December 2004

# A Positivist Methodology for Archival Case Studies in Information Systems Research

Jeffrey Merhout
*Miami University*

Allen Lee
*Virginia Commonwealth University*

# A Positivist Methodology for Archival Case Studies in Information Systems Research

**Jeffrey W. Merhout**
Miami University
merhoujw@muohio.edu

**Allen S. Lee**
Virginia Commonwealth University
allenslee@alum.mit.edu

**ABSTRACT**

Few guidelines are available about how a case researcher may collect data about past or historical phenomena. A methodology for case studies based on archival data would be useful for taking advantage of a wealth of evidence (e.g., corporate documents such as memoranda and e-mail, as well as popular press) that occurs naturally in organizational and societal experiences of dealing with information technology. The objective in this paper is to offer an archival case study methodology sufficiently rigorous to be deemed scientific.

**Keywords**

Archival/historical case study, positivism, hypothetico-deductive logic, electronic markets hypothesis

## INTRODUCTION

Today, the information systems (IS) discipline accepts case studies as a form of scientific research. Case study methodologists (e.g., Benbasat, Goldstein and Mead 1987; Eisenhardt 1989; Lee 1989a; Walsham 1993; Yin 1984, 1994) offer numerous guidelines about how a case researcher may collect data about phenomena in the present – a "real time" case study, as it were. However, a search through research journals in the IS discipline reveals few, if any, research articles explicitly using a historical methodology. Overall, there are few guidelines about how a case researcher in the IS discipline may conduct studies about phenomena in the past – e.g., historical case studies, of which archival case studies are a specific form.

A methodology for archival case studies would be useful for taking advantage of a wealth of evidence (e.g., corporate documents such as memoranda and e-mail, as well as popular press) that occurs naturally in organizational and societal experiences of dealing with information technology. Lessons following from such naturally occurring evidence could add significantly to the body of theory in the IS discipline, as well as yield practical lessons relevant to managers, executives, and consultants. One might even argue that it is a significant oversight that such archival data have not yet been substantially mined for the rich lessons that they hold. Our objective in this paper is to offer an archival case study methodology sufficiently rigorous to be deemed scientific.

We begin the paper by addressing, and resolving, two special concerns raised by historical case studies, including archival case studies. After that, we propose a scientific methodology for archival case studies. Finally, we turn to an actual historical IS case study for examples to illustrate how an archival case study about information systems can indeed be conducted in a way deemed scientific.

## TWO SPECIAL CONCERNS RAISED BY ARCHIVAL CASE STUDIES

The IS discipline recognizes science in different forms, such as positivism, interpretivism, and critical theory. In offering a scientific methodology for archival case studies, we put forward a positivist methodology while we recognize that methodologies from interpretive and critical perspectives largely remain to be developed (e.g., Mason, McKenney and Copeland 1997a offer suggestions regarding an interpretive approach). In this paper, we build on the positivist case research methodology of Lee (1989a, 1991). In addition to the special concerns that Lee identifies and resolves regarding the scientific status of the study of a single case, we focus on two additional concerns raised by the study of a single case of a phenomenon *in the past*:

1. How can a theory be tested scientifically when the research subjects and research site are no longer available in their original context (or are not available at all) for interviews or other forms of direct observation by the researcher?

2. How can archival data and a trail of other artifacts left behind by the past phenomenon constitute reliable evidence with which to test the theory?

Similar to Lee (1989a), we are taking a perspective that is positivist and that focuses on *testing* a theory. Of course, perspectives on *building* a theory are no less important to historical case research; therefore, we emphasize that the positivist, theory-testing methodology that we propose in this paper is only the first of many efforts that would need to be taken in the overall development of methodologies for historical IS case studies in general, and archival IS case studies in particular. In the next section, we propose a methodology to address the two concerns stated above.

## A SCIENTIFIC METHODOLOGY FOR ARCHIVAL IS CASE STUDIES

In preparing to do our archival research, we began with a research methodology that has long been available. It is the methodology of hypothetico-deductive logic, the validity of which has long been recognized in positivist science (Ackroyd and Hughes 1992; Lee 1989a, 1989b, 1991; Sarker and Lee 1999; Lee and Baskerville 2003)[1]. Despite being well established among methodologists, hypothetico-deductive logic is not necessarily well understood, accepted, or practiced among IS researchers; for instance, in contrast to the hypothetico-deductive requirement that the logic of empirical testing must be deductive rather than inductive, many IS researchers (as noted by Lee and Baskerville 2003) still hold the belief that induction from a large sample size is required for establishing the generalizablity of a theory. In this section of the paper, we offer a detailed description and example of hypothetico-deductive logic and then show how it applies no less when its propositions happen to refer to historical phenomena.

