Toolism! A Critique of Econophysics

Kakarot-Handtke, Egmont

University of Stuttgart, Institute of Economics and Law

30 April 2013

Toolism! A Critique of Econophysics

Egmont Kakarot-Handtke*

Abstract

Economists are fond of the physicists' powerful tools. As a popular mindset Toolism is as old as economics but the transplants failed to produce the same successes as in their aboriginal environment. Economists therefore looked more and more to the math department for inspiration. Now the tide turns again. The ongoing crisis discredits standard economics and offers the chance for a comeback. Modern econophysics commands the most powerful tools and argues that there are many occasions for their application. The present paper argues that it is not a change of tools that is most urgently needed but a paradigm change.

JEL A12, B16, B41

Keywords new framework of concepts; structure-centric; axiom set; paradigm; income; profit; money; invariance principle

*Affiliation: University of Stuttgart, Institute of Economics and Law, Keplerstrasse 17, D-70174 Stuttgart. Correspondence address: AXEC, Egmont Kakarot-Handtke, Hohenzollernstraße 11, D-80801 München, Germany, e-mail: handtke@axec.de

1 Powerful tools

When Arnold Schwarzenegger, in his most popular roles, has seen and suffered enough evil he makes up his mind and first of all breaks into a gun store. With the eyes of an expert he spots the most suitable devices for the upcoming tasks. When he leaves the store with maximum firepower and determination we can rely upon that in the sequel humankind will be better off. This is how Hollywood reflects and thereby reinforces a plausible, convenient, and impressive problem solving strategy. Science seems to be the antithesis of Hollywood but in most cases the *modus operandi* is not much different. In how many economic papers or books have you read that, with this or that powerful tool, some urgent problem will now be solved for good? In JSTOR you will find about 20,000 items. In the foreword of their *Recursive Macroeconomic Theory* the authors use the word power four times on one single page and advertise: 'We aim to give readers a taste of the power of the methods . . . ' (Ljungqvist and Sargent, 2004, p. xix). Sounds as promising as Arnold's "I'll be back."

Let us call this popular mindset Toolism. Keynes, for example, has to be counted as an old fashioned Toolist.

> There is a role for historical generalisation, which relies on one of the most important logical tools, pattern recognition (metaphor, analogy); and a role for argument from first principles. (Keynes, quoted in Chick, 1998, p. 1860)

Debreu was an outspoken advocate of Toolism in the heydays of general equilibrium.

> It [rigor] may also lead to a radical change of mathematical tools. In the area under discussion it has been essentially a change from the calculus to convexity and topological properties, a transformation has resulted in notable gains in the generality and simplicity of the theory. (Debreu, 1959, p. x)

If there ever was a Toolist, then John von Neumann. In fact, he inspired the program of modern econophysics.

> You know, Oskar, if those books are unearthed sometime a few hundred years hence, people will not believe they were written in our time. Rather, they will think that they are about contemporary with Newton, so primitive is their mathematics. Economics is simply still a million miles away from the state in which an advanced science is, such as physics. (quoted in Ingrao and Israel, 1990, p. 197), this anticipates the curriculum of (McCauley, 2006, p. 20)

Keynesianism and General Equilibrium Theory are now known to be failures. Exactly for this reason the 'present crisis might offer an excellent occasion for a paradigm change.' (Bouchaud, 2009, p. 2). Econophysics comes to the rescue with, yes, a new tool.

> Whereas the simple Curie-Weiss mean-field approximation for homogenous systems is well known and accounts for interesting collective effects, its heterogeneous counterpart is far subtler and has only been worked out in detail in the last few years. It is a safe bet to predict that this powerful analytical tool will find many natural application in economics and social sciences in the years to come. (Bouchaud, 2009, pp. 6-7)

It is an even safer bet that econophysics only kicks off the nth cycle of Toolist's promise and letdown. A change of tool is not a paradigm change and if you are on the wrong track a faster car will bring you deeper into the woods. The development of equilibrium economics from Jevons and Walras to DSGE was of this sort (Quiggin, 2010, pp. 80-136). Needless to emphasize that Jevons and Walras were Toolists. Marginalism is calculus with a behavioral interpretation.

