On Non-Parametric Statistical Inference in the Pursuit of Causal Explanations

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Abstract

This paper proposes a pragmatic alliance between critical realism and non-parametric statistical techniques in pursuit of causal explanations of economic phenomena by retroductive means. The alliance depends on clarifying the interpretive requirements for forming categories as nominal or classificatory scales or as ordinal or ranking scales. It also depends on establishing the scope of demi-regularities, as something to be explained and as something that allows a rough and ready extension of experimental conditions. The roughness and readiness of demi-regularities is matched by the assumptions and conditions of non-parametric analysis.

Key words: Theoretical development, econometrics, non-parametric statistics, critical realism, interpretivism, pragmatism.

JEL: B23, B41, C14

1. Introduction

This paper investigates the potential for, and limitations of, adopting non-parametric statistical techniques for primarily economics researchers who are interested in "putting critical realism to work" (Pratt 1995). While critical realism has long been "ontologically bold, but epistemologically cautious" (Bhaskar 1979), Lawson (1997) explains that the impossibility of meaningful controlled experiments in social sciences should not be interpreted as justification for withdrawing from theoretically, that is critically, informed causal explanations of economic phenomena. Hence, causal explanation following critical realist ontology "necessarily contains a significant empirical component" (Lawson 1997: 221), and the

> measuring and recording of states of affairs, the collection, tabulation, transformation and graphing of statistics about the economy, all have an essential (if usually non-straightforward) role to play. So do detailed case studies, oral reporting, including interviews, biographies, and so on (*ibid.*).

The argument of this paper is that techniques of non-parametric statistics allow researchers to include alongside such interpretive achievements as measuring, recording, tabulating, transforming and graphing, also analysing and assessing the adequacy of propositions. While not constituting causal explanation, the paper demonstrates how non-parametric techniques of data analysis can contribute towards causal explanation. Further, contributions from non-parametric techniques can contribute different kinds of knowledge at different phases of developing causal explanation. Hence, the reliability of knowledge being generated through on-going causal explanation may be assessed in terms of the spatial and temporal extent of, the stability of, and the nature of any relations within and between, categories and series.

Lawson's use of the phrase "empirical component" is significant. *Empirical* refers in the structured ontology established in critical realist discourse to the domain of the actual, such that the "empirical" in "empirical observation" may be presumed and so is superfluous. In critical realist discourse, empirical realists are criticised for their mistaken Humean notion of causation in terms of observed co-presence of conjectured cause and effect. For the empirical component to be meaningful in formulating and assessing casual explanations consistent with critical realist ontology, something like closure and stability must first be detected and explained, and this is the role of demi-regularities. The roughness and readiness of demi-regularities, compared with the co-present regularities of cause and effect envisaged in Humean epistemology, is matched by the tolerance to roughness and readiness of data required in non-parametric techniques, compared with greater demands placed upon data by parametric techniques.

The argument proceeds as follows. Different definitions of econometrics are investigated in the following section, along with discussion of formalism in economic theory and the nature of its relationship with economic phenomena. Section Three seeks to comment on and qualify notions of interpretivism or hermeneutics in critical realist discourse. This is especially in exploring critical realist's criticisms of the anti-epistemology stance of post-modern and interpretive theory, while still supporting the possibility of (qualified) empiricism. It also seeks to clarify Lawson's (1997: 220) demarcation of closed systems, demi-regularities and open systems, as possible conditions within which economic phenomena may be observed by researchers. The effect of both of these strands is to draw attention to the importance of category formation, both by agents involved in the economic phenomena identified by researchers, and in researchers transforming these categories into their own theoretically and critically-informed categories for the purpose of articulating knowledge-claims. Section Four addresses how non-parametric techniques may be used in

the pursuit of causal explanations that draw upon contrastive demi-regularities, an argument that is augmented by taking category formation seriously, both by agents involved in economic phenomena and by researchers in articulating their knowledge claims. Different phases in abduction, hypothesis, retroduction and retrodiction are identified, along with the contributions that non-parametric techniques can make. Section Five addresses potential difficulties in using non-parametric techniques, especially in their role in assessing the reliability of knowledge claims and in generalising these claims from some sample or samples to some population of populations. Indeed, this question is expanded to address the pervasive data recording and measuring issues faced by researchers interested in "putting critical realism to work."

