Competing Theories: Wrong or Not Even Wrong?

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1 Intellectual background

1.1 The cringe

From the start of the 20th century up until the end of the 1970s Marxists had great intellectual self confidence. They saw themselves as the wave of the future, not just in the development of society but also in the realm of ideas. The economic system they advocated seemed to be going from strength to strength. Increasing areas of the world were won by communist revolutionary movements. Marxism had political power, economic success and science behind it and seemed bound to triumph.

The political setbacks of the 1980s dented this self confidence. An alternative economic programme came to dominance - that of neo-liberalism. First in Chile, next in the Anglo Saxon countries and then in Eastern Europe liberal economic policies and doctrines rose to power.

The response of some Marxists was to change sides and, with the enthusiasm of new converts, to adopt the doctrines of their former opponents[1]. Some others on the left, whilst remaining opposed to the doctrines of neo-liberalism, became skeptical about what had previously been taken to be key components of Marxian economics such as the labour theory of value[2]. The neo-liberals had laid claim both to scientificity in economics and to the best policy proposals and this caught the left on the back foot, unsure where to tread next.

1.2 Education and the scientific method

Liberal economics has been able to claim scientificity based both on the large and sophisticated mathematical apparatus of neoclassical value theory, and on a vast number of detailed econometric studies. Those who are professionally involved in the subject are expected to be mathematically literate and experienced in the analysis of statistical data. These aspects of their training means that their background has in some ways more in common with people who are trained as natural scientists than with other social scientists. There has also

[1] See for example [Ste92] or [BL91] or [Sci95].

[2] A recent example is [NB09], an influential earlier one [Ste81].

been a long tradition of economists borrowing conceptual structures from the natural sciences. Mirowski showed that many of the concepts used in marginalist economics were borrowed directly from classical mechanics during the late 19th century[Mir89].

But there is, I think, a significant difference between the way the natural sciences are taught and the way neo-classical economics is taught, and this difference is significant.

When a student is taught an introductory course in physics or biology, they are both taught theories and told of the crucial experiments that validated the theories. They are told of Galileo's experiment that validated what we would now see as the equivalence of gravitational and inertial mass. They learn of Michelson Morley's experiment on the invariance of the speed of light, that inconvenient fact whose explanation required Special Relativity. Biology students hear of the experiments of Pasteur and Koch that established the germ theory of disease, etc. The function of these accounts in science education is twofold. On the one hand they emphasize to students the reasons why they should give credence to the theory being taught, on the other, these historical examples are used to teach the scientific method.

If one contrasts this with introductory courses in economics one sees that whilst theory is taught, the student gets no equivalent history of crucial economic observations in order to support the theory. This is no accident.

No history of crucial observations is taught, because there is no such history.

1.3 Failure of orthodox economics to relate to empirical data

In science an *experimentum crucis* serves to discriminate between competing hypotheses or to show the inadequacy of a previously dominant theory. The crucial difference between neo-classical economics and the classical school of political economy lay in their theories of value. The classical school, from Smith to Marx, had adhered to a labour theory of value which neo-classical economics replaced with marginal utility theory[3]. But one would search the history of economics in vain were one to look for the crucial experiment or observation which disproved the labour theory of value. There was none.

After Koch and Pasteur, the miasma theory of disease died out. It was completely replaced by the germ theory, whose greater practical effectiveness as a guide to public health measures was no longer in doubt. But after Jevons and Menger, the labour theory of value did not by any means die out. It continued to spread and gain influence, becoming the orthodoxy in the USSR and other socialist countries in the middle of the 20th century. Where and when

[3] Of course there is more to the neo-classical theory than just marginal utility, but the introduction of this, and elision of labour as a source of value were the crucial end results of the marginalist revolution. The marginal principle was not itself new, it had been incorporated in the Ricardian and Marxian theories of rent. In the transition between the two schools it can be argued that Gossen and Jevons supported a marginal labour theory of value[Hag06, Hag10].

a particular theory dominated owed a lot to politics, a little to aesthetics and nothing to observation.

1.4 Not even wrong

I mention aesthetics because there can be little doubt that the edifice of neo-classical economics head a mathematical sophistication and elegance that the labour theory of value at first lacked. The marginal theory had calculus, homogeneous functions, and in its later versions Brower's fixed point theorem. In contrast the labour theory of value initially involved nothing much more sophisticated than the concepts of ratios and averages[4].

