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Real-izing Information Systems: Critical Realism as an Underpinning Philosophy for Information Systems

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Abstract

The paper begins by pointing out the diversity of philosophical positions within information systems, and the range of reactions to this diversity. It then discusses problems within the underlying philosophies of science, particularly positivism and interpretivism. With this as a background, the paper proposes critical realism as an underpinning philosophy that has the potential to overcome both sets of difficulties. The theoretical arguments are practically illustrated by critiques of (positivist) statistical analysis and (interpretivist) soft systems methodology.

Keywords: Critical realism, epistemology, ontology, research methods

1 INTRODUCTION

Historically, most information systems (IS) research and systems development has been underpinned by a positivist philosophy (Mingers 2001, 2002b). During the 1980s and the 1990s, several streams of work based on different philosophies emerged (Mumford et al. 1985). The main stream is interpretivism (Walsham 1995), which emphasizes the inherent meaningfulness of the social world. Other approaches based in distinctive philosophical traditions are critical theory (Lyytinen and Klein 1985) and postmodernism (Robinson et al. 1998).

There have been several reactions to this plurality of approaches. Imperialists argue for the dominance of one particular paradigm (usually positivism), either on epistemological grounds or in the belief that it is necessary to create a strong discipline. Isolationists tend to accept the argument that there are distinctively different paradigms but that these are generally incommensurable and, therefore, research should develop separately within each paradigm. Finally pluralists accept, and indeed welcome, a diversity of paradigms and research methods. Some welcome diversity for its own sake, some see different methods as being appropriate for particular research questions or situations, and some argue that research should strive to be trans-paradigmatic, combining philosophically distinct research methods.

However, it is often not recognized that there are significant problems within the underlying philosophies—of science and of social science—themselves. Positivism has been extensively critiqued and the resulting consensus around a weak empiricist position leads to an impoverished view of (realist) ontology and causality. Within the social sciences, extreme constructivist and postmodern positions have undermined even the most basic tenets of science and rationality. This paper proposes a particular philosophy of science, *critical realism*, as a way of resolving or dissolving most of these issues and providing a consistent and coherent underpinning philosophy for information systems.

2 PROBLEMS IN THE PHILOSOPHY OF NATURAL SCIENCE

In general, a *realist* understanding of science takes the view that certain types of entities—be they objects, forces, social structures, or ideas—exist in the world, largely independent of human beings, and that we can gain reliable knowledge of them. However, especially during the 20th century, "naïve realism" has been under constant attack from empiricism (which restricts science to mathematical formulations of empirical regularities) on the one hand, and many different forms of conventionalism (that stress the involvement of human judgement) on the other (Habermas 1978). The main characteristics of variants of each are shown in Table 1.

Table 1. Different Positions Within the Philosophy of Natural Science

		Empiricism		**Conventionalism**	
	Logical Empiricism	*Hypothetico-Deductive*	*Pragmatism*	*Kuhnian Paradigms*	*Sociology of Science*
Purpose	Explaining events that can be empirically observed in terms of universal laws.	Explaining events that can be empirically observed in terms of universal laws.	A practical activity aimed at producing useful knowledge rather than truth.	Science aims at knowledge within a given framework of assumptions.	Science is essentially a social activity much like any other. It does not have a special hold on truth.
Method	Observations and measurements that can be represented mathematically. The derivation of universal laws through induction.	Proposal of hypotheses or conjectures that can be verified or falsified but not p.roven.	Theories are judged in terms of their usefulness in solving a problem or their acceptability.	Science always works within a deeply held set of theories and assumptions (paradigm) that shapes the nature of scientific activity.	In practice, science works like any social activity in terms of power and influence rather than pure access to the truth.
Assumptions	Humean causality: only constant conjunctions of events; Induction; Objective observation and measurement; Correspondence theory of truth.	Humean causality; Direct observability of the criterion for existence; Observations are theory and subject dependent; Hypotheses in principle are unproveable; deduction rather than induction.	We cannot and should not aim for ultimate truth but rather usefulness; theories are instruments. Consensus theory of truth. The meaning of a concept comes from its use.	The prevailing theoretical paradigm determines scientific activity: measurements, theories, acceptability. Over time, paradigms replace one another but these may be incommensurable. Truth is relative to the paradigm.	Knowledge is purely the outcome of power within social activity rather than a reflection of an external real world.