2. Critical Realism and Types of Econometrics

Lawson (1997) describes two types of econometrics. The first, which is presently familiar among applied economics, includes mainly multi-variate regression consistent with verifying conjectured cause and effect, undertaken in the expectation of observing co-present cause and effect in the form of stable and persistent event regularities. Hence, "econometricians concern themselves with attempting to determine constant event conjunctions ... of a probabilistic sort. Not infrequently, these sought-after relations are interpreted as 'causal'" (*ibid*.: 69). The second refers to the measuring and recording of economic events by tabulation and graphing, and extends to case studies and interviews, such that "it is to precisely such indispensable activities that the heading of *econometrics* is properly attributed" (*ibid*.: 221, *original emphasis*). In effect, this section outlines two different ways of relating and developing empirical observations with theoretical knowledge-claims in economics discourse. A further dimension is in monitoring the effects of increased

formalism in economics discourse on these different ways of relating the empirical and theoretical in developing knowledge-claims, an issue that dates to at least the *Methodenstreit*, and was notably revisited in the Lester/Machlup debate of the 1940s (Lavoie 1990). To anticipate the remainder of this section, the temptation to label the two approaches to econometrics as "broad" and "narrow" has been resisted. From a critical realist perspective, econometrics-as-regression is confined to special and probably unobtainable circumstances among the phenomena of the social sciences, while econometrics-as-measurement in sympathy with critical realism – although not well developed – generally excludes on the grounds of feasibility econometrics-as-regression.

2.1 Econometrics as Regression

The gap between economists' explanations of what economists do and what their official position should be if they implemented Popperian or Lakatosian falsification has been widely discussed (McCloskey 1986, 1994). Irrespective of what economists really do, theories have proved to be resilient and tenacious in the face of empirical assessments that have ranged from the supportive, through ambiguous to contradictory. Nevertheless, an official position does exist and is widely taught, and econometrics mainly as regression has a prominent role in this in appraising the reliability of knowledge claims that economists infer from often formal theorising. Schumpeter provides an early description in assessing Tinbergen's "pioneering efforts," which includes

> a system of … linear equations with constant coefficients, the definition of obviously important aggregates …; the relations that common sense suggests should subsist between them …; and relations that are supposed to describe the behavior of classes of households and firms. This involves the fundamental principle the construction of the theoretical set-up should *precede* the statistical work …. Statistical figures are to 'explain' the numerical values of some variables by given numerical values of others

> by the method of multiple correlation – a process which also eliminates those 'explanatory' variables whose partial regression coefficients indicate the insignificance of their influence" (Schumpeter1954: 1163, *original emphasis*).

Econometrics mainly as regression is located in the finely articulated context of verification, and casts its shadow over the less-well articulated context of discovery, from which novel conjectures are themselves expressed in a manner suitable for empirical comparison. The formalism of contexts of discovery and verification, of naïve and sophisticated falsification, has tended to be restricted to methodological discourse. The contribution of critical realism to this economics debate is to question the reliability of econometrics in either formal or informal modes. The weakness of econometrics in its epistemic role has, in effect, allowed formal theory to escape the attentions of empirical analysis, and the many ambiguous outcomes, along with informal techniques adopted, has strengthened the already tenacious and resilient characteristics of formal theory.

This tenacity and resilience may or may not be detrimental to economics discourse, but the model of econometrics mainly as regression has consequences of cutting off many opportunities to use knowledge from and of phenomena in developing knowledge-claims and may also establish a bias in favour of formalism. Critical realist arguments are formulated upon structured and layered ontology and proceed in terms of how science, natural and social, should cope with inherent system openness in establishing the reliability of its researchers' knowledge claims (Bhaskar 1978, 1979). The arguments are familiar. Natural systems' inherent openness is by virtue of the complex interactions across a layered or structured ontology of objects' mechanisms and tendencies. So, any particular conjectured causal explanation of an object's tendencies and mechanisms cannot be expected to be present in the empirical realm of the actual reliably and on a regular basis, especially in a cause-effect relation to some other conjectured object. Social systems' inherent openness resides in its

agents' essential abilities to reproduce and transform social structures or institutions through actions that have been subject to varying degrees of conscious reflection.

If a researcher's expectation is articulated as a knowledge claim of some relationship between social phenomena, or parts of a phenomenon, its reliability may only be assessed if it can be isolated and if it achieves stability. These are, respectively, the conditions of extrinsic and intrinsic closure, and are often explained compared with the levels of control achieved in some ideal scientific experiment. Theorising though is itself a mental model or experiment, a type of abstraction in the traditional sense of temporarily neglecting some aspects to focus on another, reminiscent of Marshall's partial equilibrium approach, highlighted by Lawson (1997: 227). Such abstraction in theorising is a type of closure in mental modelling that is unlikely to be mirrored among actual economic phenomena, and may be taken further in the form of situational analysis (Langlois and Csontos 1993; Nightingale 1994).

