Foundations of Neuroeconomic Analysis, by Paul W. Glimcher, New York: Oxford University Press, 2010, 467 + xix pp., $69.95 (hardback), ISBN 978-0-19-974425-1.

Forthcoming in the Journal of Economic Methodology

"Subjective values are real numbers ranging from 0 to 1,000. They take action potentials [bioelectrical pulses in neurons] as their natural units." (p. 398): this exemplifies how far Paul Glimcher, a professor at NYU, wants you to follow him in his new book, *Foundations of Neuroeconomic Analysis*. Can he be possibly serious?

Searching for the physiological substrate of subjective value is like re-opening a very cold case – almost a taboo, for several reasons. During most of the twentieth century, it was an undisputable premise that the investigation of cultural and social behaviour was the exclusive province of the social sciences and the humanities. Call it "emergence", "complexity" or "ontological disconnect", but there was no question that higher cognitive functions, such as judgment and decision-making, could not be explained by lower level biological processes (of course there is also the heavy hand of the historical context – the reactionary politics which drew their inspiration from biosocial theories of human traits, such as "intelligence" or "race", contributed to make any biosocial theory controversial from the start).

In economics, this is a Chinese wall of a special sort which was erected against choice theory explanations emerging from natural sciences. Samuelsonian economics established the orthodoxy that "revealed preference is choice is observed behaviour", in an explicit move away from the – at the time - intractable problem of what processes govern an individual's choice. Psychology and biology did progress on this front especially since the 1970s, but once isolated most economists never caught up with the developments taking place in these fields, to the point of deeming them *a priori* irrelevant to

their own research object. As Geoffrey Hodgson, Jack Vromen and others have amply shown, this is not to say that economics and biology parted ways completely. But their relationships unfolded through analogies (exchange of concepts and models, such as "Darwinian competition" or "maximization of fitness-utility"), not on a common experimental ground – with some noteworthy exceptions, such as John Kagel, Raymond Battalio and Howard Rachlin's series of experiments on the demand curves for "animal consumers" published in the 1970s and 1980s. By all accounts, an insular attitude still characterizes the majority of the profession of economists today. Many economists suspect that contacts with biology are encouraged by the hype and easy successes coming with interdisciplinary projects and by the marvel caused by machines like fMRI, but at the cost of a degradation of academic standards (an opinion developed by Glenn Harrison in the journal *Economics and Philosophy*, but which is also voiced through more informal channels: http://www.econjobrumorsarchive.com/topic.php?id=10327#post-202562).

Even closer to the interests of the readers of this journal, the post-modern turn in the methodology of science possibly provides the strongest case to doubt that economic theories will ever be grounded in neuroscience. If it is indeed the case that methodologies are historically situated and contextualized, as Foucault or Kuhn hammered, so that one would be incapable to pronounce a verdict on the truth value of a theory for all times, then it follows that a piece of theory can hardly be "discovered" to be embodied in our timeless human nature. This point may be made more clearly: after Philip Mirowski's *More Heat Than Light*, which demonstrated that "utility" in the version developed by the marginalists was a circumstantial (and wobbly) development in their larger effort to emulate the achievements of contemporary physics –how is it conceivable that this "utility" can ever be later "discovered" or "measured" in the brain as an objective product of eons of biological evolution, as Glimcher seems to proclaim? If it ever happens, the presumption will be strong that the biologist simply realigned nature (here, the brain) with the categories and concepts most dominant in the intellectual atmosphere of his

time (here, *homo economicus*). This would be a forceful criticism of neuroeconomics, reminiscent of other judgments passed in similar circumstances: in a letter to Engels, Marx famously derided Darwin's reading of the economy of nature in tooth and claw as reflecting the values of contemporary British industrial capitalism, while more recently anthropologist Marshall Sahlins pointed that the fitness maximizers populating Edward Wilson's sociobiology were capitalist neoclassic agents in disguise.