2.1 Empiricism

Empiricism refers to those philosophies that see science as limited to explaining events that can be empirically observed. Events are expected to display regularities or patterns that can be explained as being particular instances of universal laws of the form "given certain conditions, whenever event X occurs then event Y will occur." Science is seen as the systematic observation of event regularities (Humean causality [Hume 1967]), the description of these regularities in the form of general laws, and the

prediction of particular outcomes from the laws. This must apply equally to social science. This view of science was extensively critiqued. The idea of pure, objective perception and observation was exploded by psychologists, sociologists, and philosophers; others showed that observational terms were not an atomistic picturing of reality but part of a pre-given linguistic structure—in short that all observation was theory-dependent; and Popper (1959, 1969), based on Hume, rejected the possibility of verification and induction, replacing it with falsification and deduction. In response, the "deductive-nomological (D-N)" or "hypothetico-deductive" method was developed.

Within IS, empiricism generates the dominant form of research (Mingers 2002b). It leads to studies that primarily focus on observation and measurement, classification, experiment, and statistical analysis. The results of such studies are intended to confirm or falsify prespecified hypotheses about an objectively observable, independent reality.

2.2 Conventionalism

Problems with the empiricist view of science center around the impossibility of pure, unmediated observation of empirical "facts." So, the term conventionalism covers a wide range of philosophies, all of which emphasize the inevitable dependence of scientific theories on human perception, conceptualization, and judgement.

Pragmatism is a view about the purpose of science: that it is essentially a practical activity aimed at producing useful knowledge rather than understanding the true nature of the world. Thus Peirce (1878) developed a pragmatist theory of meaning such that the meaning of a concept was specified purely in terms of the actual practical effects that it would have, and a consensus theory of truth as that which would come to be believed by a community of scientists in the long term, rather than as correspondence to reality.

Kuhn's (1970) identification of major paradigms of thought throughout science is so well known as to need little exposition. This view leads to a much greater recognition of the social and psychological nature of scientific activity. The idea of paradigms replacing each other over time has developed, particularly within social science, to the idea of there being competing paradigms existent at the same time (e.g., positivist, interpretive, and critical). This is often combined with the claim that paradigms are incommensurable. Clearly, the Kuhnian view has major relativistic implications for empiricism. It highlights the constructed, conventional nature of scientific theorizing, and truth is that which is accepted by a scientific community rather than correspondence to some external reality. The incommensurability thesis is even more undermining since in makes it impossible to judge between paradigms or even assert that a later paradigm is actually superior to an earlier one.

Within IS research, we can clearly see the influence of Kuhn (and Burrell and Morgan 1979) on the whole debate about research methods as discussed in the introduction. Research underpinned by pragmatism tends to be case study oriented and aimed at improving practice as in action research or even consultancy. The common demands that research should be relevant (rather than or as well as rigorous) is also clearly driven by principles of pragmatism (Goles and Hirschheim 2000).

3 THE RELATIONSHIP BETWEEN NATURAL AND SOCIAL SCIENCE

So far, the discussion has centered around the nature of natural science on the assumption that this was most relevant to information systems, but in recent years there has been persuasive arguments that since IS is conducted within social organizations, social science is also of relevance. This then brings into the picture major philosophical debates concerning the nature of social science in relation to natural science that can only be sketched here.

Broadly, there are three possible positions.

(1) The *naturalist* view that there is one general approach to science that applies to all domains. Within this category, positivists hold that for anything to be scientific it must follow the canons of positivism/empiricism and thus be based on universal generalizations from empirical observations.

(2) The antithesis is the view that the social world is intrinsically different from the natural world, being constituted through language and meaning, and thus involves entirely different hermeneutic, phenomenological, or social constructivist approaches. The argument here would be the idealist one that ontologically social objects do not exist in the way physical

ones do (i.e., as subject independent), and that epistemologically there is no possibility of facts or observations that are independent of actors, cultures, or social practices.

(3) The most radical position denies the possibility of objective or scientific knowledge at all, in either domain. Arguments here come from the strong sociology of knowledge program; post-structuralists such as Foucault (1980), and more generally post-modernists (Best and Kellner 1991), who attempt to undermine even the most basic categories of modernist rationality.