Maths can be seductive.

The rigour and consistency of a mathematical theory can, to those who have expended the effort to understand it, give it credence. This is unproblematic where the theory is just maths. But when the maths claims to be a model of the real world, beauty can mislead. There has, for example, been recent criticism within physics of the dominance of string theory[SH08, Woi06]. Smolin alleges that the mathematical beauty of string theory has seduced a generation of physicists into an area which, lacking any experimental verification, is little more than beautiful speculation. That, he says, is why five Fields Medals given for mathematical work on String Theory but no Nobel prizes. Fields Medals are given for being smart, Nobel Prizes for being right. The problem with string theory, Smolin and Woit say, is that it gives no substantive testable predictions, and in the absence of these it is neither verifiable nor falsifiable as a scientific theory.

It would be a mistake for non-specialists to express a definite opinion on this. String theorists may yet come up with some empirically testable proposition. But the basic methodological point raised by its critics is surely valid. To be scientific, a theory must tell us something different about the world. It has to tell us something we would not have known without it. If the theory is true, then reality must be discernibly different from the way it would be if a rival theory was true.

A hypothesis can be scientific and turn out eventually to be wrong. It may make predictions about observations, and when these observations are made, some of them may turn out different from what was predicted. Such a theory was at least a scientific hypothesis, albeit a finally falsified one. But the charge is that string theory is *not even wrong*, because it says nothing about the universe that can be empirically tested.

If we go from physics to economics we can ask, what sort of theory is the labour theory of value?

Is it a validated scientific theory, a falsified theory, or one that is not even wrong?

[4] With time, the labour theory of value became much more complicated, from Dimitriev on it acquired the full rigour of linear algebra, and by the middle of the 20th century the maths used by Marxian and Neo-classical economists tended to have rather distinctive flavours.

Well it is clear that, in its strongest and simplest form, the labour theory of value does say something testable. It says that expended labour is the source of monetary value added. One can, in principle, add up hours of labour that are directly and indirectly used up in producing the outputs of different industries and then compare this with the monetary value added. If the hours of labour turn out to be uncorrelated or rather poorly correlated with the monetary value added then the theory would have been falsified.

One can often guard a theory against falsification by auxiliary hypotheses. The most famous of these were the Greek epicycle and deferent adjustments to models of planetary motion. These allowed the hypothesis that all planetary motion could be decomposed into uniform circular components to be reconciled with the at times visibly retrograde motion of the planets. In more recent theory, one may suspect that the hypothesized dark matter and dark energy, used to explain galactic orbits and accelerated cosmic expansion, play a role that is philosophically analogous to Ptolemaic epicycles.

In economics one can formulate weaker versions of the labour theory of value in which monetary value added is proportional not to observed labour, but to social necessary labour. If one so defines socially necessary labour, that its necessity is only revealed by by the movement of market prices, then one does indeed end up with a theory so weak as to be not even wrong. There is an ambiguity in the usage of the term socially necessary labour. On the one hand it may be used to mean using no more labour to produce say a loaf of bread than is necessary under the prevailing state of technology, on the other it may mean using no more labour in the baking industry than is necessary given the level of demand for bread. The first interpretation of 'socially necessary' still leaves us with a testable hypothesis, the second insulates the hypothesis from test. There has been a regrettable tendency by some authors[5] to formulate the labour theory of value in this weak unfalsifiable form.

The strong form of the labour theory of value, however, is not only testable but has actually been tested and verified by empirical studies, [Sha98], [MCC95], [Zac06], [TM02] among others. These studies show typically show correlations of around 95% or more between the monetary value of industries' outputs and the labour required to produce that output[6].

It is interesting to contrast this strong result for the simple labour theory of value, with its main competitor - the marginalist theory of value. This is based on the idea that prices evolve to levels at which marginal utilities per $ are equalised across different products. This is an unfalsifiable proposition. Since subjective utilities are unobservable, it is impossible to do the sort of correlation studies comparing the price structure of a country with utilities that have been done for the labour theory of value. Any price structure that one

[5] I am thinking here of advocates of 'value form theory' such as Williams and Reuten.