And yet, this is precisely why *Foundations of Neuroeconomic Analysis* is intensely thought provoking. Despite the reasons just enumerated, it succeeds at making a strong case for neuroeconomics – and arrived at page 398, the reader has no trouble accepting the definition of subjective value in a cardinal and physiological sense which seemed so inconceivable before one had opened the book. Glimcher achieves this result by suggesting a new methodological approach to interdisciplinarity, and then using it to reinterpret a large body of recent theoretical and empirical work. His strategy consists in presenting a theory of choice which meets the constraints of three bodies of knowledge: it has to be physiologically plausible (e.g., neural representations of value must be cardinal), psychologically plausible (empirical regularities such as anticipation and regret should be accommodated in the axiomatization of choice, not discarded as "errors" or "biases"), and economically plausible (a physiological theory of choice should explain what leads individuals to exhibit choices coherent with axioms of expected utility, and why they diverge in specific circumstances nonetheless).

Though neuroeconomics is mostly known for its fMRI studies, Glimcher relies very little on them and refers mostly to results obtained in electrophysiology, following a procedure reminiscent of reverse engineering: in a classic experimental setting, monkeys are trained to indicate their preferred of two options by directing their gaze at a specific visual target. Hence, the very last step of this decision process is the movement of the eyes in the direction of the target. This allows investigating the choice performed by the monkey by reverse engineering it, starting from the very last step of the decision:

what caused the movement of the eyes, which happens to be a very well-known neural circuitry. This certainly is not where the origin of the decision process will be identified, but Glimcher shows that a great deal of information can already be gleaned: how is the choice set involved in the decision represented in this brain region?, how is the value of each choice option instantiated?, and how can the degree of randomness inherent to behaviour be reconciled with the causal mechanisms of choice? – all these fundamental questions find fascinating answers by observing the electrophysiological properties of the motor control circuitry responsible for the eyes's movements. The same strategy is used for arms movements in decision tasks, allowing Glimcher to compare structures and functions in both cases and establish what are probably the common, universal mechanisms involved in choice.

The result is a causal account of how decisions between competing choice options are processed in our brains and transpose into behaviour. By necessity, the book is a difficult read: biologists will be asked to seize the logic of WARP and Von Neumann-Morgenstern utility and prospect theory, while economists will be challenged to follow discussions on cerebral architecture and the modelling of neuronal spike rates (though as always, familiarity with statistics and modelling does make it easier to grasp the logic of an argument, even formulated in a totally unfamiliar disciplinary context). More surprisingly maybe, this exercise in interdisciplinary dialogue has for effect to provide insight also into one's discipline – and this might require some cognitive effort as well. A good example is Glimcher's discussion of economists Faruk Gul and Wolfgang Pesendorfer's work on the cost of self-control and random utility theory: one of Glimcher's central arguments is that this kind of theoretical work, which redefines the classic axiomatization of choice to account for basic empirical psychological and behavioural regularities, shows the way forward for the integration of economics with psychological and neurological accounts of decision making. It is certainly food for thought for Gul and Pesendorfer, who not long ago authored a widely circulated indictment of neuroeconomics as a valid scientific project for economists. In the same vein, Glimcher's discussion of the fit of behavioural economics in a neuroeconomic theory of choice,

focusing on the importance of the reference point, outlines a much more promising research program than the common view in (methodology of) economics that neuroeconomics is behavioural economics in the scanner. I would not be surprised if neurobiologists and psychologists found their own methodological assumptions productively challenged as well in the parts of the book focusing on their respective disciplines.

At the index of past ambitious attempts to account for traits of human behaviour by making economics and biology dialogue, *Foundations of Neuroeconomic Analysis* stands out by the breadth of the comprehension of vastly different intellectual traditions, by the degree of integration achieved, and by the solidity of the empirical material presented. This is a truly important book, which raises many questions. One of the most interesting is certainly: in what sense is "decision" explained by this account? In a very narrow sense, obviously. As Glimcher is the first to point out, he has a very detailed story for the very last stages of the decision (when the decision is about to be enacted in behaviour), but the antecedent, more fundamental stages are still very much unknown: how is the number of options balanced in a given choice, and their respective subjective values, determined? What makes an individual take a decision in the first place? Notwithstanding the methodological doubts and headaches it will give to its most postmodernist readers, *Foundations of Neuroeconomic Analysis* gives confidence that these questions can in principle be answered by the field Glimcher contributed to create.

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