4 AN INTRODUCTION TO CRITICAL REALISM

Critical realism has been developing for some years (Archer et al. 1998) in response to the fundamental difficulty of maintaining a realist position in the face of the criticisms, outlined above, of an empirical and naturalist view of science. Its original aims (on which this paper will concentrate) were: (1) to reestablish a realist view of *being* in the ontological domain while accepting the relativism of knowledge as socially and historically conditioned in the epistemological domain, and (2) to argue for a critical naturalism in social science. The use of the qualifier *critical* reflects several themes. First, the two mentioned above—that it is not naively realist or naturalist, accepting significant limitations on the objectivity of our knowledge. Second, and relating to critical social theory, is the argument that no social theory can be purely descriptive, it must be evaluative, and thus there can be no split between facts and values, and, following from this, the view that social theory is inevitably transformative, providing an explanatory critique that logically entails action (Archer et al. 1998, Part III).

Critical realism is becoming influential in a range of disciplines: geography (Pratt 1995; Yeung 1997), economics (Fleetwood 1999), organization theory (Tsang and Kwan 1999), sociology (Sayer 1997), and research methods in general (Layder 1993; Sayer 1992). Its potential for information systems has been recognized by Dobson (2001a, 2001b).

4.1 Arguments Establishing a Stratified Ontological Domain

Bhaskar's (see Archer et al. 1998, p. 23) starting point is to argue specifically against empiricism and positivism, that science is not just about recording constant conjunctions of observable events but is about objects, entities, and structures that exist (even though perhaps unobservable) and generate the events that we do observe. The form of the argument is a *transcendental* one. That is, it begins with some accepted phenomenon and asks what must the world be like for this to occur. In this case, what is accepted by both empiricism and many forms of idealism is that we do have perceptual experience of the world, and that science is carried out through experimental activity in which scientists bring about particular outcomes. The argument is that neither empiricism nor idealism can successfully explain these occurrences and that they necessitate some form of realist ontology. With regard to perception, we can note that as human beings we have to learn (as babies) to perceive things and events, that our perceptions can change (e.g., visual illusions), and that scientists, for example, have to be trained to make observations correctly. These all imply that there must be a domain of events that are independent of our perceptions of them (what Bhaskar calls an *intransitive* domain). And, indeed, that these events would exist whether or not they were observed or there even were observers. There is thus a domain of actual events, only a (small) subset of which are perceived and become empirical experiences.

Moving on to experimental activity, we can note (1) that the experimenter causes (i.e., brings about) the experimental conditions but does not cause the results, these depend upon the causal laws that are operative; (2) that the regularities that are expected may or may not occur depending on how well the experiment is carried out rather than on whether the presumed laws are or are not working; (3) that in fact the occurrence of empirical regularities (i.e., constant conjunctions) in general is fairly rare—that is why the experiment is necessary to try to bring them about—but that, despite this, results do in fact hold outside the experiment. The implications of this are that causal laws must be different from and independent of the patterns of events they generate, and that the experimenter aims to produce a constant conjunction of events by *closing* what would otherwise be an open system. Thus the intelligibility and success of experimental activity demonstrates the existence of an intransitive domain of casual mechanisms separate from the events they generate, and the corrigibility of perception demonstrates the separation of events from particular experiences of them. The empiricist identification of causal laws with empirical regularities thus involves a double reduction: that of laws to events and events to experiences.

The argument can be expressed in terms of the mistake that both empiricism and strong forms of idealism or conventionalism make, that is, the *epistemic fallacy*. The essential mistake is in reducing the ontological domain of existence to the epistemological domain of knowledge: statements about being are translated into ones about *our* (human) knowledge or experience of being. For the empiricist, that which cannot be experienced cannot be. For the conventionalist, limitations of our *knowledge* of being are

taken to be limitations on being itself. In contrast, the realist asserts the primacy of ontology: the world would exist whether or not humans did.

What exactly are causal laws? Or, rather, what is it that causes or generates events given both the regularities that can be established in experiments, and the common absence of regularity outside? Equally, how can we assure ourselves that event regularities are based on necessary connections rather than simply coincidence? The answer is that there must be enduring entities, physical (e.g., atoms or organisms), social (e.g., the market or the family), or conceptual (e.g., categories or ideas) (Bhaskar 1997), observable or not, that have powers or tendencies to act in particular ways. The continual operation and interaction of these entities generates (i.e., causes), but is independent of, the flux of events. Entities may have powers without exercising them at a particular time (it may need an experiment to trigger them), and powers may be exercised but not become manifest in events because of the countervailing operation of some other generative mechanism. The heart of this argument is that of a *causal* criterion for existence rather than a perceptual one. In other words, for an empiricist, only that which can be perceived can exist, whereas for a (critical) realist, having a causal effect on the world implies existence, regardless of perceptability.