[6] It is worth mentioning in the light of criticism by Bichler and Nitzan, that these high correlations are obtained whether labour inputs are measured directly in person years as was done in Zachariah's work on Sweden, or estimated indirectly from wage bills as was done in other studies. The Swedish government data has the advantage of giving direct person-year figures for the labour used in each industry.

observes could be said to reflect subjective utilities. This part of marginalist theory is unscientific and falls into the 'not even wrong' category.

The other part of marginalist theory – that prices will be set equal to marginal productivities is potentially falsifiable. It deals with things that are in principle observable and measurable. It is falsifiable, and has already been falsified[Hal88].

The marginalist theory of value melds the wrong to the not even wrong.

2 The relevance of probabilistic models

The labour theory of value is empirically testable, and the evidence for it is empirically strong. The marginalist theory is in large part untestable, and testable parts have been falsified, but it retains enormously more influence than its old rival. Why?

There are obviously sociological reasons why the labour theory of value might be unpopular and it also takes time for results published in relatively little read journals to percolate. But even among those sympathetic to classical or Marxian political economy who are aware of the published results there has been less than universal acceptance of them. This, I think, is because whilst the labour theory of value is empirically supported, it has historically lacked any obvious mechanism. It remained at the level of a stable empirical relationship but the causal process behind it was unclear. Why should prices be determined by the work necessary to make things?

2.1 Farjoun and Machover's theory

> In that early and rude state of society which precedes both the accumulation of stock and the appropriation of land, the proportion between the quantities of labour necessary for acquiring different objects, seems to be the only circumstance which can afford any rule for exchanging them for one another. If among a nation of hunters, for example, it usually costs twice the labour to kill a beaver which it does to kill a deer, one beaver should naturally exchange for or be worth two deer. It is natural that what is usually the produce of two days or two hours labour, should be worth double of what is usually the produce of one day's or one hour's labour.([Smi74] Chapter 6)

Well, a skeptical neo-classical might say, that was all very well in an early and rude state of society, but why should the same principle apply today when Smith's original mechanism no longer operates?

The first really coherent reason why was given by Farjoun and Machover[FM83] back in the 1980s. They point out that for any commodity it is in principle possible to work out how much wage expenditure was directly or indirectly incurred in its production. So a particular model of Ford would have wage expenditure at the Ford factory, wage expenditure at the tyre factory, at the power station that supplied the factory etc. In principle one might have to trace this back

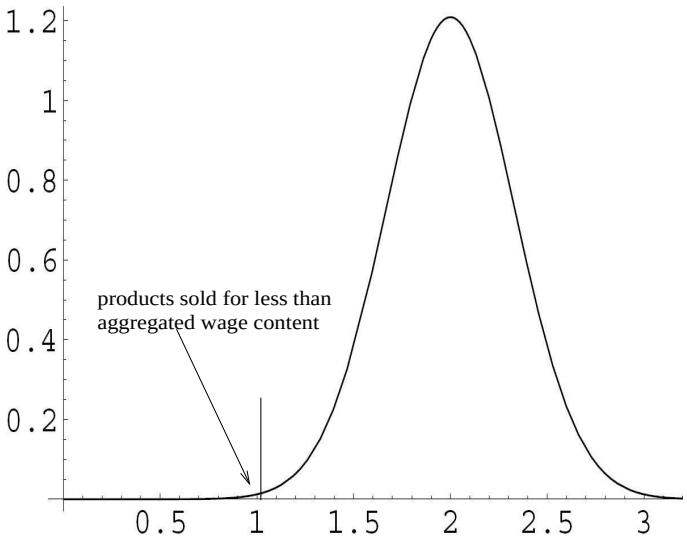

Fig. 1: Only a very small proportion of products will sell for less than their aggregated wage content. The horizontal axis shows the selling price in $ of the commodity per $ spent on direct and indirect wages. The vertical axis shows the relative frequency with which this is likely to occur. The exact mean and standard deviation of the normal distribution are chosen for illustrative purposes.

through many layers of the economy, but the further back you go, the less difference it starts to make. In practice one obtains reasonably stable estimates if one goes back through about 8 or 10 layers of indirect inputs. These wage costs are called vertically integrated labour costs.