Even older than hypothetico-deductive logic is the logic of the syllogism, of which hypothetico-deductive logic is a special case. The syllogism consists of a major premise, a minor premise, and the conclusion that follows from applying the major premise to the minor premise. The most familiar illustrations of the major premise, minor premise, and conclusion are, respectively, "all men are mortal," "Socrates is a man," and "Socrates is mortal."

Another application of the syllogism is hypothetico-deductive logic, which involves the special case where the major premise, minor premise, and conclusion are, respectively, the theory, the initial conditions (e.g., those at the beginning of the experiment, prior to the application of the experimental stimulus or treatment[2]), and the prediction (of what should be observed if the theory, as applied to the initial conditions, is true). For instance, the major premise or theory is "f=ma" (i.e., force is equal to mass times acceleration), the minor premise or initial conditions at the beginning of the experiment are "f=10 and m=2," and the conclusion or prediction is that, if the theory "f=ma" is true, then the acceleration after applying the stimulus of a continual force of 10 to an object whose mass is 2 will be observed to be 5 or, simply, "a=5." Then, the observation of what the acceleration actually is (i.e., the empirical value taken by "a" or the actual acceleration) would be compared to what the acceleration was predicted to be.[3] An observation of the value of "a" as being 5 would play the role of evidence consistent with (i.e., "confirming") the theory "f=ma," but any observation of a value for "a" other than 5 would play the role of evidence disconfirming this theory.[4]

Although this example involves mathematically stated propositions, it would be irrelevant to the logic of hypothetico-deductive reasoning if its propositions were expressed in words instead of in mathematical symbols. It would also make no difference to the logic of hypothetico-deductive reasoning if the empirical content of its propositions were to refer to phenomena in past. In other words, the logic that relates the major premise, minor premise, and conclusion to one another remains the same, regardless of whatever the content or empirical referent of these propositions might be, *including the empirical referent's being in the past, present, or future*.

Suppose that the time at which the initial conditions exist is t=1 and the time at which the response to the experimental stimulus or treatment occurs is t=2. For the scientific researcher who compares the expected or predicted response to the actual response, it makes no difference if both t=1 and t=2 happen to be in the past. For this reason, a historical theory can be considered to be, in its logical form, no different from any natural-science theory whose testing also relies on evidence about events that are in the past, that no contemporary researcher had been present to observe, and that cannot be replicated for observation; an example is the theory that a meteor caused the mass extinction of the dinosaurs. And in the social sciences, researchers in economics and finance routinely use census data and economic data, collected in the past (and not even collected by themselves, but by government agencies), to test their theories.

In this paper, the theory (major premise) is the electronic markets hypothesis (EMH) (Malone, Yates and Benjamin 1987).[5] The initial conditions (the minor premise) are those in the residential real estate market in the United States in the period from the mid-1990s to 2002. The prediction (the conclusion, following from applying the EMH to these initial conditions) is that, *if the EMH theory is true*, we will observe the presence of a significant electronic market in the residential real estate industry in the U.S. by the time 2002.

In the remainder of this section, we will propose ways to address the two special concerns that we earlier identified that are raised by the study of phenomena in the past.

**Special Concern 1:**

How can a theory be tested scientifically when the research subjects and research site are no longer available in their original context (or are not available at all) for interviews or other forms of direct observation by the researcher?

The time dimension of observations – i.e., observation statements resulting from a laboratory setting, a real-time field study, or the examination of historical evidence – makes no difference to the logic by which a researcher may relate propositions (e.g., major premise, minor premise, conclusion) to one another. The dimension of time refers to the *content* of the observation statements and not to the manner of reasoning or *logic* by which a researcher may appropriately relate different statements to one another.

For the social sciences that take a positivist approach, hypothetico-deductive logic is a general strategy to manage and test theories[6] regardless of whether the evidence used to draw conclusions is about real-time or historical phenomena. The rules of formal logic and mathematics are literally blind to whether a theory's propositions refer to a subject matter in the present or the past. Along these same lines, there is no difference between the logical form of a prediction and the logical form of its counterpart in historical research, a postdiction.[7] The deductive logic that relates the major premise (the theory), minor premise (the initial conditions of the field site, case, organization, or other setting), and conclusion (predictions or postdictions) to one another remains the same, regardless of whatever the content or empirical referent of these propositions might be, including the empirical referent's being in the past, present, or future.

