U.S. Congress, Office of Technology Assessment, *Statistical Needs for a Changing U.S. Economy -- Background Paper*, OTA-BP-E-58, Washington, DC: U.S. Government Printing Office, September 1989.

10. See J. Lardner, "Annals of Business: The Sweater Trade--II," *The New Yorker*, January 18, 1988, pp. 66 and 72.

11. Executive Office of the President, Office of Management and Budget, *Budget of the United States Government*, Fiscal Year 1995, Washington: GPO, p.4.

12. Waldrop, pp. 333-34.