One wonders whether econophysicists have a sense of irony. What they criticize with full justification about standard economics is exactly the product of econophysics vintage 1844.

> The backward state of the Moral Sciences can only be remedied by applying to them the methods of Physical Science, duly extended and generalized. (Mill, 2006, p. 833)

Original econophysics did not work as intended and it is of some importance for new econophysics to find out why. The obvious drawbacks of Toolism are twofold. First, a tool may work superbly in one environment but not at all in another, and second, a tool is no better than its user, 'and not all users are skilled' (Clower, 1995, p. 308). Economists have borrowed many powerful tools from physics (Mirowski, 1995) and experienced a roughly equal number of disappointments. Econophysics vintage 2013 commands the most powerful tools ever but seems to be at loss where to put them to work: 'So where should one start?' (Bouchaud, 2009, p. 2)

2 It's not the tool, it's the paradigm

Physics has its own experience with a stagnant research program but it seems that the lesson has been forgotten. For two millenia physicists and mathematicians worked on the geocentric theory, well aware of its conspicuous flaws, only to arrive at a system that was 'extremely ingenious and completely mad' (Koestler, 1979, p.

68). From the very beginning nothing stood in the way to the correct solution but the scientists themselves.

> One of the most instructive facts in scientific history is the pertinacity with which the human mind clung to the belief that the heavenly bodies must move in circles, or to be carried round by the revolution of spheres; merely because those were in themselves the simplest suppositions ... (Mill, 2006, p. 756)

It was not a new and powerful tool that finally broke the deadlock. The four conic sections were common knowledge since 300 BC. It was the idea of circular motion, the premise of cosmology, that had to give way first. With it then vanished the self-produced complexity of 55 epicycles.

> ... Kepler qualified his own achievement as cleansing of the Augean stables. (Koestler, 1979, p. 339)

What does this imply for econophysics? The foundational vision of standard economics is the individual as optimizer and price taker who invariably ends up in simultaneous equilibrium. The behavioral hypothesis has often been criticized for its unrealism. Although everyone could easily agree, this argument is second-best because it does not go to the root. The crucial point is that the optimizing hypothesis forces one to assume a production function with decreasing returns. This has to be rejected on methodological grounds. The production function is a physical relationship that has to be taken as empirical fact. We cannot know *a priori* whether it exhibits increasing, constant, or decreasing returns. To let a behavioral hypothesis determine a physical relationship is an elementary methodological blunder.

> Such thinkers do not reflect that the idea, being a result of abstraction, ought to conform to the facts, and cannot make the facts conform to it. (Mill, 2006, p. 751); for Galileo's critique of the Peripatetic school in almost the same words see (Kline, 1982, p. 48)

It is for methodological reasons that the belief to which standard economists cling most has to go overboard. This is consensus among econophysicists.

> To be quite blunt, all existing 'lessons' taught in standard economics texts should be either abandoned or tested empirically, but should never be accepted as a basis for modelling. (McCauley, 2006, pp. 6-7)

This brings us to the question of what can be accepted as as basis for modeling. There is no way around it, econophysics is in need of a new economic paradigm. What is known for sure at the moment is that this paradigm cannot be based on behavioral assumptions of any sort. Agent-based models are more realistic, this is beyond question, but they too are built on behavioral assumptions.

3 What is conserved?

Physicists have found out that local invariance principles are the foundations for the discovery of mathematical laws (McCauley, 2006, p. 3). Conservation laws which follow from invariance principles are at the heart of physics (cf. Mirowski, 1988, pp. 18-19). For an econophysicist it is therefore quite natural to look first for a conserved entity in economics.

> The budget constraint *is* conservation of money, and that constraint is badly violated in the real world, where money is created and destroyed with the tap of a computer key via credit. ... In our era, conservation of money is a silly assumption. (McCauley, 2006, pp. 4-5)

This seems to be the premature end of a promising idea. However, this is only due to a lack of understanding of money's essential properties.