Simultaneous with assessing whether extrinsic and intrinsic closure has been achieved in empirical research that uses econometrics mainly as regression to assess the reliability of knowledge claims is a second issue of whether sensible conclusions may be drawn from manipulating data for the purposes of multi-variate regression (Lawson 1997: 80-84; Manicas 1998: 334-36). This presumes that the type of measurement used to represent observations of economic phenomena can be converted onto an arithmetic numerical structure such that observations may be described meaningfully by summary measures of arithmetic mean and standard deviation (Hollander and Wolfe 1973; Siegel 1956). Other forms of combination and composition are set out in Section Four below, which addresses the potential of non-parametric statistical techniques for researchers interested in "putting critical realism to work."

2.2 Econometrics as the Measurement of Economic Phenomena

If research that aims at causal explanation of economic phenomena is to have a significant empirical component, the measurement and manipulation of researchers' observations of phenomena has to be in sympathy with the nature of observations, and, following critical realist ontology, with the status of observations. With a definition of econometrics that includes measuring, recording, collecting, tabulating, transforming and graphing of statistics about the economy, together with detailed case studies, oral reporting, including interviews, and biographies, theorising in order to articulate novel knowledge claims may proceed in closer contact with economic phenomena. It is highly unlikely that such an approach will include econometrics as regression because strict intrinsic and extrinsic closure is unlikely, and transformation of observations into the arithmetic numerical structure seems unreliable and also involves the loss of a great deal of context-specific information from agents' understandings. This extends to semi-parametric procedures, which are "less dependent on specific distributional assumptions, [but] their validity, nonetheless remains conditional on restrictive assumptions" (Stanley 1998: 212). It is the argument of this paper that such a definition should include non-parametric statistical techniques that can add descriptive and analytical content to research based on single samples, two or more dependent and independent samples, and correlations of hypothesised relations between samples. Possible applications of non-parametric techniques are discussed in Section Four, although reported cases of this type of econometrics in economics discourse is hard to find, such is the domination of the econometrics as regression approach to measuring economic phenomena.

Briefly, non-parametric techniques require researchers to transform their observations of economic phenomena such that they can be articulated and measured either along nominal or classificatory scales, or ordinal or ranking scales (Siegel 1956: 22-27; Siegel and Castellan 1988: 23-28). In transforming observations into measurements, the researcher is "assigning

of numbers to observations in such a way that the numbers are amenable to analysis by manipulation or operation according to certain rules" such that "manipulation will reveal new information about the objects being measured" (Siegel, 1956: 21). *Measurement* is then a broad term covering different theories that apply to different types or levels of measurement. And these types or levels of measurement permit different forms of operations and manipulations (*ibid*.: 22). Nominal or classificatory scales classify a set of observations into mutually exclusive categories, and members of each classification are equivalent with respect to the principle of the classification. Transformations that are consistent with data measured in nominal or classificatory scales are descriptive measures of modes, frequencies and counts, none of which alter the information that has been represented in the equivalent classifications (*ibid*.: 23). Researchers using ordinal or ranking scales organise data into different categories where the categories cab exhibit relations of inequality, and where numeric designations indicate that categories with higher numbers are in some way greater or more than those with smaller numbers. No inferences may be made as to the intervals between ranks. The ranking process may involve ties and attendant procedures for coping with these, and the ties may indicate that categorical schema used in ranking can disguise an underlying continuum (*ibid*.: 25-26). The permissible transformations, given rankings, are describing central tendencies by medians, and investigating any hypothesised relations between data series in the form of rank correlation measures.

Researchers who pursue econometric analysis as multi-variate regression require that observations can be meaningfully transformed into the arithmetic numerical structure, such as interval or ratio scales. Here, real numbers apply to measured objects, and intervals imply a common and constant unit of measurement. This allows the meaningful calculation of arithmetic means and standard deviations, and testing of hypotheses using the conventional *t* and *F* tests (*ibid*.: 28). Arguments and comparative tests as to the analytical power of

parametric and non-parametric statistical tests are common in non-parametric texts, but are not relevant from the critical realist perspective. Rather, a pragmatic alliance is proposed wherein the critical realist concerns about aggregation and combination of data drawn from observations of economic phenomena can be matched by organising data from observations into nominal or classificatory scales and ordinal or ranking scales. Further, and as argued in detail in Section Three, where something like stability may occur among economic phenomena, the fairly rough and ready nature of non-parametric measures can accommodate the fairly rough and ready nature of any observed stability.