4.2 Critical Realism and Natural Science

For Bhaskar, reality is both intransitive (existing independently of humans) and stratified (Archer et al. 1998, p. 41). The first form of stratification is between mechanisms, the events that they generate, and the subset of events that are actually experienced. These are known as the domains of the *real*, the *actual*, and the *empirical* (see Figure 1). The real contains mechanisms, events, and experiences, i.e., the whole of reality; the actual consists of events that do (or do not) occur and includes the empirical, those events that are observed or experienced. These distinctions arise from the transcendental arguments above, namely that we should not reduce all events to only those that are observed, and we should not reduce enduring causal mechanisms to events.

A second form of stratification is within the realm of objects themselves (Archer et al. 1998, p. 66), where causal powers at one level (e.g., chemical reactions) can be seen as generated by those of a lower level (atomic valency). One strata is emergent from another (what Bhaskar terms "emergent powers materialism"). The picture of the real is thus one of a complex interaction between dynamic, open, stratified systems, both material and non-material, where particular structures give rise to certain causal powers, tendencies, or ways of acting, often called by Bhaskar (1979, p. 170) "generative mechanisms." The interaction of these generative mechanisms, where one often counterbalances another, causes the presence or absence of actual events.

Having established the intransitive *objects* of knowledge, we must recognize that the *production* of knowledge is very much the work of humans, and occurs in what we could call the *transitive* dimension (Bhaskar 1989, p. 18). Acknowledging the work of sociologists, the practice of science is a social process drawing on existing theories, results, anomalies, and conjectures (the transitive objects of knowledge) to generate improved knowledge of science's intransitive objects. This distinction allows us to

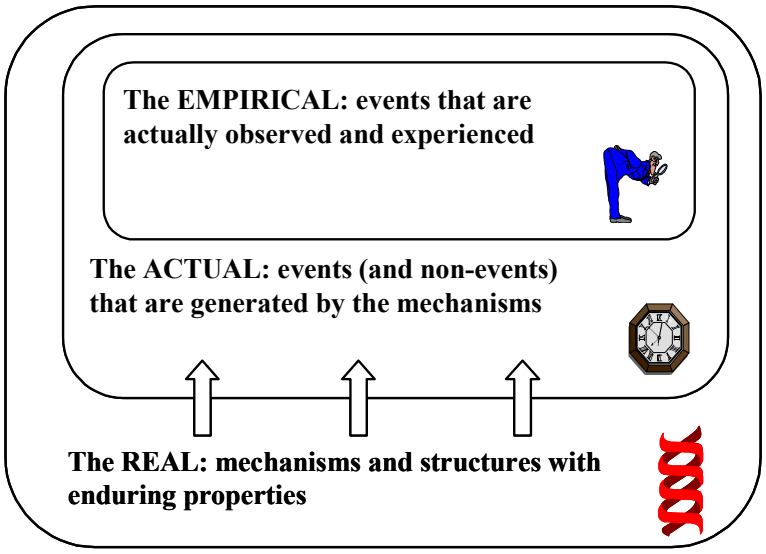

Figure 1. The Three Domains of the Real

admit the *epistemic* relativity of science, the fact that knowledge is always historically and socially located, without losing the ontological dimension. We should also note that such epistemic relativity does not imply a corresponding *judgmental* relativity, i.e., that all views are equally valid and that there are no rational grounds for choosing between them.

We can now characterize the realist method of science as one of *retroduction* (this is the same as "abduction" as developed by Peirce in contrast to induction and deduction), where we take some unexplained phenomenon and propose hypothetical mechanisms that, *if they existed*, would generate or cause that which is to be explained. So, we move from experiences in the empirical domain to possible structures in the real domain. This does not of itself prove that the mechanism exists, and we may have competing explanations, so the next step is to work toward eliminating some explanations and supporting others.

How do we *know* that such hypothetical mechanisms actually do exist rather then being merely interesting ideas? At one level the answer is that we can never know for certain, since science is always fallible. More practically, however, the intransitivity of real structures means that they will always have the potential for effects that go beyond us, i.e., are out of our control, and the methodology means that we should aim to eliminate alternative explanations by testing in some way for their potential effects.

4.3 Critical Realism and Social Science

We now move to the second major argument of critical realism, that social science is essentially similar to natural science in its realist character, albeit with modifications to reflect the particular nature of the social world. We can begin by asking what would rule out a realist approach. The answer being, there are no intransitive objects for social science to investigate. Such an argument could come from the extreme constructivists (or superidealists as Bhaskar calls them), who would also apply it to the natural world, or from those who would argue for the distinctive nature of social phenomena as being intrinsically meaningful and not existing independently of social actors.

