Review of Mark Buchanan's Book, *Forecast*

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ABSTRACT

Mark Buchanan demands that "a science of markets and economics should not seek a universal theory, but rather an assortment of related models and theories attuned to specific phenomena." Towards this end, it is common for economics journals to ban the axiomatic method. For instance, the *Journal of Philosophical Economics* declares in their mission statement, "This journal eschews monolithic perspectives and seeks innovative work that is intellectually pluralist." I contend with this view and support my conclusions with references to famous axiomatic systems, such as the primitive equations that form the axiomatic basis for numerical weather prediction as developed by Lewis Fry Richardson.

KEYWORDS

Axiomatic, Empirical, Post-Autistic, Pluralism, Econophysics,

Philosophical Economics, Numerical Weather Prediction

Mark Buchanan (2013, pp. 19, 128) writes:

> *Most physics research cannot be wrapped up in a few equations, and demands the understanding of myriad instabilities and feedbacks. This generally implies lots of different mathematical models... A science of markets and economics should not seek a universal theory, but rather an assortment of related models and theories attuned to specific phenomena.*

Consider an example from physics – the motion of the planets as described by the laws of Newtonian physics. What if Newton had somehow read Buchanan's book a few hundred years earlier and, inspired by its teachings, abandoned his Law of Universal Gravitation and instead strove for an assortment of related models?

Newton might have begun with the simple cases of the Sun and the Moon, which clearly revolve around the Earth in perfect circles. Then, for the sake of compatibility, he would have to retain the Earth's central position when developing a theory of the motion of inferior planets (Mercury and Venus), employing epicycles and deferents. The superior planets (Mars, Jupiter and Saturn) would get their own theory, though still geocentric, of course. And, as for the comets, each would have its own equation. Quite an assortment! But note that, just as Buchanan called for, while they are all attuned to specific phenomena, they are related by being geocentric. Thanks Buchanan! Newton found you to be a big help.

An even better comparison to the World Economic Association (before May 2011, the Post-Autistic Economics Network), whom Buchanan is the champion of, is the British Meteorological Office, circa. 1900. Buchanan (2013, p. 206) describes their methodology:

> *The British Meteorological Office, for example, then [1900] maintained a huge and ever-growing index of weather maps recording air pressures, humidity, and other atmospheric variables at stations scattered around the country, day by day, stretching well into the past. It was a history of the weather, and meteorologists consulted it as a "look it up" guide to what should happen next. The idea was simple. Whatever the current weather, scientists would scour the index of past weather looking for a similar pattern.*

Weather forecasting in those days was just a catalog of proverbs: red sky at night, sailor's delight; red sky in the morning, sailors take warning; rainbow in the morning gives you fair warning; halo around the sun or moon, rain or snow soon; etc. A "scientist" was just one with access to a bigger and more detailed catalog of proverbs. For instance, instead of just looking for a red sky at night (a particularly reddish sunset), a 19^{th} century meteorologist might have checked his catalog for instances of high pressure to the west and noted that they were often followed by fair weather. Robert Friedman (1989, p. 4) observes:

> *By 1900 most meteorologists sought statistical patterns rather than physical or dynamic insights to predict weather. Disillusionment set in. Institutional conservatism towards new approaches tended to reinforce a sense of hopelessness.*

Institutional conservatism towards new approaches – does this not describe the PAE/WEA campaign to ban axiomatists? Does it not describe the German Historical School's attacks on marginal utility theory? Does it not describe medieval guilds, which jealously guarded chemical formulas that any modern chemist could deduce in an hour, without recourse to experiment?

What finally lifted meteorologists from their stupor? The axiomatic method! Specifically, Lewis Fry Richardson proposed seven axioms, in the form of seven differential equations now called primitive equations (he called them a set of computing forms – see Appendix), which define how variables describing the weather in a cell – an imaginary box in the atmosphere – relate to adjoining cells. The conservation of mass that serves as the axiomatic foundation for balancing chemical equations is found in Richardson's axiom that all the air in the atmosphere must be accounted for. (Richardson (1922, p. 23) refers to the indestructibility of mass as a "principle.") The wind blowing out the east side of one cell is the wind blowing into the west side of the adjoining cell. This is an example of an axiom that defines how the equations describing one cell must interface with the equations in adjoining cells. The Ideal Gas Law is an example of an axiom that defines what must always be true of the equations within the cell they describe.

Jean-Philippe Bouchaud writes:

> *The goal [of economics] is to describe the behavior of large populations, for which statistical regularities should emerge, just as the law of ideal gasses emerge from the incredibly chaotic motion of individual molecules.*

But a statistical result requires a datum for every individual element. Yet we do not have data on every individual molecule, or even on one of them. They are too small to see. The Ideal Gas Law is an axiom derived from first principles using the kinetic theory of gases.

Richardson's axiomatic system demands more mathematics than can reasonably be expected of economists, so we will here describe a simpler axiomatic system that retains the fundamental structure of Richardson's system. Forecasting the weather is an initial value problem that requires differential equations, but interpolating between observations can be accomplished with basic linear algebra, in this case the solution of a tridiagonal system of equations.