Non-parametric tests may also be useful throughout the process of formulating and assessing the reliability of knowledge claims in the form of causal explanations. Much iteration is expected during knowledge development, and tests may be undertaken to establish the scope of a category, of differences between categories, and of the strength and reliability of causal relations between or within economic phenomena. Such a combination of critical realism and non-parametric statistics, alongside other categorical and retroductive activities involved in measuring economic phenomena, blurs a distinction between context of discovery and context of justification. Instead of these two major events of official economic epistemology, the researcher may explain the development of knowledge claims through an iterative process of small-scale discovery and verification. Critical attention is focussed on how categories are formed, and whether these enjoy relations of equivalence or inequality, and on the scope of categories across time and space, and this is prior to causal explanation being attempted.

2.3 The Decadence of Formalism

The argument of this section so far has been that econometrics interpreted mainly as regression is unlikely to provide a sound basis for assessing the reliability of economics researchers' knowledge claims. However, econometrics interpreted as measuring economic phenomena may be a more useful approach, especially allied with non-parametric techniques that are in sympathy with the understandings of economic phenomena by its agents and researchers. Both approaches are premised upon a need to relate formal and formalising economic theory with practical assessments of a theory's, or a knowledge-claim's, reliability. As such, both interests may be seen as pragmatic, although the reliability of the econometrics as mainly regression approach in assessing the reliability of a knowledge claim is compromised by its neglect of intrinsic and extrinsic closure and of the inappropriateness its aggregation presuming an arithmetic numeric structure. Nevertheless, both approaches presume the utility of checking formal theorising with empirical assessment of its practical consequences. This ambition is contentious, despite its common-sense appearance. Machlup (1946, 1967) questioned the empirical methods of Lester and other later behavioural researchers in attempting to undermine marginalism, and his reply was both to criticise the questionnaire methods used, and to establish some aspects of formal price theory as beyond empirical testing.

But some aspects of formalism may also compromise the important role for empirical analysis. Ziman (1978) argues that formalism has efficient rhetorical properties in terms of articulating knowledge claims in a universally understood form that increases the chances of consensus across otherwise culturally, spatially and temporally, disparate members of scientific communities. Formal theory is then useful as a source of metaphor, of pre-understanding and orientation, in other disciplines that have yet to achieve such formal means of articulation:

> Axiomatization is the final, decadent stage of *theorizing*. A body of quantitative scientific knowledge that has been assimilated to an abstract structure of mathematical relations is no longer fit for human consumption; it provides fodder only for the computer … it has scientific interest only as an instrument for the advancement of learning in other fields (Ziman 1978: 22, *original emphasis*).

However, the relation of such efficient rhetoric and reality is, following Ziman, problematic because "*the logic of empirical statements is not the logic of mathematical theory*. Statements about the real world are always subject to uncertainty" (*ibid*.: 26, *original emphasis*). Mathematical theory is a two-valued and idealised logic of true and false, while empiricism is a three-valued logic of true, false and undecided. Dow (1990: 144) develops and criticises Ziman's three-valued logic of empiricism, and, in so doing, his comparison of theoretical and empirical logic. Once uncertainty is recognised, it has a corrosive effect on a categorical schema that divides true, false and undecided. Rather, there are explanations and understandings that may be held in different contexts and for different purposes with varying degrees of belief.

The consequences of conflating the categorically different types of idealised logic and empirical logic – notwithstanding Dow's comments on uncertainty – are "devastating" for social sciences according to Ziman, for it "does such a grave injustice to their inherent properties and behaviour as to make nonsense of symbolic, logical, mathematical communication about them" (Ziman 1978: 28). Could this be the fate of the bifurcation of theoretical and empirical activities among economics researchers, and of the resilience and tenacity of formalism in the face of empirical research that aims to assess the reliability of formal knowledge claims? To conclude this section, it seems to be the unwillingness of those seeking to map the theoretical and empirical to also transform formal logic into empirical logic that has weakened the impact of assessments as to the reliability of knowledge claims.

3. Issues to be Resolved: Interpretivism and the Scope for Empirical Research

Section Two suggested that potential exists in developing a pragmatic alliance between critical realist ambitions for articulating knowledge claims of economic phenomena as causal explanations, and using non-parametric techniques in developing assessment the reliability of such knowledge claims. But two important issues await resolution before the complementary nature of causal explanation and non-parametric techniques may be established. First, the process of categorisation is central to non-parametric techniques, whether based upon nominal or classificatory scales or ordinal or ranking scales. And it would appear that a useful source for researchers in formulating such categories is the explanations and understandings of agents involved in the phenomena being researched. But critical realists are often suspicious of basing knowledge claims in the form of causal explanations on the everyday explanations of agents, and are often critical of phenomenological, hermeneutic and post modern approaches to explanation (Bhaskar 1989: 146-79). The scope and role for interpretivism and hermeneutics requires clarification. Second, Lawson introduces the concept of demi-regularities as approximate statistical regularities that may be observed and recorded over spatial-temporal zones. This is consistent with the categorical aspirations of non-parametric techniques, but an explanation of the likely extent of demi-regularities, as opposed to systems that achieve intrinsic and extrinsic closure, and open systems, is required. In other words, the critical realist principle of explaining the explanation is necessarily extended to explaining the conditions that may allow non-parametric techniques to be drawn upon in formulating knowledge claims of economic phenomena as causal explanations.

