Mathematical Economics as Aid or Obstacle to Heterodox Economists? A Personal Experience

By Ben Fine*

In this comment piece, Professor Ben Fine reflects upon the use of mathematics in mainstream and heterodox economics.

I. Introduction

It is a pleasure and an honor to contribute to this special issue. I have known both Anwar and Duncan for a long time and have always greatly admired and eagerly followed their work whenever it has come my way, although our face-to-face meetings have been infrequent. This is not to say that we agree on everything. I do not share Duncan's position on the new solution to the transformation problem, both substantively and methodologically, not least because his approach (and others in similar vein) are looking for a "solution" rather than correctly specifying the real processes that are under consideration in the movement from production to exchange in capitalist accumulation (see Fine et al. (2004) and, for a more recent dispute with Fred Moseley on similar grounds see Fine (2017)). With Anwar, I have differences over the interpretation of Marx's Law of the Tendency of the Rate of Profit to Fall (and Counteracting Tendencies), for which I see him as suggesting, in light of competition to lower unit costs, that capitalists choose a lower rate of profit. By contrast I see the law and counteracting tendencies as underlying tensions deriving from capital accumulation, which do underpin crises, but which do not necessarily lead empirically to a fall in the rate of profit (Fine and Saad-Filho 2016). In addition, whilst I do consider we can observe value empirically, quantifying it in relation to price in empirical work is problematic as the value-price relation is complex and the consequence of many determinants.

But these and other differences, or agreements, are not my concern in this paper. I want to emphasize and explore something we all share—the use of mathematics in heterodox economics, not least as each of us was initially trained in mathematics and have continued to use it extensively. To some degree, this is frowned upon by heterodoxy, more in principle than in practice as I do not recall a single instance in which I have myself been criticized for using mathematics in my political economy.

Nonetheless, there is antipathy to mathematics in economics for a number of overlapping reasons; it is a (but not the—see below) leading characteristic of the mainstream; it is deterministic or not open, for which Lawson (2015) is the most prominent source of criticism;[1] and in research and teaching, the use of mathematics (and statistics) has become a goal in and of itself at the expense of other methods and approaches. Nonetheless, mathematics and its progeny, modelling, are alive and well within heterodoxy. For the moment, I presume that this cannot be dismissed as subservience to, or influence of, the mainstream over heterodox thinking although I do not doubt that this does exist—think, what would heterodoxy be like if orthodoxy were different as, indeed, it was before the formalist revolution inspired by Samuelson and the like following the second world war. Indeed, I seek to show the role mathematical reasoning can play for heterodoxy in setting out a number of examples in what follows, seeking to categorize them in successive sections.[2]

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[1] In my view, this leads Lawson to mis-specify the nature of neoclassical economics and even to deny that it exists (Fine (2015) in response to Lawson (2013)). In a nutshell, by use of mathematics in particular, Lawson emphasizes the closed social ontology of mainstream economics, but it also has a more important, and evolving, theoretical and conceptual content.

[2] This is more a speculative than a heavily researched piece, unduly drawing selectively and unduly, with apologies, upon my own experiences and contributions at the expense of a survey of the use and impact of mathematics across economic analyses more generally.

II. The Mainstream is Wrong on Its Own Terms

Whilst economics prides itself on its rigor, derived from its supposed mathematical/axiomatic/deductive reasoning, it is well-known within heterodoxy, and by orthodoxy itself if it cares to learn and pay attention, that it is not well-founded mathematically in a number of ways. One is in the implausibility of its assumptions that have transparently been adopted not for their mathematical rigor but for their convenience, or even necessity, for the theory to proceed. This is true of all of the technical and other assumptions made for constructing optimizing individuals and for them to combine into a stable, unique, Pareto-efficient equilibrium that lie, at least implicitly, at the heart of the mainstream.