If the actual observations made in the archival case study agree with the postdictions, then the researcher can conclude that the theory is confirmed in this case (where the accepted usage of the term "confirmed" or "corroborated" in this context indicates that the theory is consistent with evidence, *not* that the theory is proved true). If, on the other hand, the actual observations are not what were expected (i.e., not consistent with the theory's postdictions), the theory can be considered falsified or refuted in this instance and should possibly be discarded or refined (Darke, Shanks and Broadbent 1998; Lee 1989b, 1999).

**Special Concern 2:**

How can archival data and a trail of other artifacts left behind by the past phenomenon constitute reliable evidence with which to test the theory?

Historical and archival data collected to test the postdictions formulated via hypothetico-deductive logic are arguably sometimes superior to other forms of data (i.e., data collected in the present). In a real-time interview, for example, the interviewee could have a limited memory, may want to say things to impress the researcher, or may exaggerate past events. Moreover, Glaser and Strauss (1967) comment that every book and every magazine article in the popular press is essentially equivalent to an anthropologist's informant or a sociologist's human subjects. They are not referring to research books or research periodicals, but to books, newspapers, and magazines (i.e., popular press) that are the natural artifacts created by the members of a society and that, therefore, actually form a source of primary (not secondary) data. Researchers can gather evidence from multiple primary sources of data for the purpose of establishing a pattern of convergence and, subsequently, drawing a conclusion about whether the theory's propositions are confirmed. Moreover, historical artifacts are not hampered by the problem of limited memory.

Several of the strategies that Yin (1994) suggests for ensuring reliability in a case study can be adapted for use in archival case studies. The goal of reliability is to demonstrate that specific facets of research, particularly the data collection procedures, are done in a manner that is consistent and precise so as to minimize errors and researcher biases. Yin argues that the objective is to allow another researcher to follow the same procedures in the same case and eventually to draw the same conclusions. Three specific tactics for ensuring reliability in a case study are: using a case study protocol (for collecting evidence), developing a case-study database, and establishing a chain of evidence. All three tactics remain feasible and valid for historical case research in general and archival case studies in particular.

## AN ILLUSTRATION OF THE PROPOSED ARCHIVAL IS CASE STUDY METHODOLOGY

The following section will illustrate how an archival case study in the residential real estate industry, conducted to test the electronic markets hypothesis (EMH), sufficiently addressed the special concerns raised in the study of historical phenomena (Merhout, 2002).

**Special Concern 1:**

How can a theory be tested scientifically when the research subjects and research site are no longer available in their original context (or are not available at all) for interviews or other forms of direct observation?

We were able to test the EMH scientifically with archival data by employing hypothetico-deductive logic:

> Major premise (the EMH theory): In an era in which communication and information technologies (IT) in business (e.g., those involving electronic connections between firms, suppliers, and customers) undergo major advances, the Economic Activity Coordination Mechanism (EACM) in a given industry will evolve into an electronic market (and electronic market coordination that becomes increasingly more prevalent).
>
> Minor premise (the initial conditions): In the residential real estate market in the United States in the period from the mid-1990s to 2002, communication and information technologies in business underwent major advances.
>
> Conclusion (the prediction): A significant electronic market will have developed in the residential real estate industry by 2002.
>
> Observation based on archival evidence: A significant electronic market did indeed exist in the residential real estate industry by 2002.

In our archival study, the initial conditions in the residential real estate industry (the minor premise) were such that advances in communication and information technologies during the period from the mid-1990's to early 2002 (most prominently involving the Internet) provided the infrastructure necessary for the development of a significant electronic market. It is clear from the multiple sources of archival evidence which we accumulated that the Internet and Internet-based communication and information technologies served as the advanced communication and information technologies required by the EMH in order for the theory to be confirmed in this setting.

For example, Havala (2000) states that the most important technology focus in the industry "is the rapid spread and acceptance of the Internet." Muldavin (2000) adds that "[t]he Internet's communication capabilities will be particularly powerful for the real estate industry because of recent advances in real estate data and property management systems." Jud and Roulac (2001) discuss the "the revolution of information [and cyberspace] technology," which suggests that the advances in IT had been dramatic and substantial. Finally, Benjamin, Jud, Roth and Winkler (2002) refer to the "ever-expanding" and "growing use of the Internet," thereby providing evidence that these information technologies have permeated the industry as required by the EMH. While one could argue that none of these quotations poses strong evidence as a stand-alone statement, when considered as a whole, they indicate a pattern consisting of advancing information technologies that facilitate the processing of real estate information. Moreover, we found no significant instances where the evidence contradicted the general pattern. These data (which are representative of the articles from which the quotations are drawn) provide the initial conditions.