3.1 Interpretive Aspects of Forming Categories

Econometrics interpreted as measurement includes the measurement of economic phenomena arranged into categories along nominal or classificatory scales and ordinal or ranking scales. Categories are important for agents in organising knowledge and learning and such schema have been described as personal constructs, interpretive frameworks, mental models and quasi-morphisms (Kelly 1963; Holland *et al*. 1986). It would appear that a reasonable starting place for researchers in forming such categories would be agents' own understandings, especially if these can be articulated in such a way as to reflect some aspects of their own otherwise partly tacit categorical schemas. Critical realist writers have recognised the inevitability of such a position, but have an uneasy relationship with the practical requirement of engaging in interpretive tasks, such as establishing categories for the purposes of theory development in connection with categories of agents' understandings of their own situations. Interpreting agents' understandings is inevitable because social structures only exist as they are reproduced and transformed through agents' actions. Critical realist unease with the role of agents' explanations as part of causal explanations of economic phenomena may emanate from the descriptive rather than causal ambitions of research consistent with hermeneutics. But the usefulness of agents' understandings articulated as explanations is tempered for critical realists by the limited extent of that knowledge, and by difficulties in articulating its inevitable tacit and unreflective content, often summarised as agents' opaque understandings of the physical and social structural properties of their situations (Lawson 1997: 192-93). At the same time, if causal explanation is to have a significant empirical component, and if this is to include detailed case studies, oral reporting, including interviews, biographies, and so on, interpretive issues in formulating causal explanations should be addressed.

Lavoie (1990) provides a hermeneutic commentary on the Lester/Machlup debate, and draws out important points for researchers wishing to develop knowledge claims in the

form of causal explanations that make use of econometrics as measurement. Lavoie is critical of interpretations of the debate that seem to highlight the futility of attempting empirical assessment of the adequacy of marginal analysis established in price theory. It should be pointed out that Machlup (1946) provides some supported for this "futility" interpretation, but limits it to formal versions of price theory. Instead, Lavoie draws on Machlup's own interpretive heritage, especially his acquaintance with Schutz's work, to argue that the most important aspect of the debate was the inadequacy of Lester's postal questionnaire techniques for testing marginalism among company managers (Lavoie 1990: 173). And this inadequacy is not compared with understanding or hermeneutics as empathy, but as mediation between language groups:

> Understanding is a mediation of the perspective of the observer and the observed. It is not a matter of getting an exact copy of the other person's private mental picture, a complete account of his ends/means framework, but in interpreting one perspective from the standpoint of another one. We understand differently when we understand at all, is Gadamer's famous aphorism (Lavoie 1990: 177).

So where agents have an opaque understanding of their social situations, so researchers have an opaque understanding too. But if such understandings can be articulated through dialogue in interviews and case studies, and in multiple accounts of commonly perceived events, such articulations may be coded and categorised by the researcher. The dimensions and extent of tacit knowledge are not fixed, but may be adjusted over time with effort and dialogue in devising means of articulation or coding (Boisot 1995).

3.2 How Pervasive are Demi-regularities?

Econometrics as measurement, including non-parametric techniques, can be used in developing knowledge claims as causal explanations by researchers working in the critical

realist tradition. But the tractability of this possibility of naturalism depends, following Lawson, on the presence of demi-regularities associated with the economic phenomena being explained. A demi-regularity is:

> A partial event regularity which *prima facie* indicates the occasional, but less than universal, actualisation of a mechanism or tendency, over a definite region of time-space. The patterning observed will not be strict if countervailing factors sometimes dominate or frequently co-determine the outcomes in a variable manner. But where demi-regs are observed there is evidence of relatively enduring and identifiable tendencies in play (Lawson 1997: 204).