Of course, it could be argued that the mathematics and rigor are right, it is just the assumptions that are wrong or unrealistic.[3] I am unconvinced that this separation is sustainable in practice even if legitimate in principle. This is well-illustrated by my first example—Cambridge Capital Theory in which Anwar played a leading critical role in debunking the empirics involved (Shaikh 1974). The Critique revolves around whether capital can be measured in such a way that the rate of profit, for example, can be determined by the marginal productivity of capital. But it turns out that this is only valid in a world of one good and is invalid in a world of more than one good (unless all are reducible to an as if one good). In my view, the Critique is best interpreted as being about the properties of models—do the properties of a model with just one good, carry over to the properties of a model with more than one good. The answer is a resounding, NO. So all the neoclassical (theoretical) intuitions derived from a one-good model are essentially invalid if we are prepared to take the simple step that realism dictates that most economies have more than one good in reality.

This ought to be a profound critique of much neoclassical thinking around production functions, quite apart from the fallacious measurement of technical progress as total factor productivity on the empirical side of things (it can measure progress when there has been decay and vice-versa depending on the composition of output which only arises if there is more than one good).[4] In short, doubling up with general equilibrium, the mathematics demonstrates that the latter is unlikely to be representative of reality just as the Cambridge critique, even more so, does the same for the valid use of (one-sector) production functions. But, crucially, these critical results do not depend upon rejection of the use of mathematics but upon positively embracing it, so much so that neoclassical economics lost the debate on its own terms, admitted it, and then proceeded pretty much as if it had not happened. At the very least, they offer a negative result of the sort that this is not the way to do things. Indeed, this does show that the mainstream is prepared to reject the implications of its mathematics if it does not suit in favor of not only its framings but even its narrow assumptions within those framings. Rigor as science does not rule in economics, even before we get onto the conceptual issues small and large.[5]

Similar arguments apply in case of the theory of the second best (if you cannot correct all market imperfections, correcting some may make matters worse). But another telling example is measurement of effective protection (or whether reducing the net tariff on a good will enhance economic outcomes). In a nutshell, what a survey of the mainstream, mathematical literature shows is that defining and measuring effective protection, let alone drawing policy conclusions from changing it, depend upon numbers of assumptions including: no unemployment; no economies of scale and scope; only two goods; no technical change; perfect competition for inputs and outputs; no non-traded goods; no multinational corporate inter-affiliate trade; and, the one I like the best, no smuggling (Deraniyagala and Fine 2001, 2006). The theory is simply shown to be inapplicable in practice unless such considerations are taken into account in deference to realism.

Moving tack, I have used (the foundations of) mathematics to criticize the methodology of the mainstream in a very different way, for its presumption that individualistically derived categories and

[3]Essentially in defence of mainstream economics, and his marginal if welcome deviations from it, Rodrik (2015, 213) makes the astonishing, and revealing, claim in the fourth of his 'Ten Commandments for Economists' that, 'unrealistic assumptions are ok; unrealistic critical assumptions are not ok'. Quite apart from determining where the boundaries between realistic and unrealistic lie, this leaves aside that the critical nature of assumptions cannot be independent of the entire framing within which they are set (including the other assumptions made).

[4]For my own, most recent take on the issues, see Fine (2016, Chapter 5).

[5]Here, my favorites are that we have to assume a Walrasian auctioneer for perfect competition as no one sets prices (and what are the prices of refreshments during the tatonnement tea break), and if capital markets were or could be perfect, everyone would borrow indefinitely and pay back interest due by borrowing even more.

social categories can be used side-by-side as if in harmony (Fine 2011). For example, we can define the state by the set of individuals who belong to it and do various things or by the set of powers that it has (what is done to individuals), or similarly for institutions more generally. So, consider the institution defined by the property of not belonging to an institution, the powerless it seems. People both belong and do not belong to the institution at the same time, a contradiction.