To begin with, forget stories about the gold standard mechanism or the quantity of money as a fixed stock and think of money as the liability side of a central bank which stands at the moment for the whole banking industry (for details see 2011c). In order to reduce the monetary phenomena to the essentials it is supposed that all financial transactions between the household and the business sector are carried out without costs by the central bank. The stock of money then takes the form of current deposits or current overdrafts. Initial endowments can be set to zero. Then, if the household sector owns current deposits as a result of the ongoing transactions between both sectors the current overdrafts of the business sector are of equal amount, and vice versa if the business sector owns current deposits. Money and credit are symmetrical; the stock of money of each sector can be either positive or negative. The quantity of money is equal to the amount of deposits and always ≥ 0.

Money in the form of current deposits is not fix and can change in any period by a random amount. At first sight money is not conserved. However, when deposits and overdrafts are added the result will be zero at each measurement. This is an elementary conservation law.

Money is conserved in a second and actually more important sense (for details see 2011a). Imagine a simple consumption economy (see Section 4) with the household sector making a small deficit in relation to total income in each consecutive period. That is, the overdrafts of the household sector grow and, by the same amount, the deposits of the business sector. The quantity of money grows. There is no need to go into details like interest and collateral; this process can go on for an indefinite time. Logic, though, cannot be content with this vague outcome. The process has to be reversed because the overdrafts have to be redeemed before the end of time. The *logical* endpoint is that the quantity of money in the form of deposits must return to zero at some unknown date. Seen over all periods, then, the budget constraint holds. This, too, is a conservation law, albeit a temporal indeterminate one. No

sifting of terabytes of historical data will reveal it because the descending half of the trajectory lies in the future.

The inviolable temporal budget constraint has a direct consequence for the ongoing crisis. As long as the household sector (or the public sector, for that matter) expands overdrafts the business sector as a whole will post a profit (see Section 5, eq. (10)). This is, in the first approximation, a good thing because a market system with overall zero profit and more than one firm is impossible (except for the Walrasians). How this overall profit is distributed among sectors and firms can be left open here. It is in any case obvious from (10) that an entrepreneur who demands a reduction of the public debt has not grasped the essential point about profit. The cumulated profit of the business sector is, in the simplest case, exactly equal to the cumulated deficits of private and public households (in the absence of distributed profits). Now, the logical consequence of the conservation principle is somewhat uncomfortable. When the private and public households start to pay off their debt, voluntarily or involuntarily, the business sector makes a loss. Seen over all periods the conservation law demands that the sum of losses is equal to the sum of profits. That is, over all periods the net outcome is zero (with zero distributed profits). The conservation law makes itself felt, not in full of course, in any debt deflation. The current economic situation in many countries provides an occasion for econophysics to test this conservation law (for details see 2012a). The prediction for a closed economy with no change of distributed profit is: a reduction of private and public debt is necessarily accompanied by an exactly equal reduction of overall profit in the period under consideration.

Some econophysics hold that it is a 'fundamental fallacy to base economic models on a principle of conservation' (Gallegatti et al., 2005, p. 8). This is correct only insofar as such a principle cannot be fetched out of thin air or simply postulated. A theory is needed to discover it.

> The moral of the story is simply this: it takes a new theory, and not just the destructive exposure of assumptions or the collection of new facts, to beat an old theory. (Blaug, 1998, p. 703)

4 Take three: the indispensable formal minimum

The formal foundations of theoretical economics must be nonbehavioral and epitomize the interdependence of real and nominal variables that constitutes the monetary economy (for details see 2013b).

The first three axioms relate to income, production, and expenditures in a period of arbitrary length. For the remainder of this inquiry the period length is conveniently assumed to be the calendar year. Simplicity demands that we have at first one world

economy, one firm, and one product. Quantitative and qualitative differentiation is obviously the next logical step.

Total income of the household sector Y in period t is the sum of wage income, i.e. the product of wage rate W and total working hours L, and distributed profit, i.e. the product of dividend D and the number of shares N.

$$Y = WL + DN \quad |t \tag{1}$$

Output of the business sector O is the product of productivity R and working hours.

$$O = RL \quad |t \tag{2}$$

The productivity R depends on the underlying production process. The 2nd axiom should therefore not be misinterpreted as a linear production function.

Consumption expenditures C of the household sector is the product of price P and quantity bought X.

$$C = PX \quad |t \tag{3}$$

A set of axioms is a *tentative* formal starting point. The assessment comes on the next stage with the interpretation of the logical implications of the formal world and the comparison with selected data and phenomena of the real world. Axioms should have an intuitive economic interpretation (von Neumann and Morgenstern, 2007, p. 25). The economic meaning is rather obvious for the set of structural axioms. What deserves mention is that total income in (1) is the sum of wage income and *distributed profit* and not of wage income and profit. Profit and distributed profit have to be thoroughly kept apart.