In our research, we also concluded that the pattern of observations confirmed the prediction that the economic activity in the residential real estate industry in 2002 was significantly facilitated by electronic market coordination. Indeed, the Internet is the marketplace for this very significant electronic market. For example, per the 2002 "Survey of Home Buyers and Sellers" by the powerful real estate trade association, the National Association of Realtors (NAR), "[f]orty-one percent of homebuyers surveyed in the biennial report said they used the Internet as a home search resource, up 4 percent from 2000" (Inman News 2002). In addition, Realtor.com, the official Web site of the NAR, "attracted more than 4.43 million unique users in May [2002]"…, "a 23 percent increase over May 2001" (National Association of Realtors 2002).

Moreover, as touted by the NAR, "Realtor.com [offered] a potential homebuyer nearly 2 million homes listed for sale as well as the most brokers and agents to contact. The site also provides home sellers with the Internet's largest marketplace to reach millions of potential viewers" (National Association of Realtors 2002, emphasis added). In addition, Muhanna and Wolf (2002) conclude that "web sites such as Yahoo!Real Estate, MSN's HomeAdvisor.com, HomeSeekers.com, Homestore.com, the NAR's official web site Realtor.com, and several others provide visitors with a breadth of information, including data on recent house sales and prices of comparable houses, information on neighborhoods, schools, taxes, costs of living, and maps and tools for locating, buying, financing and insuring a home."

These observations are just a small portion of the archival evidence which we observed and that confirm the EMH. We used hypothetico-deductive logic so that we could conduct an archival case study in a way that could be deemed scientific. Thus we concluded that the EMH was confirmed (or corroborated) in this empirical test. However, we do not claim to validate the theory as true because hypothetico-deductive logic does not allow any theory to be proved true. To corroborate or confirm a theory is simply to state that the evidence from an empirical test is consistent with the theory's propositions.

**Special Concern 2:**

How can archival data and a trail of other artifacts left behind by the past phenomenon constitute reliable evidence with which to test the theory?

Yin (1994) argues that that the generally accepted scientific tests of the quality of a research design – construct validity, internal validity, external validity and reliability – are just as relevant to case study research as they are for other forms of empirical social research. Our archival case study design incorporated procedures to ensure that each of the four elements of a quality design was present. For example, to achieve construct validity, we used multiple sources of evidence (e.g., archival documents from trade sources plus academic resources), established a chain of evidence (by linking conclusions about each EMH variable to the supporting evidence), involved knowledgeable persons in reviewing and providing feedback on the write-up that analyzed the industry, and defined unclear variables (such as IT) and possible data values (such as electronic markets).

For internal validity, as Yin recommends, we utilized pattern matching to test postdictions of the theory and created a secondary analysis across cases (including other studies of the EMH). For external validity, we tested the theory in the two industries (we were studying the home mortgage industry at the same time) and we were able to confirm the theory in both settings. Yin calls this "replication logic" (p. 36). Finally, for reliability, we created a case study protocol and separate bibliographies for the archival evidence (to serve as a case study database). Additionally we established a logical chain of evidence by answering the research questions we formulated for each EMH variable and by immediately following the answers to the questions with the archival evidence that supports the answers. Accordingly we argue that our research design has met the standards for a quality study.

The archival data (articles from trade journals, newspapers, and other industry-related sources) we assembled constitute reliable and representative evidence for testing the EMH. The quotations we provided as historical evidence are prototypical of the context of the articles – i.e., the natural artifacts – containing these statements and represent definitive examples of the underlying evidence, which needed to be analyzed in a cumulative manner for each variable during pattern matching. When the patterns coincide, as they have done with the major postdictions in our study (as formulated through hypothetico-deductive logic), then the theory's propositions are confirmed.

Moreover, it should be recognized that reports from the trade press (one significant source of evidence used in our study) are primary, not secondary data because the members of the trade press are normally members ("natives") of the same culture as the managers and workers who inhabit this specific industry. Hence, the information in these artifacts was not filtered by outsiders. In addition, academic articles (another source of evidence for the study) complement evidence from trade sources because the conclusions drawn from the research summarized in these publications were critiqued during the scholarly review processes. When the data from these two sources converge, as they have in our study, one can feel more confident about the overall evidence and about the conclusions drawn from this evidence.