This might seem a trick, but it goes to the heart of the foundations of mathematics as Russell's paradox, the set of sets that do not belong to themselves is a self-contradictory set (it belongs to itself if it does not and vice-versa). We cannot both define sets one by one by its membership (aggregating the individuals) and otherwise by a relational property. We have to choose. In principle, methodological individualism chooses one by one and presumes it can derive social properties from this unproblematically. But this is false. Nor is the rejection of social properties viable, otherwise how do we deal with social categories such as profits, wages, and the like. As it would be arbitrary to limit the social categories we are allowed to deploy, the social, not the individual, must be the starting point.[6]

As a further example consider money and liquidity. Mainstream understanding of money sees it as liquid, in the sense of being able to purchase other things more readily than barter. It also suggests that money emerges as a spontaneous result of the cumulative effect of more and more individual acts of barter which become inefficient because of non-coincidence of wants. But this is impossible since the power of purchase is a social property, it has to be sanctioned and accepted, and cannot be derived from more and more individual acts of exchange however extensive.

Another example is the economics of identity popularized by Akerlof and Kranton (2000), with Fine (2009*a*) as critique and for detail for what follows, drawing upon numbers of results in the mathematically-grounded (social) choice theory. More or less without a second thought, Akerlof and Kranton plug identity into a utility function because that is what you do. The only difference is that your utility and your choice of identity will depend upon the identity of, or chosen by, others. On the grand scale, this inevitably and neatly falls foul of Russell's paradox since identity cannot both be a social property and a collection of aggregated individual memberships without contradiction. However, on the narrower technical terrain of utility functions, it has conveniently been forgotten that representation of preferences by a utility function depend on axioms of choice such as completeness, reflexivity, transitivity and continuity. These simply do not hold for identity—not least because there are multiple identities undermining completeness, and continuity can be violated with any sort of lexicographical ordering around your (intolerance of) racism, sexism or the like.

To complete this section, deploying mathematics to bring out that there can be demonstrable problems for heterodoxy as well as for orthodoxy in light of mathematical reasoning, consider the model of monopoly capitalism in the tradition of Kalecki, in which oligopoly pricing unduly raises prices and profits at the expense of wages, depressing demand, thereby prompting stagnation. This was neatly formalized by Keith Cowling (1982) in a model in which firms maximized profits, subject to their unit costs, their degree of collusion with other firms, and elasticity of demand for the product. These parameters allowed for a degree of monopoly (price relative to unit cost) to be measured in light of outputs across firms. But, overlooked by Cowling, is that the analysis can be taken further since firm outputs are not given but do themselves depend upon the parameters. It is possible to show that firms' outputs (and so profits on both lower/higher costs and higher/lower profits) is inversely related to unit costs (Fine and Murfin 1984*b*,*a*).

This begs the question, if not within the model itself, why some firms have lower unit costs than others, and why those with higher unit costs would not seek to lower their costs. They could do by increasing their fixed costs which only otherwise are taken as exogenous and a deduction from profits. There is also the issue of why, if firms can collude over price, why they cannot collude over output, shifting all production to the firm with lowest unit costs, and it compensates the other firms whilst keeping a margin for itself. Or why would not acquisitions or mergers bring about the same result. What this reveals is that the model systematically excludes what are commonplace aspects of the competitive

[6]Hodgson (2011) draws a similar conclusion, denying that neoclassical economics is characterized by methodological individualism since it must include the social within its analysis. This is a bit like saying, if you do not believe in God, then religion does not exist because it is based on falsehood (see Fine and Milonakis (2012)). The point is that neoclassicals (priests) proceed as if it can legitimately be methodologically individualistic (God exists) whilst breaching the principle along the way.

process,[7] but precisely ones that would undermine the results that prevail in their absence because of the different sorts of competition involved than market share due to monopoly power.[8]

III. Mainstream as Critical Point of Departure

In the previous section, the goal has been to deploy mathematical reasoning to undermine the mainstream on its own terms. This has the added benefit of providing a way in teaching by both presenting the mainstream (as will often be required of heterodox economists) and criticising it. This has been a major strategy in my own teaching (see Fine (2016; 2018) and Fine and Dimakou (2016)). But there is a more constructive role that can be played in bringing out fuller logical implications of the mainstream on its own terms, whether it be as a result of correcting what is wrong and/or bringing into play considerations that have been omitted but which can be considered to be vital.[9]

To some degree, this is already in play from the previous examples—most obviously that we need a price setting mechanism in the absence of the admittedly fictitious auctioneer, or in making the social rather than the individual as the analytical starting point. Continuing in this vein from above: the Cambridge Critique points to the need for a theory of distribution; trade policy needs to take into account lack of full employment, imperfect competition, the presence of multinationals, technical change, intersectoral linkages, economies of scale and scope, etc; there are more and more important forms of competition than market share; and the notion of identity as a utility choice is hopelessly inadequate given the social nature of identity.