Lawson discusses demi-regularities in two ways. First, they are described as "rough and ready," "remarkable" given necessarily open social systems, and also "widely in evidence" (*ibid*.: 204-5). They are something to be explained given the fundamentally open system nature of economic phenomena. Second, they allow an extension and simultaneous loosening of the notion of experiment among both natural and social phenomena beyond strict conditions of intrinsic and extrinsic system closure. This extension retains the possibility of experiments, depending upon some form of reliable and known control rather than intrinsic and extrinsic closure, but dispenses with the precise calibration consistent with Humean empirical co-presence of conjectured cause and effect. Through demi-regularities, Lawson describes a three way categorisation of the domain of the actual: "there is a possibility … of a continuum of pattern outcomes stretching from closed systems of constant conjunctions of events to an inchoate random flux, with contrastive demi-regs lying between these extremes" (*ibid*.: 220).

The contrast part of contrastive demi-regularities indicates some possibly surprising aspect to an observed partial regularity in the form of something like a natural experiment. A control group may exhibit a particular pattern of demi-regularity over a temporal-spatial zone, but a different outcome may occur in some other ostensibly similar temporal-spatial

zone. The difference between the two observed situations that exhibit demi-regularities may be understood in the context of a control or set of controls that can allow the difference itself to be explained adequately. Such an explanation would be in terms of some factor(s) being present in one observed situation and absent in some other similar situation. Note that the perception of contrastive demi-regularities depends upon categories within and between economic phenomena, that observation is theory-laden (Sayer 1992). Hence, categories themselves become pragmatic hypotheses that may be confirmed through categorical success.

Given that causal explanation that is developed through understanding contrastive demi-regularities, through something like rough and ready natural experiments, the basis of these related partial regularities should form part of any explanation (Lawson 1997: 213). This is the principle of explaining the explanation that is set out in greater detail in Section Four. Institutional economics, particularly analyses of shared mental models may be useful here (Downward *et al.* 1999; Lane *et al.* 1996).

4. Using Non-Parametric Techniques in Causal Explanations Involving Contrastive Demi-Regularities

The aim of this section is to explain how different non-parametric tests can be used as part of a causal explanation following critical realist principles of retroduction. It is proposed that non-parametric techniques can be deployed, following econometrics as measurement, in support and of and in extension to causal explanations of economic phenomena. In contrast to econometrics as mainly regression, non-parametric techniques are not in themselves causal explanations. Rather, different non-parametric tests can be undertaken in different phases of developing and assessing the reliability of knowledge-claims about economic phenomena. And undertaking non-parametric analysis depends on researchers first being able to

characterise economic phenomena in the form of contrastive demi-regularities (as with any attempt at causal explanation) in which aspects of phenomena may be articulated in nominal or classificatory scales or ordinal or ranking scales. The roughness and readiness of categorical schema, as opposed to the precision of parametric variables, matches that of contrastive demi-regularities.

As noted "rough and ready" demi-regularities and, in particular, *contrastive* demi-regularities, play a key role in the investigative process. The critical realist conception of demi-regularities can be traced to the 'stylized facts' employed by Nicholas Kaldor and Arthur Okun as the basis of their analytical processes. Indeed, the process of "putting critical realism to work" commences with the identification of demi-regularities and contrastive demi-regularities, which may range from the benign (there is a greater incidence of church-going on a Sunday as opposed to a Tuesday) to the "surprising" or controversial given current knowledge. Lawson (1997: 211) argues that it is the contrastive demi-regularity that surprises that is of most interest since it generates alternative and competing explanations.

Following the identification and description of demi-regularities, the investigative process follows retroductive (or abductive) reasoning, which is

> the movement, on the basis of analogy and metaphor amongst other things, from a conception of some phenomenon of interest to a conception of some totally different type of thing, mechanism, structure or condition that, at least in part, is responsible for the given phenomenon (Lawson 1997: 24).

The context of investigation is of considerable importance in the process of retroduction, and indeed retrodictive inferences about causal hypotheses. More specifically, retroduction by seeking to identify underlying, and frequently non-observable, causal mechanisms involves the personal experiences, beliefs and experience of the investigator. Obviously, such a process will be subject to differences in interpretations and value judgements; such is the

essence of scientific discourse. However, what Lawson (1997) and Tsang and Kwan (1999) emphasise is the desirability of feedback in analysis: conjectures and established knowledge are subject to amendment as the process of analysis unfolds. As Lawson notes, "conceptions of the practices which led to the research being undertaken in the first place may themselves require reinterpretation once an overall understanding is achieved" (Lawson 1997: 218). Thus, in essence "doing" critical realist research is principally an explanatory and interpretive (as opposed to predictive) exercise that commences with the description of demi-regularities. What critical realism requires elaborating are the underlying theories of measurement and data construction associated with the identification and description of demi-regularities. In our view the inference of many non-parametric techniques would aid this task.

