Calculation, Complexity And Planning: The Socialist Calculation Debate Once Again

Allin Cottrell and W. Paul Cockshott*

July, 1993

Abstract

This paper offers a reassessment of the socialist calculation debate, and examines the extent to which the conclusions of that debate must be modified in the light of the subsequent development of the theory and technology of computation. Following an introduction to the two main perspectives on the debate which have been offered to date, we examine the classic case mounted by von Mises against the possibility of rational economic calculation under socialism. We discuss the response given by Oskar Lange, along with the counter-arguments to Lange from the Austrian point of view. Finally we present what we call the 'absent response', namely a re-assertion of the classic Marxian argument for economic calculation in terms of labour time. We argue that labour-time calculation is defensible as a rational procedure, when supplemented by algorithms which allow consumer choice to guide the allocation of resources, and that such calculation is now technically feasible with the type of computing machinery currently available in the West and with a careful choice of efficient algorithms. Our argument cuts against recent discussions of economic planning which continue to assert that the task is of hopeless complexity.

*Department of Economics, Wake Forest University, and Department of Computing Science, University of Glasgow, respectively.
This paper was published in *Review of Political Economy*, vol. 5, no. 1, July 1993, pp. 73–112.

Contents

> In the main socialist production might only appear rationally realizable, if it provided an objectively recognizable unit of value, which would permit of economic calculation in an economy where neither money nor exchange were present. And only labour can conceivably be considered as such (Ludwig von Mises, 1935: 116).

1 Introduction

This paper offers a reassessment of the socialist calculation debate of the 1920s and '30s, and examines the extent to which the conclusions reached in that debate must be modified in the light of the development of the theory and technology of computation since that time. The paper is organized thus: following a brief introduction to the two main perspectives on the debate which have been offered in the literature to date, we examine in section 2 the classic case mounted by von Mises against the possibility of any kind of rational economic calculation under socialism. Section 3 of the paper discusses the response to Mises and Hayek given by Oskar Lange. We also consider in this section the counter-arguments to Lange which have been made from the Austrian point of view, including the recent arguments of Don Lavoie. Section 4 presents what we call the 'absent response', namely a re-assertion of the classic Marxian argument for economic calculation in terms of labour time. That is, we endorse the claim made by Mises that we have taken as our epigraph, but contest his view that labour-time calculation is unworkable. Specifically, we argue (a) that labour-time calculation is defensible as a rational procedure, particularly when supplemented by algorithms which allow consumer choice to guide the allocation of (a subset of) economic resources, and (b) that such calculation is now technically feasible, with the type of computing machinery currently available in the West and with a careful choice of efficient algorithms. Our argument therefore cuts against recent discussions of economic planning which continue to assert that the task is of hopeless complexity (e.g. Nove, 1983). The final section presents our conclusions.

We should perhaps also point out what this paper does not deal with: while we defend a version socialist planning against the Austrian challenge, it is beyond our scope here to offer a full, positive case for socialism (or a thorough socialist critique of capitalism). Nonetheless, we believe that such a case can be made, and have tried to do so elsewhere.[1]

1.1 Two histories of the debate

Before engaging with the substance of the Austrian argument it is worth noting the two main interpretations of the debate that have been offered to date. These may be labelled the Standard Version and the Revised Version. By the Standard Version we mean that given by various prominent neoclassical writers in the early postwar period, notably Bergson (1948), Schumpeter (1954) and Samuelson (1948). Taking Bergson as the exemplar of this approach, the order of events is basically the following:[2]

1. In the first decade of the twentieth century, Pareto and Barone show the formal equivalence between the optimal allocation of resources in a socialist economy and the equilibrium of a perfectly competitive market system. In each case, one requires the solution of the equations of Walrasian general equilibrium.

[1] This paper is conceived as complementary to a forthcoming book on the redefinition of socialism (Cockshott and Cottrell, in press). Some of the issues touched upon here are treated at greater length in the book, although the latter does not deal with the historic socialist calculation debate.

[2] We draw here on Bergson (1948: 445–8). Similar accounts of the Standard Version have been given by Lavoie (1985: 10–20) and Temkin (1989: 33–4).

2. In 1920 Mises asserts the impossibility of rational economic calculation under socialism. This appears puzzling: was he unaware of the Barone result? If Mises was asserting the logical impossibility of attaining general equilibrium under socialism, even given full information on consumers' valuations of the various goods along with detailed knowledge of production techniques, and unlimited 'logical faculties' among the planners, then his argument was 'easily disposed of'—indeed it had already been answered in advance. Perhaps then he was really arguing that although rational calculation was logically possible under socialism, there was 'no practical way of realizing it'.

3. This latter position was taken by Hayek in the 1935 book in which he reprinted Mises' article along with two essays of his own: the Austrians thereby retreated from an untenable strong impossibility claim, to the weaker claim that socialist calculation would face practical difficulties—in effect, it was being claimed that the socialists could not solve all the necessary equations, while the market mechanism could.

4. This weakened Austrian position was then successfully assailed by Lange in 1938, when he showed that the socialists could emulate the Walrasian auctioneer, using a 'trial and error' process to arrive at the general equilibrium price vector. It was not necessary to solve all the equations 'on paper', in advance.

Thus according to the standard version the debate closed with a clear defeat for the Austrians. It had been shown that rational calculation in a socialist economy was, as it were, practicable in principle. Of course, one might have doubts about the real practicability of a Lange-type system, but it sufficed as a theoretical answer to Mises and Hayek.