Such potential for constructive out of critical analysis from mathematical reasoning is served by a number of further examples. By accident, I became interested in what is termed the order of acquisition of consumer durable (i.e., which you are more likely to acquire first, second, third, and so on). Mathematically, I found that the standard method had a peculiar property—that a person could move up their preference for a durable, but its calculated ranking could move down.[10] This is a violation of what is termed monotonicity in social choice.[11] But, by the same token, social choice theory could be used to construct an order of acquisition satisfying monotonicity and other desirable properties. The technique was then used to distinguish orders of acquisition by socio-economic strata finding, for example, the importance of telephones and videos for single mothers, and to challenge the new household economics as the basis for understanding both the (diffusion of the) ownership of durables and their putative labour-saving properties in explaining increasing female labour market participation (Fine et al. 1992, 1993; Fine 1992; Fine and Simister 1995). The technique was extended to discovering the relative importance of different types of food as part of a broader programme of research into the UK's burgeoning incidence of poor diets (Fine 1998; Fine, Heasman and Wright 1996), with results such as the increasing consump-

[7] As reflected in Anwar's theory of falling profit due to competition over unit costs through larger fixed capital (Shaikh 2016).

[8] There is also the countervailing power of other monopsonistic firms (not all goods go directly into consumption) and, in aggregating over the economy, demand elasticities mutually condition one another and cannot necessarily be taken as fixed parameters and without aggregation conditions. Note that the model of monopoly capital has strong resonances with the stance of Baran and Sweezy and the Monthly Review school (much more influential in the US than the UK). Elsewhere, I have shown how Sweezy's approach seems to draw more or less directly from the British feudal coal industry, on which he wrote his PhD thesis, by extrapolation to advanced capitalism (Fine 1988, 2009*b*). This involves undue extrapolation from feudalism to capitalism and from one to many sectors.

[9] Following Althusser, this might be termed a myopic reading, bringing out contradictions from within. The mainstream can itself play this role, for which there are two examples which I favour. One is the Harrod accelerator-multiplier knife-edge, suggesting growth is unstable; the other is Dornbusch's overshooting model which suggests the slightest deviation from New Classical assumptions is unstable around new equilibria (the less so the economy is more Keynesian) (see Fine and Dimakou 2016). Note that the Dornbusch model can be adapted to be entirely domestic with two financial assets, leading to financial overshooting. Also, myopic readings do not necessarily support heterodoxy as macro since the knife-edge can be interpreted as systematically excluding factors that would have the effect of dampening if not eliminating its effects.

[10] This is a result of probabilistic orderings so that if a dishwasher, say, is maginally second but gets a few extra firsts in place of seconds, it may not have enough to become first but lose its second place and become third.

[11] By another accident, my mathematical training threw me into social choice theory in the first week in which I studied economics. It gave me my PhD, some publications, the basis for tenured post, the grounds for criticising orthodoxy and, as will be seen, some basis for heterodox analysis.

tion of skimmed milks was strongly associated with increasing consumption of cream-based cheeses and desserts, and decline in direct consumption of sugar with its use in manufactured foods and drinks.[12]

Measurement, and the use of (mathematically-based) econometrics, is at the heart of my next two examples. The first concerns equal pay for work of equal worth for women and how, under appropriate legislation, this can be operationalised, especially given occupational segregation by gender. To argue for wage discrimination, apart from qualitative arguments over the nature of the way in which labour markets function in general, and in the particular case under consideration, the various conditioning factors have to be brought into play around wage determination. Doing this for women in the British coal industry ultimately gave rise to a famous victory, with over 1000 women sharing £3 million pounds back pay in 1990 after an eight-year struggle (Fine 1990*d*).[13]