Bhaskar's (1979, Chapter 2) primary point is against methodological individualists who argue that all explanations can be couched in terms of the individual's beliefs and actions. The first refutation concerns emergent properties: there are attributes that can be applied to people that concern physical features, height, weight; there are attributes that we share with other animals such as pain or hunger; but there are many attributes, essentially human ones, that are unavoidably social, for example bachelor, banker, or nun. These are only intelligible within the context of a social institution or practice. The second argument is that many activities we undertake, most obviously perhaps language, must already exist and be available for people to learn and then use. As Wittgenstein (1958) argued, there can be no such thing as a private language: every time anyone has a conversation, uses a credit card, or waits for a train, they are assuming the existence of a structured, intransitive domain of resources, concepts, practices, and relationships. The successful occurrence of social activities warrants the existence of causally efficacious, although unobservable, social structures.

Bhaskar (1979) does accept, however, that social phenomena are inherently different from material phenomena and that this does put limits on the nature of social science. Social science is, however, still driven by the existence of an intransitive domain of generative mechanisms, a recognition of the epistemic (but not judgmental) relativity of knowledge, and a retroductive methodology that explains events by hypothesizing causal mechanisms.

5 APPLYING CRITICAL REALISM TO IS RESEARCH

Critical realism is important for IS because (1) critical realism enables us to take a basically realist stance while accepting the major critiques of naïve realism; (2) it addresses both natural and social science and thus encompasses both hard and soft (and critical) approaches; and (3) it does potentially fit well with the reality of IS as an applied discipline. To back up the theoretical arguments, two antithetical IS research approaches will be discussed. Statistical analysis (e.g., regression), because it is arguably the dominant research method within IS and yet is apparently incompatible with critical realism, embodying an empiricist philosophy; and soft systems methodology, an important method for both research and intervention, which would seem to conflict with critical realism from the opposite direction, namely interpretivism.

5.1 Statistical Modeling: The Empiricist Approach

This section will show the weaknesses of the conventional interpretation of statistics, but also how statistics can be better employed within a realist framework. Consider first multiple regression, a technique used in a range of social sciences as well as in IS. It claims to be a causally-oriented technique (in comparison with, say, ARIMA modeling) that aims to explain the variation in a dependent variable in terms of a set of supposedly causally-related independent variables. A linear functional form is assumed and parameters are estimated from a sample of data. Inferences are drawn toward a wider population. In practice, where it has been used extensively, for example in econometrics, its predictive ability has been extremely poor (Lawson 1997; Sherden 1998). From a critical realist viewpoint this is hardly surprising since there are severe limitations in this approach (Mingers 2002a):

(1) The notion of causality is impoverished, being essentially the Humean one of a constant conjunction of events which underlies empiricism. The main problem with this is that it remains in the superficial world of the empirical, with no attempt to get at underlying mechanisms that may be responsible for the observed regularities.

(2) The procedure rests on an implicit assumption of closure which, as we have already seen, cannot be expected to occur in social systems. The stability of the coefficients, and their statistical significance, rests on assuming that the factors that have not been included, usually because they are unknown or impossible to measure, have only a small and essentially random effect. In practice, the effect may well be large and there is no way of knowing what the influence will be outside of the sample data.

(3) The main assumptions of regression—multivariate normal distributions, independence of variables, one-way causality, linearity, etc.—are highly implausible to say the least.

(4) All of this makes it very difficult to choose between competing models for the same data. Elaborate methods have been devised (e.g., stepwise, best-subsets, fragility analysis), but in practice many different models are developed and choices made on essentially subjective grounds such as experience, usefulness, or perhaps just intuition.

Given these problems, it might seem that critical realism would abandon statistical analysis all together, especially since empirical verification is not a necessary feature of a realistic scientific explanation (since causal tendencies may be possessed but not actualized). This is not the case, but it does require a rethinking of the purpose of such analysis, and also a differentiation between different techniques.

Critical realism proceeds by trying to discover underlying structures that generate particular patterns of events (or nonevents). Statistical analysis can help in several areas:

(1) It can be very useful in the exploratory stage in detecting particular patterns within the data. Any non-randomness must imply some structure or set of constraints that is generating it, although, of course, this may be just as much a result of the mechanism of data production as any underlying generative mechanism. Nevertheless, detecting such patterns within large sets of multivariate data is very difficult and methods such principal components, factor analysis, cluster analysis, and regression are very valuable. The results, though, will merely be the starting point for more substantive investigations.