By choosing *objective* structural relationships as axioms behavioral hypotheses are not ruled out. The structural axiom set is open to *any* behavioral assumption and not restricted to the standard optimization calculus (for details see 2011b). The analysis of behavioral interaction is, for compelling methodological reasons, moved from the center of the domain to the periphery.

Definitions are supplemented by connecting variables on the right-hand side of the identity sign that have already been introduced by the axioms (Boylan and O'Gorman, 2007, p. 431). They add no content to the set of axioms but merely facilitate the use of symbols. New variables are introduced with new axioms. With (4) wage income Y_W and distributed profit income Y_D is defined:

$$Y_W \equiv WL \qquad Y_D \equiv DN \quad |t. \tag{4}$$

With (5) the expenditure ratio ρ_E, the sales ratio ρ_X, the distributed profit ratio ρ_D, and the factor cost ratio ρ_F is defined:

$$\rho_E \equiv \frac{C}{Y} \qquad \rho_X \equiv \frac{X}{O} \qquad \rho_D \equiv \frac{Y_D}{Y_W} \qquad \rho_F \equiv \frac{W}{PR} \quad |t. \tag{5}$$

The axioms and definitions are consolidated to one single equation:

$$\rho_F \frac{\rho_E}{\rho_X}(1+\rho_D) = 1 \quad |t. \tag{6}$$

The period core (6) as absolute formal minimum determines the interdependencies of the measurable key ratios for each period. It asserts that the product of the constituents which characterize the firm, the market outcome, and the income distribution is always equal to unity.

The period core is purely structural, i.e. free of any behavioral assumptions, unit-free[1] because all real and nominal dimensions cancel out, and contingent. Contingency means that it is open until explicitly stated which of the variables are independent and which is dependent. The form of (6) precludes any notion of causality; it states that the interdependence of the key ratios is subject to a conservation law. Walras's law is a limiting case of (6) (for details see 2013c).

The factor cost ratio ρ_F summarizes the internal conditions of the firm. A value of $\rho_F < 1$ signifies that the real wage $\frac{W}{P}$ is lower than the productivity R or, in other words, that unit wage costs $\frac{W}{R}$ are lower than the price P or, in still other words, that the value of output per hour PR exceeds the value of input W. In this case the profit per unit is positive. Then we have the conditions in the product market. An expenditure ratio $\rho_E = 1$ indicates that consumption expenditures C are equal to income Y, in other words, that the household sector's budget is balanced. A value of $\rho_X = 1$ of the sales ratio means that the quantities produced O and sold X are equal in period t or, in other words, that the product market is cleared. In the special case $\rho_E = 1$ *and* $\rho_X = 1$ with budget balancing and market clearing the factor cost ratio ρ_F and with it the profit per unit is determined solely by the distributed profit ratio ρ_D. The period core (6) covers the key ratios about the firm, the market, and the income distribution and determines their interdependencies. The period core represents the pure consumption economy, that is, no investment expenditures, no foreign trade, and no taxes or any other state activity.

From (6) one gets, as the first and most significant application, for employment in the pure consumption economy:

[1] "This procedure is in accordance with the principle of objectivity requiring that the whole theory and its interpretations have to be independent of the choice of the units of measurement. And this requirement is met, if the theory is unit-free, the necessary condition stated in Buckingham's Π-theorem." (Schmiechen, 2009, p. 176)

$$L = \frac{Y_D}{\frac{\rho_X}{\rho_E} PR - W} \quad |t. \tag{7}$$

Employment L depends, with distributed profit Y_D given and the product market cleared, i.e. $\rho_X = 1$, (a) on the expenditure ratio ρ_E which is the indicator of effective demand, and (b), on the relation of wage rate W, price P, and productivity R (for details see 2012b). All variables are measurable in principle. The message for a successful full employment policy is straightforward and does not entail any filibustering about sticky wages or rational expectations.