The coal industry, and Britain's historical performance, and econometrics also figure in my next example. Leading scholars had argued through simple correlations that neither small mine size nor failure to mechanise explained poor levels of productivity. I undertook my own modelling of these on the basis of multiple regression to show that both mine size and mechanisation were important (Fine 1990*a*,*b*,*c*, 1993).[14] How can the simple be reconciled with the multiple regressions? The answer is that it is the smaller mines that are mechanising most, something that has to be explained. In this, I could then introduce the missing factor from the mainstream accounts, the role of privately-owned landed property bearing coal, as was the case in Britain prior to 1938 (when the coal royalties were nationalised). This meant that the surplus profitability of intensive investment could be creamed off by landowners (indeed, it tended to be institutionalised in the payment of a coal royalty per ton). This would dull the incentive to mechanise and to increase mine size, with smaller mines having no alternative but to mechanise and for landowners to allow them to do so without undue royalty charges.

IV. Mathematics and Heterodoxy in Its Own Right

The role of landed property in the British coal theory prompted what was to be a longstanding interest in rent theory, particularly within Marxist political economy for its impact upon accumulation (see Fine (2019) for most recent contribution but Fine (1979) for extensive detail). My interpretation of Marx rested on examining the impact of landed property on the pace of accumulation. Contingent upon the historical form of relations between capitalists and landlords (after all the two can coincide), as already suggested in case of British coal, the surplus profitability of intensive accumulation (through mechanisation, mine size, etc) can to a greater or lesser degree be appropriated by landlords rather than capitalist farmers. To the extent that is so, what Marx called differential rent II is substituted for by absolute rent, a mark-up on price on what it would otherwise be relative to other sectors more generally.

Around these arguments, there has been considerable confusion in the literature and tendency to reject Marx. First, absolute has been confused with monopoly rent, and therefore potentially available in any sector. Second, Marx's association of absolute rent with lower organic composition of capital in agriculture has been seen to be arbitrary (whether it be lower and why not the same result in other sectors with low organic composition). Third, crucially, these are more or less static arguments against Marx and mistake the organic composition (how much productivity is increasing) with the value composition (the momentary ratio of constant and variable capital). Indeed, Marx's argument is relatively simple; to the extent that landed property appropriates the fruits of surplus productivity, it will impede accumulation which involves a higher organic composition, and sets a corresponding level of absolute rent (as capital is forced to go onto new land instead of intensively cultivating existing land). So landed property can lead to a lower organic composition and corresponding absolute rent. What Marx argued without algebra, but I was able to show with algebra, is that the difference between the lower price relative to value warranted by the lower organic composition of capital is exactly the surplus profitability that would

[12]Such empirical results gave rise to an understanding of consumption based on social norms, with material cultures attached (Bayliss and Fine 2021).

[13]See also O'Donnell (1990).

[14]I estimated production functions, or implicit labour demand from them and, being mindful of Cambridge Critique, used numbers of coal-cutters for capital not value of capital. I also showed that, across different mining districts, diffusion of mechanization could be slow and towards levels below 100%.

accrue if the organic composition had increased in line with other sectors (see Fine and Saad Filho 2016).

But, in Marxist political economy, the use of mathematics has been used most prominently in the context of the transformation problem (deriving from Sraffianism) and the law of the tendency of the rate of profit to fall (deriving from Okishio). Invaluable mathematical results have been yielded. On the one hand, value theory (based on labour) is an inappropriate foundation for a theory of equilibrium prices. On the other hand, in comparative statics (comparison of equilibria), with productivity increase there cannot be a fall in profitability unless wages rise disproportionately. These results, however, have very little to do with Marx's own political economy and, like the rent theory discussed above, there is an almost universal misuse of the concept of the organic composition of capital. For both transformation and the law of the tendency of the rate of profit to fall are about value and price formation in a context of changing values which can hardly be tied to equilibrium (see Fine and Saad Filho 2016).[15]