A Ford selling for $20,000 might have an ultimate wage cost of let us say $12,000. From this you can get a figure for the value added per $ spent on wages: in this example $\frac{20,000}{12,000} = 5/3 = 1.66$. For different commodity sales the ratio of selling price to vertically integrated labour costs will vary in a random fashion. The actual ratio for any given product will be the result of a huge multiplicity of adventitious causes. It will depend on wage rates and the prices of inputs which are themselves randomly varying in terms of labour cost. Statistical theory says that a random sum of things which are themselves random can be described by the Normal distribution, the familiar Bell Curve shown in Figure 1.

A normal distribution can be characterized by only two numbers :

1. The *mean* or average of the distribution
2. The width or *standard deviation* of the distribution

What can we deduce about bell curves for value added per vertically integrated $ of wages, like that shown in Figure 1?

Farjoun and Machover point out that wages tended to make up around 50% of value added in developed capitalist countries[7], which implies that the mean value added per $ of wages will tend to be around 2 as shown in the diagram. We can also say something about the width of the distribution. They point out that only a very small proportion of commodities will sell for less than their vertically aggregated wage costs. Were they to do this not only would the firms making them be failing to meet their wage costs, but there would be no room for profit income in the raw materials supplied. They suggest that only about 1/1000 of sales of commodities will be at prices this low.

By consulting a table of the normal distribution, one finds that the probability of events 3 standard deviations away from the mean is about 1/1000, so for a mean of 2, then the standard deviation must equal $\frac{1}{3}$. How do these predictions stack up against real data?

Using data for the United Kingdom in 1984, the year after their book was published, we calculated [CC98] that the bell curve for the UK could be pretty well approximated by a normal distribution with a mean 1.46 and standard deviation of 0.151. They had underestimated the wage share in UK income, but they had got the share of output selling below its aggregated wage cost about right : for the UK the standard deviation was 1/3 the distance between 1 and the mean.

What are the implications of this?

If the standard deviation in the ratio of the selling price to vertically integrated labour costs has to be small, the consequence is that real selling prices have to

[7] This was roughly right when they were writing.

be closely clustered around Marxian labour values.

In other words the simple labour theory of must hold. The strong correlation[8] observed between labour content and monetary value of output is a necessary or emergent result of the statistically random process of price formation.

The form of argument used by Farjoun and Machover is rather alien to the tradition of political economy. The later has tended, from its inception, to look for explanations in terms of the actions of rational profit maximising individuals directing the economy towards some sort of equilibrium. Instead Farjoun and Machover, who were mathematicians not economists, imported the form of reasoning that had been used in thermodynamics or statistical mechanics. This branch of physics deals with the behaviour of large complex systems with huge numbers of degrees of freedom. The classical example of this type of system is gas composed of huge numbers of randomly moving molecules.

In such a system it is fruitless to try and form a deterministic and microscopic picture of the interaction of individual molecules. But you can make a number of useful deductions about the statistical properties of the whole collection of molecules. It was from the statistical properties of such collections that Boltzmann was able to derive the laws of thermodynamics[Bol95].

What Farjoun and Machover did was apply this form of reasoning to another chaotic system with a large number of degrees of freedom : the market economy. In doing this they initiated a new discipline of study : econophysics. This, in a very radical way, views the economy as a *process without a subject*. It assumes nothing about knowing subjects, instead it attempts to apply the principle of parsimony. It assumes nothing about the individual economic actors. Instead it theorises the aggregate constraints and and statistical distributions of the system that arise from the assumption of maximal disorder. A such this approach is anathema to the subjectivist Austrian school[9].

2.2 Yakovenko's model

The econophysics approach was further developed by Yakovenko who at the time did not know of Farjoun and Machover's earlier work.

Thermodynamics predicts that systems tend to settle into a state of maximum entropy. The conservation laws specify that whilst this randomization occurs energy must be conserved. Boltzmann and Gibbs showed that this implies that the probability distribution of energies that meets these two criteria is one like that shown in Figure 2. Yakovenko [CMC$^+$09, DY02] has argued that since money is conserved in the buying and selling of commodities it is analogous to energy. If the system settles into a maximum entropy state then

[8] We use the term correlation here, but other statistical measures of the closeness between labour content and monetary value such as the coefficient of variation or the cosine metric could be used. They all show a close relationship as predicted by Farjoun and Machover's theory.

[9] Given their Catholic problematic, the Austrian school find it is inconceivable for economics to dispense with the category of subject; see the debate on this issue at the Mises Organisation.