5 Profit

In the structural axiomatic context the business sector's profit in period t is given with (8) as the difference between the sales revenues – for the economy as a whole identical with consumption expenditures C – and costs – here identical with wage income Y_W:[2]

$$Q_{fi} \equiv C - Y_W \quad |t. \tag{8}$$

In explicit form, after the substitution of (3) and (4), this definition is identical with that of the theory of the firm:

$$Q_{fi} \equiv PX - WL \quad |t. \tag{9}$$

By applying the 1st axiom and the definitions (4) and (5) one arrives at:

$$Q_{fi} \equiv C - Y + Y_D \quad \text{or} \quad Q_{fi} \equiv \left(\rho_E - \frac{1}{1+\rho_D}\right) Y \quad |t. \tag{10}$$

The overall profit is positive if the expenditure ratio ρ_E is > 1 or the distributed profit ratio ρ_D is > 0, or both. The determinants of profit look essentially different depending on the perspective. For the firm price P, quantity X, wage rate W, and employment L in (9) seem to be all important; under the broader perspective of (10), which is formally equivalent, these variables play no role at all. The profit definition provokes a cognitive dissonance between the micro and the macro view but, of course, entails no logical contradiction.

[2] Profits from changes in the value of financial and nonfinancial assets are neglected here. One member of the latter class is the stock of products which may change with regard to quantity and valuation price if the product market is not cleared in successive periods. This case is here excluded by the condition $\rho_X = 1$.

6 Toolism or theory?

Neither orthodox nor heterodox economists have a clear idea of the fundamental economic concepts income and profit. What is known for sure from the most elementary structural axiomatic analysis is that the conventional approaches are logically deficient (for details see 2013a). Doing economics without a clear idea of income and profit is pointless. It is like doing physics without a clear idea of force and mass. Steve Keen, strong supporter of econophysics, has drawn a radical conclusion:

> The position I now favor is that economics is a pre-science, rather like astronomy before Copernicus, Brahe and Galileo. I still hold out hope of better behavior in the future, but given the travesties of logic and anti-empiricism that have been committed in its name, it would be an insult to the other sciences to give economics even a tentative membership of that field. (Keen, 2011, p. 158)

However, econophysics has to live up to the same empirical and formal standards. If econophysics applies a conception of profit that is different from $Q_{fi} \equiv C - Y + Y_D$ the theory is demonstrably false and therefore inapplicable to the solution of real world economic problems. If the structural axiom set is accepted, formal consistency implies that one cannot define profit as one sees fit. With regard to the formal foundations of a theory it is *not* the case that anything goes. Since Newton economics borrowed from physics but Toolism has not accomplished much. An amorphous aggregate of models and terabyte-consuming simulations are no substitutes for a comprehensive theory that exhibits both formal and material consistency. As J. S. Mill, econophysicist at heart, put it:

> Since, therefore, it is vain to hope that truth can be arrived at, either in Political Economy or in any other department of the social science, while we look at the facts in the concrete, clothed in all the complexity with which nature has surrounded them, and endeavor to elicit a general law by a process of induction from a comparison of details; there remains no other method than the à priori one, or that of "abstract speculation." (Mill, 2004, p. 113-114)

References

Blaug, M. (1998). *Economic Theory in Retrospect*. Cambridge: Cambridge University Press, 5th edition.

Bouchaud, J. P. (2009). The (Unfortunate) Complexity of the Economy. *Econo-Physics Forum*, 0904.0805: 1–9. URL http://www.unifr.ch/econophysics/paper/show/id/0904.0805.

Boylan, T. A., and O'Gorman, P. F. (2007). Axiomatization and Formalism in Economics. *Journal of Economic Surveys*, 21(2): 426–446.

Chick, V. (1998). On Knowing One's Place: The Role of Formalism in Economics. *Economic Journal*, 108(451): 1859–1869. URL http://www.jstor.org/stable/2565849.

Clower, R. W. (1995). Axiomatics in Economics. *Southern Economic Journal*, 62(2): 307–319. URL http://www.jstor.org/stable/1060684.

Debreu, G. (1959). *Theory of Value. An Axiomatic Analysis of Economic Equilibrium*. New Haven, London: Yale University Press.