V. Concluding Remarks

Two of the major issues over my academic life over the past two decades have been economics imperialism (the colonisation of other social sciences by economics) and how to sustain a heterodox economics, and who will do it, that critically commands the orthodoxy as well as offering alternatives of its own—who will replace Duncan and Anwar? This issue inspired the setting up of the International Initiative for Promoting Political Economy.[16] As retirement loomed, I could see that: those genuinely interested in the material realities of the economy would be drawn to studying political economy within other social science disciplines where there is greater openness to it in light of the demise of postmodernism and attention to the material realities of neoliberalism, globalisation and, most recently, financialization; the technical demands of commanding the mainstream would crowd out space for alternatives especially given the strong and increasing intolerance of alternatives by the mainstream; inevitably, those trained in the mainstream would be socialised towards incorporating it, if not necessarily accepting it, alongside a rationale for doing so in terms of supposed critical engagement with, and reform of, the mainstream in the name of pluralism; and the opportunities for academic careers within economics as a result of these and other factors (such as assessment exercises) were being diminished in relative if not absolute terms.

For economics imperialism, I have argued that it is now well within its third phase.[17]. The first, the old economics imperialism, is associated with Becker and the non-economic as if a perfectly working market. The second, or new, is associated with, or derived from Stiglitz, Akerlof and the like, with the social/non-economic understood as if the response to imperfectly working markets. Each of these retain the core principles of mainstream economics around utility and production functions, optimisation and (in)efficiency properties. The latest, newer phase of economics imperialism rests on an incoherent combination of the two earlier phases together with the incorporation of any other factor gleaned from across the social sciences. Throw in any variable we like into a production or utility function (conveniently forgetting that these have and can only be constructed by taking other variables as exogenously fixed); and complement utility maximisation and the pursuit of efficiency with any other behavioural assumptions that take our fancy.

Such developments clearly extend the potential scope and life of economics imperialism. The formalisation of economics by mathematical methods and presentation means that they sit astride all of the factors just covered leading to a situation in which introspection over theory, let alone methodology, methods and conceptualisation, increasingly takes second place to model building and empirical estima-

[15]Marx is almost unique in seeking to tie price theory to a context of changing productivity. The major exception is Adam Smith whose (component) price theory was flawed in assuming wages, profits and rent could be independent of one another as they are constrained by net product. But he did seek to ground his price theory, through his components, in productivity change through the impact on components of a *growing* division of labour (see Fine (1982) and Fine and Milonakis (2009)). Interestingly, it is only through his mathematical *mistake* that Smith could be insightful over the implications of productivity change for price formation, and he was also able to posit absolute rent as opposed to Ricardian theory. Thus, whilst far from shunning mathematical rigor, breaches with it can be illuminating contingent upon the theoretical substance of what is conveyed. Note also that Ricardo only allows for differential rent by inconsistently having a different value theory for agriculture than for industry.

[16]Further information can be found at https://iippe.org/about-iippe/.

[17]For my latest work on economics imperialism, see Fine (2024*a*; 2024*b*; 2024*c*).

tion.[18] Mathematics has strengthened its already leading role as a conduit for developments within the mainstream. The latter also applies to heterodoxy, which itself can be induced to become part of the mainstream or be inclined to lean towards it whether by virtue of individual contributions, attempts at engagement, or structured power of the mainstream in determining what gets published, by whom with consequences for presence and influence within the discipline.

Whilst, then, the use of mathematics in economics is stacked in favour of the mainstream, so is everything else (other than the revival of heterodoxy, often under the banner of pluralism, following the Global Financial Crisis, and the more favourable attitude to political economy in disciplines other than economics). What I have tried to show is that mathematics can be used: to criticise orthodoxy on its own terms; more constructively, to reveal critical weaknesses through what is absented and which need to be addressed; and, most constructively, to contribute towards political economy within its own terms. Mathematics can be used both as a method of investigation and of presentation although the corresponding roles of explanation, understanding and causation must and do take precedence over these whether acknowledged as such. In short, the use of mathematics in economics is inevitable, as is its abuse, with potentially positive impact against orthodoxy but mixed results across heterodoxy contingent upon purpose and reception.