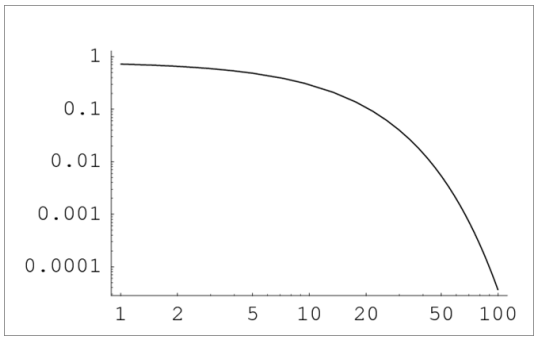

Fig. 2: The Gibbs Boltzmann form of distribution. Logarithm of energy on the horizontal axis, logarithm of probability density on the vertical one.

monetary wealth will come to follow a Gibbs Boltzmann distribution. He is able to show (see Figure 3) that the observed income distribution for 97% of the US population is well explained by a negative exponential distribution of the Gibbs form.

There remains a super-thermal tail of income (the top 3%) whose income is not conformant with maximal entropy but follows a power law distribution.

> The fact that income distribution consists of two distinct parts reveals the two-class structure of the American society. Coexistence of the exponential and power-law distributions is also known in plasma physics and astrophysics, where they are called the "thermal" and "super-thermal" parts . The boundary between the lower and upper classes can be defined as the intersection point of the exponential and power-law fits in Fig. 3. For 1997, the annual income separating the two classes was about 120 k$. About 3% of the population belonged to the upper class, and 97% belonged to the lower class. [YRJ09]

The thermal distribution arises from the application of the conservation law plus randomness. The non thermal distribution from the violation of conservation law. Yakovenko says that the non thermal group rely on income from capital and the stock market. This is consistent with Marx's analysis that profit in general can not arise within a conservative system, but from something outside of the conservative system – production of surplus value. The initial analysis of the exchange of commodities by Marx in Capital can be read as describing the laws governing the conservation of value in exchange.

> The subject of income and wealth distributions and social inequality was very popular at the turn of another century and is associated with the names of Pareto, Lorenz, Gini, Gibrat, and Champernowne, among others. Following the work by Pareto, attention of researchers was primarily focused on the power laws. However,

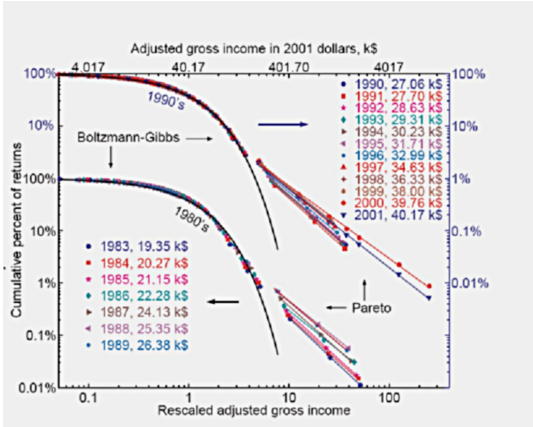

Fig. 3: The results of Yakovenko and Rosser[YRJ09] for the actual distribution of money income in the US, showing a good fit to the Gibbs Boltzmann distribution for the majority of the population. There exist a population of very wealthy people that do not fit on the curve and whose wealth must arise from a different process.

> when physicists took a fresh look at the empirical data, they found a different, exponential law for the lower part of the distribution. Demonstration of the ubiquitous nature of the exponential distribution for money, wealth, and income is one of the new contributions produced by econophysics. The motivation, of course, came from the Boltzmann-Gibbs distribution in physics. Further studies revealed a more detailed picture of the two-class distribution in a society. Although social classes have been known in political economy since Karl Marx, realization that they are described by simple mathematical distributions is quite new. Very interesting work was done by the computer scientist Ian Wright[Wri05, ?] (Wright, 2005, 2008), who demonstrated emergence of two classes in an agent-based simulation of initially equal agents. ([YRJ09])

Wright has shown, in the work that Rosser and Yakovenko cite, that random exchange models generate combined Gibbs + power law distributions as soon as you allow the hiring of labour. This is again consistent with Marx's old analysis.

In conclusion we can say that recent work has gone a long way to re-establishing the scientific credentials of Marxian economics. It has done so by taking literally his aphorism about discovering the 'laws of motion' of the capitalist system.

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