Gallegatti, M., Keen, S., Lux, T., and Ormerod, P. (2005). Worrying Trends in Econophysics. *EconoPhysics Forum*, 0601001: 1–11. URL http://www.unifr.ch/econophysics/paper/show/id/doc_0601001.

Ingrao, B., and Israel, G. (1990). *The Invisible Hand. Economic Equilibrium in the History of Science.* Cambridge, MA, London: MIT Press.

Kakarot-Handtke, E. (2011a). Beginning, Crises, and End of the Money Economy. *SSRN Working Paper Series*, 1855578: 1–19. URL http://ssrn.com/abstract=1855578.

Kakarot-Handtke, E. (2011b). The Propensity Function as General Formalization of Economic Man/Woman. *SSRN Working Paper Series*, 1942202: 1–28. URL http://ssrn.com/abstract=1942202.

Kakarot-Handtke, E. (2011c). Reconstructing the Quantity Theory (I). *SSRN Working Paper Series*, 1895268: 1–26. URL http://ssrn.com/abstract=1895268.

Kakarot-Handtke, E. (2012a). General Formal Foundations of the Virtuous Deficit-Profit Symmetry and the Vicious Debt Deflation. *SSRN Working Paper Series*, 2115185: 1–30. URL http://ssrn.com/abstract=2115185.

Kakarot-Handtke, E. (2012b). Keynes's Employment Function and the Gratuitous Phillips Curve Desaster. *SSRN Working Paper Series*, 2130421: 1–19. URL http://ssrn.com/abstract=2130421.

Kakarot-Handtke, E. (2013a). Confused Confusers: How to Stop Thinking Like an Economist and Start Thinking Like a Scientist. *SSRN Working Paper Series*, 2207598: 1–15. URL http://ssrn.com/abstract=2207598.

Kakarot-Handtke, E. (2013b). Crisis and Methodology: Some Heterodox Misunderstandings. *real-world economics review*, 63: 98–117. URL http://www.paecon.net/PAEReview/issue63/kakarot-handtke63.pdf.

Kakarot-Handtke, E. (2013c). Walras's Law of Markets as Special Case of the General Triangle Theorem: A Laconic Proof. *SSRN Working Paper Series*, 2222123: 1–11. URL http://ssrn.com/abstract=2222123.

Keen, S. (2011). *Debunking Economics*. London, New York, NY: Zed Books, rev. edition.

Kline, M. (1982). *Mathematics. The Loss of Certainty.* Oxford, New York, NY: Oxford University Press.

Koestler, A. (1979). *The Sleepwalkers*. Harmondsworth: Penguin. (1959).

Ljungqvist, L., and Sargent, T. J. (2004). *Recursive Macroeconomic Theory*. Cambridge, MA, London: MIT Press, 2nd edition.

McCauley, J. L. (2006). Response to "Worrying Trends in Econophysics". *Econo-Physics Forum*, 0601001: 1–26. URL http://www.unifr.ch/econophysics/paper/show/id/doc_0601001.

Mill, J. S. (2004). *Essays on Some Unsettled Questions of Political Economy*, chapter On the Definition of Political Economy; and the Method of Investigation Proper to It., pages 93–125. Electronic Classic Series PA 18202: Pennsylvania State University. URL http://www2.hn.psu.edu/faculty/jmanis/jsmill/Unsettled-Questions.pdf. (1844).

Mill, J. S. (2006). *A System of Logic Ratiocinative and Inductive. Being a Connected View of the Principles of Evidence and the Methods of Scientific Investigation*, volume 8 of *Collected Works of John Stuart Mill*. Indianapolis, IN: Liberty Fund. (1843).

Mirowski, P. (1988). *Against Mechanism*. Totowa, NJ: Rowman & Littlefield.

Mirowski, P. (1995). *More Heat than Light*. Cambridge: Cambridge University Press.

Quiggin, J. (2010). *Zombie Economics. How Dead Ideas Still Walk Among Us*. Princeton, NJ, Oxford: Princeton University Press.

Schmiechen, M. (2009). *Newton's Principia and Related 'Principles' Revisited*, volume 1. Norderstedt: Books on Demand, 2nd edition.

von Neumann, J., and Morgenstern, O. (2007). *Theory of Games and Economic Behavior*. Princeton: Princeton University Press. (1944).