REFERENCES

Akerlof, George, and Rachel Kranton. 2000. "Economics and Identity." *Quarterly Journal of Economics*, 115(3): 715–753.

Bayliss, Kate, and Ben Fine. 2021. *A Guide to the Systems of Provision Approach: Who Gets What, How and Why.* Basingstoke: Palgrave MacMillan.

Cowling, Keith. 1982. *Monopoly Capitalism.* London: Palgrave.

Deraniyagala, Sonali, and Ben Fine. 2001. "New Trade Theory versus Old Trade Policy: A Continuing Enigma." *Cambridge Journal of Economics*, 25(6): 809–825.

Deraniyagala, Sonali, and Ben Fine. 2006. "Kicking away the Logic: Free Trade Is neither the Question nor the Answer for Development." In *The New Development Economics: After the Washington Consensus.* , ed. Ben Fine and K.S. Jomo, 46–67. Delhi: Tulika.

Fine, Ben. 1979. "On Marx's Theory of Agricultural Rent." *Economy and Society*, 8(3): 241–279.

Fine, Ben. 1982. *Theories of the Capitalist Economy.* London: Edward Arnold.

Fine, Ben. 1988. "The British Coal Industry's Contribution to the Political Economy of Paul Sweezy." *History of Political Economy*, 20(2): 235–250.

Fine, Ben. 1990*a*. "The British Coal Industry Prior to Nationalisation: A Case for Quantitative Marxism?" In *Quantitative Marxism.* , ed. Paul Dunne, 60–83. Oxford: Blackwell.

Fine, Ben. 1990*b*. *The Coal Question: Political Economy and Industrial Change from the Nineteenth Century to the Present Day.* London: Routledge.

Fine, Ben. 1990*c*. "Featherbedding Cartel or Economies of Scale: The Case of the British Interwar Coal Industry." *Economic History Review*, XLIII(3): 438–449.

Fine, Ben. 1990*d*. "Gender Discrimination and Bargaining Structures in the Coal Industry: Evidence on behalf of the NUM to the Equal Pay Tribunal." *Historical Studies in Industrial Relations.* forthcoming.

Fine, Ben. 1992. *Women's Employment and the Capitalist Family.* London: Routledge.

Fine, Ben. 1993. "Is Small Beautiful? Mine Size in the British Inter-War Coal Industry." *Economic History Review*, XLVI(1): 160–162.

Fine, Ben. 1998. *The Political Economy of Diet, Health and Food Policy.* London: Routledge.

Fine, Ben. 2009*a*. "The Economics of Identity and the Identity of Economics?" *Cambridge Journal of Economics*, 33(2): 175–191.

Fine, Ben. 2009*b*. "Enigma in the Origins of Paul Sweezy's Political Economy." *Review of Political Economy*, 21(1): 157–161.

Fine, Ben. 2011. "The General Impossibility of Neoclassical Economics." *Ensayos Revista de Economía*, XXX(1): 1–22.

[18] For an account of the evolution of the role of mathematics in economics, see Milonakis (2017).

Fine, Ben. 2015. "Neoclassical Economics: An Elephant is not a Chimera But Is a Chimera Real?" In *What Is This 'School' Called Neoclassical Economics?: Debating the Origins, Meaning and Significance.* , ed. Jamie Morgan, 180–199. London: Routledge.

Fine, Ben. 2016. *Microeconomics: A Critical Companion.* London: Pluto.

Fine, Ben. 2017. "Neither Equilibrium as Such nor as Abstraction: Debating Fred Moseley's Transformation." *International Journal of Political Economy*, 46(1): 22–28.

Fine, Ben. 2018. "In and Against Orthodoxy: Teaching Economics in the Neoliberal Era." In *Advancing Pluralism in Teaching Economics.* , ed. Stefan Decker, Wolfram Elsner and Stefanie Flechtner, 78–94. London: Routledge.