As noted in Section Two above, conventional parametric econometric modelling invokes rather restrictive conditions regarding the measurement of variables. This is part of the closure conditions required by econometric techniques. By contrast, non-parametric techniques do not invoke such restrictions. Techniques involved in measuring association do not require the employment of cardinal measures redolent of interval scales. Instead, the only measurement requirement is that ordinal scales can be deployed (Lehmann and D'Abrera 1975; Siegel and Castellan 1988). There is even a technique, the Cramer Coefficient, which demands the weakest form of measurement, categorisation, in its measure of association. Thus, not only does non-parametric inference presume that phenomenon are not necessarily cardinally measurable, but by doing so does not require the same degrees of closure of regression econometrics (McMaster 1996). Indeed, there is good reason to conjecture that non-parametric inference involves no more than the quasi-closure associated with demi-regularities.

In his outline of examples of demi-regularities, Lawson draws on Leamer's (1983) anecdote about farmers' hypotheses concerning higher yields of a particular crop. Two

farmers observe, in different fields, that crop yield is higher where crops are grown under trees. Lawson employs this as an example of a contrastive demi-regularity, and notes Leamer's two competing hypotheses: farmer one claims that higher yields result from birds' dropping, whilst farmer two claims that it is a consequence of the amount of shade. A further example of a contrastive demi-regularity utilised by Lawson (1997: 255) is the relatively poor productivity growth performance of the UK when contrasted with other industrialised states (as measured by growth in GDP per man-hour). He then examines a number of competing explanations, including underlying industrial relations.

These examples of demi-regularities, rather ironically, involve considerable measurement closure. The "farmers' yields" imply that interval scales, at least, can be established. This may not be an unreasonable conjecture, but there is an underlying tacit presumption in the anecdote that the quality of yield does not vary either through time or between the farmers.

In the productivity demi-regularity, Lawson invokes a much stronger closure presumption concerning the measurement; both time series and cross sectional, and data construction of productivity. There are a number of underlying assumptions that suggest that closure is sufficient for quantification of this extent. The most obvious is that an interval scale can measure productivity, and that data construction is sufficient for this process in that the probability of error is considered tolerable (a point that Lawson frequently criticises regression econometrics on). Moreover, that aggregated averages are admissible in the establishment not only of the demi-regularity, but following from this, the direction, and even the focus of the investigative process.

In the first example (farmers' yields) there are, from a critical realist perspective, firmer grounds for supposing that empirical measurement of this sort is justifiable from an open-systems ontology. However, the closure conditions for measurement in the second case

are rather more problematic. Not only is there a presumption that interval measurability is possible, but that there is some durability in underlying structures that permits the validity of such measurement: a constant and continuous conjunction of events? Arguably, by employing interval scales in this manner Lawson effectively concedes that there is some role, for *quantification* through interval scales in critical realist inquiry. *In extermis* this may be contradictory to the critical realist project.

This is important, since it further suggests that non-parametric inference is undoubtedly complementary to "putting critical realism to work." Non-parametric techniques can achieve this in two ways.

First, non-parametric tests by highlighting measures of association between population samples can indicate the nature of demi-regularities. For instance, this technique has proven to be of some attraction in behavioural psychology (Siegel and Castellan, 1988) in establishing the similarity or otherwise between groups of respondents (including a control group). *It does not indicate causality*, it can however, establish to some degree, the relatedness of samples and populations, and some measure of association. Moreover, to reiterate, non-parametric inference can achieve this by invoking fewer closure conditions in terms of measurement and data construction than Lawson's productivity demi-regularity. In this respect the need for critical realists to take cognisance of theories of observation and data construction is emphasised.

Second, non-parametric tests can also provide a *partial* basis for assessing a hypothesis' empirical adequacy. *In argumentum*, if a non-parametric technique reveals some "surprising" association, or by the same token non-association it could not only contribute to the reconsideration of a demi-regularity, but also established knowledge claims.

However, it must be stressed that non-parametric inference, as with any statistical inference, is not without issues of measurement bias. For instance, categorisations are

susceptible the biases of the researcher. Nevertheless, given its weaker closure conditions this is unlikely to be as problematical as the deployment of interval and ratio scale measures in the establishment of demi-regularities.