## CONCLUSION

Organizations and information technology produce a wealth of natural artifacts – especially in the form of documents – that can be examined to advance theory about information systems. Moreover there is a significant need for historical case studies: for theories to be general, they need to apply not only across organizations and technologies, but also across time. The durability of our theories across time requires historical research, to which archival studies can be a major contributor. Also, studies of past experiences and past practices can yield lessons useful to managers and executives regarding the management of information technology. In this paper, we have presented a scientific methodology for doing archival case studies (that uses the same hypothetico-deductive logic as used in the natural sciences and positivist social sciences) and illustrated how an industry case study can sufficiently address the special requirements of study of phenomena in the past. These examples illustrate that the time dimension of historical phenomena is a property of evidence, not of theoretical propositions, and requires no special treatment with regard to the rules of formal logic and rules of empirical testing used to manage and test theoretical propositions.

## RESEARCH REFERENCES

1. Ackroyd, S. and Hughes, J.A. (1992) Data Collection in Context, Longman, New York.
2. Benbasat, I., Goldstein, D. K. and Mead, M. (1987) The Case Research Strategy in Studies of Information Systems, *MIS Quarterly,* 11, 3, 369-386.
3. Campbell, D. T. and Stanley, J. C. (1963) Experimental and Quasi-Experimental Designs for Research, Houghton Mifflin, Boston.

4. Cook, T. D. and Campbell, D. T. (1963) Experimental and Quasi-Experimental Designs for Generalized Causal Inference, Houghton Mifflin, Boston.
5. Darke, P., Shanks, G., and Broadbent, M. (1998) Successfully Completing Case Study Research: Combining Rigour, Relevance and Pragmatism, *Information Systems Journal,* 8, 4, 273-289.
6. Eisenhardt, K. M. (1989) Building Theories from Case Study Research, *Academy of Management Review,* 14, 4, 532-549.
7. Glaser, B. and Strauss, A. (1967) The Discovery of Grounded Theory: Strategies of Qualitative Research, Wiedenfeld and Nicholson, London.
8. Lee, A. S. (1989a) A Scientific Methodology for MIS Case Studies, *MIS Quarterly,* 13, 1, 33-50.
9. Lee, A. S. (1989b) Case Studies as Natural Experiments, *Human Relations,* 42, 2, 117-137.
10. Lee, A. S. (1991) Integrating Positivist and Interpretive Approaches to Organizational Research. *Organization Science,* 2, 4, 342-365.
11. Lee, A. S. and Baskerville, R. L. (2003) Generalizing Generalizability in Information Systems Research. *Information Systems Research,* 14, 3, 221-243.
12. Malone, T. W., Yates, J., and Benjamin, R. I. (1987) Electronic Markets and Electronic Hierarchies, *Communications of the ACM,* 30, 6, 484-497.
13. Mason, R. O., McKenny, J. L., and Copeland, D. G. (1997a) Developing an Historical Tradition in MIS Research, *MIS Quarterly,* 21, 3, 257-278.
14. Mason, R. O., McKenny, J. L., and Copeland, D. G. (1997b) An Historical Method for MIS Research: Steps and Assumptions, *MIS Quarterly,* 21, 3, 307-320.
15. Merhout, J. W. (2002) Industry Case Studies for Testing and Refining the Electronic Markets Hypothesis, Unpublished Doctoral Dissertation, Virginia Commonwealth University.
16. Nagel, E. (1979) The Structure of Science: Problems in the Logic of Scientific Explanation, Hacket, Indianapolis.
17. Sarker, S. and Lee, A.S. (1999) IT-Enabled Organizational Transformation: A Case Study of BPR Failure at TELECO, *Journal of Strategic Information Systems,* 8, 1, 83-105.
18. Walsham, G. (1993) Interpreting Information Systems in Organizations, Wiley, New York.
19. Yin, R. K. (1984) Case Study Research: Design and Methods, Sage Publications, Beverly Hills, CA.
20. Yin, R. K. (1994) Case Study Research: Design and Methods, 2nd ed., Sage Publications, Thousand Oaks, CA.