Instead of partitioning the atmosphere into millions of cells, let us partition the next few days into n intervals and make a single observation, x_i, at each node t_i for i = 0, 1, 2,..., n. This is typical of initiating some process and then measuring some result of it at discrete intervals. Because of the difficulty and expense of taking these measurements, there are significant gaps in time between them. We wish to deduce the equations of n cubic polynomials, $S_i(t)$, with domains $[t_i, t_{i+1}]$ for i = 0, 1, 2,..., n-1 from the following five axioms:

Axiom #1	$S_i(t_i) = x_i$	for i = 0, 1, 2,..., n-1
Axiom #2	$S_i(t_{i+1}) = x_{i+1}$	for i = 0, 1, 2,..., n-1
Axiom #3	$S_i'(t_{i+1}) = S_{i+1}'(t_{i+1})$	for i = 0, 1, 2,..., n-2
Axiom #4	$S_i''(t_{i+1}) = S_{i+1}''(t_{i+1})$	for i = 0, 1, 2,..., n-2
Axiom #5	$S_0''(t_0) = S_{n-1}''(t_n) = 0$	

Observe how axioms #1 and #2 define how a polynomial behaves within the interval it describes while axioms #3 and #4 define how a polynomial must interface with the polynomials in adjoining intervals. This is somewhat similar to Richardson's system where some axioms, like the Ideal Gas Law, define conditions that must always be true within a cell and other axioms define how the equations describing a cell must interface with those describing adjoining cells.

I leave it as an exercise for the reader to carry out this deduction. But the point is that splines are axiomatic systems, just as numerical weather prediction is an axiomatic system, and just as economics would be if the PAE/WEA did not ban the axiomatic method. Basically, Buchanan and other post-autistic economists are trying to take economics back to a proverb-based "science," similar to pre-Richardson meteorology, where every argument has the form, "five of the last nine recessions had such-and-such characteristic, therefore the current recession will too." For example, Buchanan (2013, p. 75) approvingly quotes a hedge fund manager:

> *When we came in on Monday, October 19, 1987, we knew that the market was going to crash that day… The previous Friday was a record volume day on the downside. The exact same thing happened in 1929, two days before the crash.*

This is science??? Recalling that a crash came two days after a record volume day is no different than recalling having been drenched in a sudden squall two days after observing a beautiful sunrise, or that there was an earthquake two days after one's town was inundated with toads – just proverbs and superstition.

Richardson (1922, p. vii) contends with Buchanan's view:

> *It would be safe to say that a particular disposition of stars, planets and satellites never occurs twice. Why then should we expect a present weather map to be exactly represented in a catalog of past weather?*

Indeed! Can you help me lift economists from their stupor?

Victor Aguilar (1999) proposed the following three axioms and proved a number of theorems based on these axioms and on nothing else – unlike Debreu (1959), whose foundations were quickly found to be in need of increasingly numerous and unrealistic assumptions. This procedure is just the opposite of the assortment of models that Buchanan would devise, each attuned to specific phenomena and associated with one another in the most tenuous manner.

1) One's value scale is totally (linearly) ordered:

i)	Transitive;	$p \leq q$ and $q \leq r$ imply $p \leq r$
ii)	Reflexive;	$p \leq p$
iii)	Antisymetric;	$p \leq q$ and $q \leq p$ imply $p = q$
iv)	Total;	$p \leq q$ or $q \leq p$

2) Marginal (diminishing) utility, u(s), is such that:

- **i)** It is independent of first-unit demand.
- **ii)** It is negative monotonic; that is, $u'(s) < 0$.
- **iii)** The integral of $u(s)$ from zero to infinity is finite.

3) First-unit demand conforms to proportionate effect:

- **i)** Value changes each day by a proportion (called $1+\varepsilon_j$, with j denoting the day), of the previous day's value.
- **ii)** In the long run, the ε_j's may be considered random as they are not directly related to each other nor are they uniquely a function of value.
- **iii)** The ε_j's are taken from an unspecified distribution with a finite mean and a non-zero, finite variance.

APPENDIX

Richardson (1922, p. 21) summarizes his axiomatic system in Chapter IV, The Fundamental Equations:

"There are four independent variables:

t	time.
h	height above mean sea level.
λ	longitude, reckoned eastward.
ϕ	latitude, reckoned negative in the southern hemisphere.

"Seven dependent variables have been taken, namely:

v_E	velocity horizontally towards the east.
v_N	velocity horizontally towards the north.
v_H	velocity vertically upwards.
ρ	density.
μ	joint mass of solid, liquid and gaseous water per mass of atmosphere.
θ	temperature absolute centigrade.
p	pressure, expressed in dynes cm^{-2}.

"If an eighth dependent variable had been taken, it might perhaps have specified the amount of dust in the air.

"The rates of change of the seven dependent variables are given by the following seven main equations. The 'tributaries' in the table supply the values of certain terms occurring in the main equations.

	Main equations	Tributaries
$\partial v_E/\partial t$	eastward dynamical equation … …	eddy-viscosity
$\partial v_N/\partial t$	northward dynamical equation … …	eddy-viscosity
$\partial v_H/\partial t$	upward dynamical equation … …	eddy-conduction of heat
$\partial \rho/\partial t$	indestructibility of mass … … …	precipitation
$\partial \mu/\partial t$	conveyance of water … … …	precipitation, stirring
$\partial \theta/\partial t$	conveyance of heat … … …	precipitation, stirring, radiation and clouds
$\partial p/\partial t$	characteristic gas equation, $\partial \theta/\partial t$ and $\partial \rho/\partial t$	

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