(2) Some techniques do lend themselves more to identifying underlying structures, especially something like factor analysis that aims to identify common factors generating observed variables, or path analysis that involves a series of interrelated equations. Even here, however, the results are merely suggestive, not conclusive.

(3) Perhaps the main use might be in validating possible explanations by corroborating, or falsifying them. This could be done either by testing the implications of a theory through collecting and analyzing data, or, more sophisticatedly, by regarding the analysis as a quasi-experiment, inducing artificial closure on a system by controlling for the influence of normally uncontrolled factors.

5.2 The Interpretive Approach: Soft Systems Methodology

Soft systems methodology (SSM) could also be seen initially as being antithetical to critical realism. Checkland (Checkland and Holwell 1998) denies the ontological reality of "systems," instead reserving this concept for *thinking about* the world. He also

distinguishes strongly between natural and social science, or rather positivist and interpretivist approaches within social science, and allies SSM clearly with the phenomenological tradition. The main problem is that Checkland takes positivism as the only alternative to interpretivism as a philosophy of (social) science. This inevitably means that he has to adopt a full-blown phenomenological position that then generates all kinds of contradictions and problems in dealing with a "real-world" external to the observer that is, after all, what SSM aims to improve. The major advantage of a critical realist approach is that it maintains reality while still recognizing the inherent meaningfulness of social interaction.

It might be said that SSM only concerns ideas or concepts (root definitions or conceptual models) and that these are somehow less real than objects, or that it is strongly relativist in accepting all viewpoints as being equally valid. Against this, critical realism demonstrates that ideas, concepts, meanings, and categories are equally as real as physical objects (Bhaskar 1997). They are emergent from, but irreducible to, the physical world, and have causal effect both on the physical world (e.g., in the generation of technology) and the social and ideational world. They are also inevitably social products and participate in transformations of the social world, just the sort of transformations that SSM aims to bring about. With regard to relativism, critical realism makes a distinction between epistemic relativism and judgmental relativism: people may well hold different beliefs about processes in the world but this does not mean that we are unable to rationally judge between them and prefer one to another given some particular purpose. Equally, ideas once expressed are no longer wholly subjective: they become intransitive and available for investigation, debate, and judgement by others.

A final point is the weakness of SSM with regard to the origin of the *Weltanschauungen* that it explores, and an understanding of the difficulties of individual and organizational change. These both stem from the individualistic social theory that it embodies. With a critical realist interpretation, both of these are avoided. We can generate explanations of why particular actors may hold the beliefs they do in terms of their social and organizational position, their history of experiences particularly as these relate to underlying social characteristics such as gender, race, age, and, of course, their individual personalities. We are also in a position to understand the psychological and social structures that may impede or facilitate learning and change.

5.3 Critical Realism and Research Methods

Critical realism does not have a commitment to a single form of research, rather it involves particular attitudes toward its purpose and practice. First, the critical realist is never content just with description, whether it is qualitative or quantitative. No matter how complex a statistical analysis, or rich an ethnographic interpretation, this is only the first step—CR wants to get beneath the surface to understand and explain *why* things are as they are, to hypothesize the structures and mechanisms that shape observable events. Second, CR recognizes the existence of a variety of objects of knowledge—material, conceptual, social, psychological—each of which requires different research methods to come to understand them. And, CR emphasizes the holistic interaction of these different objects. Thus it is to be expected that understanding in any particular situation will require a variety of research methods (multimethodology [Mingers 2001]), both extensive and intensive. Third, CR recognizes the inevitable fallibility of observation, especially in the social world, and therefore requires the researcher to be particularly aware of the assumptions and limitation of their research. A more detailed discussion about practical research methods within a critical realist framework can be found in Mingers (2002a), Sayer (1992), Layder (1993) and Pawson (1997).

6 CONCLUSIONS

This paper has made a case for the contribution of critical realism as a philosophy for IS. It has approached this in two ways. The first approach is in terms of the unresolved problems within the philosophy of science, whether it be natural or social, that critical realism successfully addresses. In particular, the impoverished view of explanatory theory within empiricism, the major critiques of observer- and theory-independence that empiricism assumes, the logical problems of induction and falsification, the dislocation between natural and social science, and the radical anti-realist positions adopted by constructivists and postmodernists. Second, it has demonstrated across opposing research methods how critical realism's retroductive methodology can shape the practice of IS research.

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