Fine, Ben. 2019. "Marx's Rent Theory Revisited? Landed Property, Nature and Value." *Economy and Society*, 48(3): 450–461.

Fine, Ben. 2024*a*. *Economics Imperialism and Interdisciplinarity: Before the Watershed; Critical Reconstructions of Political Economy.* Vol. 1, Leiden: Brill.

Fine, Ben. 2024*b*. *Economics Imperialism and Interdisciplinarity: The Watershed and After; Critical Reconstructions of Political Economy.* Vol. 2, Leiden: Brill.

Fine, Ben. 2024*c*. *Cliometrics as Economics Imperialism: Across the Watershed; Critical Reconstructions of Political Economy.* Vol. 3, Leiden: Brill.

Fine, Ben, and Alfredo Saad-Filho. 2016. *Marx's 'Capital'.* . 6th ed., London: Pluto.

Fine, Ben, and Andrew Murfin. 1984*a*. *Macroeconomics and Monopoly Capitalism.* Brighton: Wheatsheaf.

Fine, Ben, and Andrew Murfin. 1984*b*. "The Political Economy of Monopoly and Competition: A Critique of Monopoly and Stagnation Theory." *International Journal of Industrial Organisation*, 2(2): 133–146.

Fine, Ben, and Dimitris Milonakis. 2012. "Interrogating Sickonomics, From Diagnosis to Cure: A Response to Hodgson." *Review of Social Economy*, 70(4): 477–491.

Fine, Ben, and Julian Simister. 1995. "Consumption Durables: Exploring the Order of Acquisition." *Applied Economics*, 27(11): 1049–1057.

Fine, Ben, and Ourania Dimakou. 2016. *Macroeconomics: A Critical Companion.* London: Pluto.

Fine, Ben, Costas Lapavitsas, and Alfredo Saad-Filho. 2004. "Transforming the Transformation Problem: Why the 'New Solution' Is a Wrong Turning." *Review of Radical Political Economics*, 36(1): 3–19.

Fine, Ben, Michael Heasman, and John Wright. 1996. *Consumption in the Age of Affluence: The World of Food.* London: Routledge.

Fine, Ben, Neil Foster, John Simister, and John Wright. 1992. "Access to Phones and Democracy in Personal Communication: Myth or Reality?" SOAS Working Papers in Economics, no 20.

Fine, Ben, Neil Foster, John Simister, and John Wright. 1993. "Consumption Norms, Trickle-Down and the Video/Microwave Syndrome." *International Review of Applied Economics*, 7(2): 123–143.

Hodgson, Geoffrey. 2011. "Sickonomics: Diagnoses and Remedies." *Review of Social Economy*, 69(3): 357–376.

Lawson, Tony. 2013. "What Is This 'School' Called Neoclassical Economics?" *Cambridge Journal of Economics*, 37(5): 947–983.

Lawson, Tony. 2015. *Essays on: The Nature and State of Modern Economics.* London: Routledge.

Milonakis, Dimitris. 2017. "Formalising Economics: Social Change, Values, Mechanics and Mathematics in Economic Discourse." *Cambridge Journal of Economics*, 41(5): 1367–1390.

Milonakis, Dimitris, and Ben Fine. 2009. *From Political Economy to Economics: Method, the Social and the Historical in the Evolution of Economic Theory.* London: Routledge.

O'Donnell, Kathleen. 1990. "Canteen Workers' Wages and Collective Bargaining Arrangements in British Coal." *Historical Studies in Industrial Relations.* Evidence on behalf of the NUM to the Equal Pay Tribunal, Case No: 31708/85/LS, forthcoming.

Rodrik, Dani. 2015. *Economics Rules: The Rights and Wrongs of the Dismal Science.* New York: W.W. Norton.

Shaikh, Anwar. 1974. "Laws of Algebra and Laws of Production: The Humbug Production Function." *Review of Economics and Statistics*, 51(1): 115–120.

Shaikh, Anwar. 2016. *Capitalism: Competition, Conflict, Crises.* Oxford: Oxford University Press.