**ARCHIVAL EVIDENCE REFERENCES**

1. A Benjamin, J. D., Jud, G. D., Roth, K. A. and Winkler, D. T. (2002) The Internet and the Financial Performance of Residential Brokerage Firms, UNC Greensboro Research Paper Series Number FIN02002, retrieved from the WWW at <www.uncg.edu/bae/badm/research.html>.
2. Havala, M. J. (2000) 'Next Economy' Real Estate: The Convergence of Technology and Real Estate, *The Real Estate Finance Journal*, 16, 2, 23-29.
3. Inman News (2002) Web Beats Newspapers: Print World's Loss of Home Shoppers is 'Net's Gain, Inman News Features at www.inman.com, June 14, 2002, retrieved from the WWW on 6/18/02 at <http://www.inman.com/inmanstories.asp?ID=30463>.
4. Jud, G. D. and Roulac, S. (2001) The Future of the Residential Real Estate Brokerage Industry, *Real Estate Issues,* 26, 2, 22-30.
5. Muhanna, W. A. and Wolf, J. R. (2002) The Impact of E-Commerce on the Real Estate Industry: Baen and Guttery Revisited, *Journal of Real Estate Portfolio Management,* 8, 2, 141-152.
6. Muldavin, S. (2000) Internet Influences on the Real Estate Capital Markets, *Real Estate Finance,* 17, 1, 62-63.
7. National Association of Realtors (2002) Consumers Flock to REALTOR.com for the Most Listings on the Web, www.realtor.org, July 9, 2002, retrieved from the WWW on 7/11/02 at <www.realtor.org/realtororg.nsf/pages/rcomconsumers?OpenDocument>.

**ENDNOTES**

[1] Of course there are approaches other than hypothetico-deductive logic that can be used as a historical method. For example, see Mason, McKenny and Copeland 1997b. This current paper focuses on hypothetico-deductive logic.

[2] The current discussion pertains not only to experimental treatments, but also to statistical treatments in statistical experiments (Campbell and Stanley 1963; Cook and Campbell 1963) and natural treatments in natural experiments (Nagel 1979; Lee 1989b).

[3] The term "prediction" implies a time dimension: An event or condition will occur at a time following the application of the experimental treatment or stimulus. However, in hypothetico-deductive logic, the conclusion can be not only a prediction of a future event or condition, but also an expectation of an event or condition contemporaneous with the initial conditions.
In a longitudinal experiment, a researcher begins to apply a continual force of 10 to an object whose mass is 5 and waits for it to begin moving, whereupon the researcher measures the object's actual acceleration to determine if it matches the predicted value of 2. On the other hand, a researcher can conduct a cross-sectional experiment in which the researcher observes or measures both the mass and acceleration of an object already in motion (so that m=2 and a=5), whereupon the researcher observes or measures the actual force to determine if it matches the expected force of f=10. In the cross-sectional experiment, we may only figuratively and not literally call the expected force of f=10 to be a prediction because it refers to a contemporaneous condition. In this situation, we may refer to this instead as the hypothesized value of "f" rather than the predicted value of "f." Unfortunately, the term "hypothesis" is also popularly used as a synonym for "theory," which occupies the role of the major premise in the syllogism, whereas the hypothesized value of "f" occupies the role of the conclusion in the syllogism. To avoid this confusion, we will use term "prediction" throughout our discussion, where we emphasize that its application in cross-sectional experiments is figurative but still correct.

[4] Note that evidence consistent with a theory never proves the theory to be true. At best, it leaves open the possibility that the theory is valid and it points the way to additional testing. If evidence may play any decisive role in the testing of a theory, it is the role of being inconsistent with and refuting the theory. Based on this line of reasoning, it is said that theories may never be proved true, but only shown to be false.

[5] As will be explained in more detail in a later section of this paper, the EMH theorizes that, in an era of advances in electronic interconnections among business partners (and including the end consumer), the economic activity coordinating mechanism to facilitate the purchases of goods and services in a given industry will eventually shift to proportionately more electronic market coordination. In our research, we operationalized the main proposition of the theory by denoting the phenomenon of advances in electronic interconnections (i.e., communications and information technologies) as the independent variable, IT. We denoted the predominant economic coordination mechanism as the dependent variable, EACM. While the EMH also postulates effects on the EACM from mediating variables, those variables are not included in the scope of the illustrations we use in this paper.

[6] While human non-determinancy is a possible concern with extending hypothetico-deductive logic to the social sciences, the logic of scientific inquiry is determinant. Non-determinancy is actually a feature of human beings, their organizations, their societies, etc.; however, the rules of formal logic and the rules of experimental design in the social sciences remain as determinate as they are in the natural sciences.

[7] The *Oxford English Dictionary* defines postdiction as "(The making of) an assertion or deduction about something in the past."