5. Inference, Samples and Populations

Given that non-parametric techniques may be used in pragmatic alliance with critical realist causal explanations, it is clear that non-parametric techniques do not in themselves provide causal explanations. The normal rhetoric of all statistic techniques is in tests of hypotheses. Principles of abduction and retroduction in economics, perhaps aligned with induction and deduction, encourage researchers to break down the big events in contexts of discovery and justification into smaller and iterative events such as category formation, category composition, and relations between categories and between a category's constituents. Each research activity has a purpose, such that each may be considered as a hypothesis in relation to a practical research purpose. Seeing retroduction or abduction in this practical manner sits uneasily with the rhetoric of statistical tests, such as that set out in Siegel:

> This chapter is devoted to the presentation of nonparametric measures of correlation, and the presentation of statistical tests which determine the probability associated with the occurrence of a correlation as large as the one observed in the sample under the null hypothesis that the variables are unrelated in the population. That is, in addition to presenting measures of association we shall present statistical tests which determine the "significance" of the observed association (Seigel 1956: 195).

Tests suggest some once and for all big event in the context of justification. But retroduction or abduction seems to envisage smaller iterations. It presumes we know something of the population from which the sample was drawn, or at least something of the manner in which the sample was drawn. But early stage hypothesis articulation may more appropriately be

understood in terms of sample and population being synonymous. McCloskey (1986: 163) distinguishes statistical and economic significance. Statistical significance pertains the to the researcher who wants to know "what the probability is that *because of the small sample he faces* he will make a mistake of excessive gullibility in accepting a false statistical proposition" (*ibid*.: 160, *original emphasis*). Economic significance, following McCloskey, has much in common with pragmatic principles of retroduction. It is to do with the quality of hypotheses, and the practical consequences of choosing to frame one's understanding of an economic phenomenon in one way rather than another (*ibid*.: 158).

Another useful ally in casting the role of non-parametric techniques within an iterative approach to retroduction or abduction is in grounded theorists' distinctions between theoretical and statistical sampling (Glaser and Strauss 1967: 32-45). Where statistical sampling is guided by principles of random selection, given some knowledge of a larger population from which the sample is drawn and so shares important characteristics, theoretical sampling is undertaken initially in ignorance of the characteristics of some overall population. An investigation is guided, especially in its early stages, by principles of category saturation that can be judged (tested) by an absence of surprises yielded from additional observations, given some categorical interpretive schema which is itself being developed. Measures of relatedness, for instance calculated from Wilcoxon matched-pairs signed rank tests, or Mann-Whitney *U* tests, provide useful information in developing hypotheses for different purposes, and these data may be interpreted relative to whether the researcher is thinking in terms of the sample being the population, or whether there may feasibly be some wider population with which the (now) sample shares critical characteristics.

6. Concluding Remarks

The relationship between formalism and realism in economics has arguably not been well served by Humean empirical realism that focuses on the observation of co-presence of conjectured cause and effect. Formalism has acquired characteristics of tenacity and resilience in the face of many unreliable empirical assessments. Tenacity and resilience in formalism are not necessarily undesirable qualities, but theorists are cutting themselves off from useful sources of information and ideas in theory development by casting realism as empiricism, to do with big event context of justification. Critical realists promote the pragmatic principle of retroduction or abduction as a more effective combination of theorising and realism. More effective because it is predicated upon a layered and structured social ontology that is necessarily open and depends upon agents to reproduce and transform its structures. Empirical research can still play an important role in undertaking causal explanations in full recognition of necessarily open systems predicated upon structured and layered social ontology dependent upon its agents for its reproduction and transformation.

It is argued in this paper that empiricism can have many interrelated roles. None of these roles constitute causal explanation, but all of which can contribute to causal explanation. And empiricisms can include econometrics defined as measurement rather than econometrics defined as mainly regression. The scope of empiricism depends upon the scope of demi-regularities, or observed partial regularities among economic phenomena. These may come about over defined spatial-temporal zones through institutional social practices that require explanation. Causal explanation may proceed further if contrastive demi-regularities, or rough and ready natural experiments, can be detected. Non-parametric statistics are appropriate research activities within econometrics as measurement, rather than as mainly regression, and can contribute to the analysis of the extent of demi-regularities, and to measures of the nature of any relationship between demi-regularities cast into a contrastive

relationship by researchers expressing knowledge claims following retroductive or abductive principles. This is because non-parametric statistics are measured in nominal or classificatory scales, or ordinal or ranking scales, and not arithmetic numeric scales, so are not amenable to arithmetic manipulation that requires meaningful quantification of intervals between symbols that represent equivalence or inequality. The categories in which data are arranged may more closely reflect categories in which agents themselves arrange data in understanding their situations, although this requires considerable interpretive expertise among researchers. Further, the roughness and readiness of categorical measurement is matched by the roughness and readiness of the contrastive demi-regularities that allow empiricism to have a role in causal explanation in the first instance.

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