The Revised Version is very different. The fullest statement of this view is given by Lavoie (1985); earlier versions were given by Ramsay Steele (1981) and Murrell (1983), among others, and the argument has since been amplified by Temkin (1989). On this view Mises' critique of socialism was not invalidated in advance by the Barone–Pareto equivalence thesis, and neither was it effectively answered by Lange. Rather, the Walrasians and the Austrians were talking past each other. Throughout the 'debate' the Walrasian side was thinking in terms of the attainment of static general equilibrium, while the Austrians had a quite different problem in mind, namely that of dynamic adjustment (and discovery) in the face of continuously changing technologies and preferences. According to Lavoie, Mises never denied that socialism would be able to perform alright under static conditions, but this was irrelevant to the real world. The whole Walrasian apparatus—acceptance of which was shared by western socialist economists of the Lange cohort and the neoclassical commentators of the Standard Version—served at best to define the limiting end-point of dynamic adjustment under competitive capitalism. But this limit was never reached in a real capitalist economy, and neither could it be reached under socialism. The formal equivalence argument was therefore irrelevant to the Austrian charge that socialism could not effectively emulate the disequilibrium profit-seeking dynamic of capitalism.

We should note that on the Revised Version, the 'computation argument' is downplayed. The problem is not that there are too many equations to solve, but that the equations cannot be set up in the first place. Lavoie even chides Hayek for including the original (Walrasian) Barone piece in his 1935 book, and for making any reference to the difficulty of solving 'thousands of equations'. Far from strengthening the Austrian case by providing the backstop of computational impossibility, Hayek unwittingly drew attention away from his own central argument and created the misleading impression that advances in computational technology might have some bearing on the matter.

As will become apparent, we wish to dispute both of the above readings of the calculation debate. We agree with Lavoie that Lange's Walrasian system does not provide an adequate model for a real socialist

economy; on the other hand, we shall challenge his claim that the Mises critique is effectively unanswerable. In particular, we seek to establish that the 'computational argument' *is* relevant, and that recent advances in computer technology *do* make possible an effective socialist planning system. We begin by offering our own assessment of Mises' original argument.

2 Mises on the impossibility of socialist calculation

In 1920, with the Bolsheviks victorious in the Russian civil war and the spectre of communism once more haunting Europe, von Mises produced his classic article on 'Economic Calculation in the Socialist Commonwealth'. His claims were striking, and, if they could be sustained, apparently devastating to the cause of socialism. The dominant Marxian conception of socialism involved the abolition of private property in the means of production and the abolition of money, but Mises argued that "every step that takes us away from private ownership of the means of production and the use of money also takes us away from rational economics" (1935: 104). The planned economy of Marx and Engels would inevitably find itself "groping in the dark", producing "the absurd output of a senseless apparatus" (106). Marxists had counterposed rational planning to the alleged 'anarchy' of the market, but according to Mises such claims were wholly baseless; rather, the abolition of market relations would destroy the only adequate basis for economic calculation, namely market prices. However well-meaning the socialist planners might be, they would simply lack any basis for taking sensible economic decisions: socialism was nothing other than the "abolition of rational economy".

How did Mises arrive at this conclusion? His argument involves (a) a statement of what economic rationality is all about, and (b) a supposedly exhaustive listing of possible means of rational economic decision-making; his task is then to show that none of these means can be implemented under socialism.

2.1 Rationality and optimality

As regards the nature of economic rationality, it is clear that Mises has in mind the problem of producing the maximum possible useful effect (satisfaction of wants) on the basis of a given set of economic resources. Alternatively, the problem may be stated in terms of its dual: how to choose the most efficient method of production in order to minimize the cost of producing a given useful effect. Mises repeatedly returns to the latter formulation in his critique of socialism, with the examples of building a railway or building a house:[3] how can the socialist planners calculate the least-cost method of achieving these objects? We can accept this formulation of the problem for present purposes, while noting that it is inescapably imprecise. What exactly is meant by the maximization of useful effect? Useful effect for whom, as defined by whom? The dual formulation does not escape this problem, since, if one is not to beg the question, the 'cost' that is to be minimized must be defined theoretically in terms of useful effect or want-satisfaction foregone.

If one wishes to argue that a given type of economic system, say S_1, solves *this general problem* more effectively than some other, S_2, then strictly speaking one is obliged to show that for S_1 there exists an attractor that is closer to the 'true optimum' than any corresponding attractor for S_2. One is therefore faced with the problem of producing a definition of the 'true optimum', and if this is to be defined in terms of maximal satisfaction of wants, one presumably has to construct some kind of social welfare or utility function, a notoriously difficult if not chimerical task, and one that Mises does not attempt. On the other hand, if one dismisses as unreal the notion of a 'true optimum'—an ultimate independent standard by which

[3]The railway example is in Mises (1935: 108). The house-building example is in *Human Action* (Mises, 1949: 694). It should be noted that the discussions of socialist calculation in both *Human Action* and *Socialism* (Mises, 1951) are essentially the same as in Mises (1935), with much of the material being repeated more or less verbatim in all the texts.

the results of certain concrete systems may be judged—then one must find a different basis for arguing in favour of one system over others. We find that Mises wavers on this point: he wants to argue that capitalism does get closer to optimality, while holding at arm's length the type of formal static general equilibrium theory which might be thought to support such a claim. We return to this point in section 2.4.

As regards the means for rational decision-making, Mises identifies three possible candidates: planning in kind (*in natura*), planning with the aid of an 'objectively recognizable unit of value' independent of market prices and money, such as labour time, and economic calculation based on market prices. Let us deal with these three possibilities in turn.

2.2 Planning in kind

The problem, let us grant for the present, is deciding how to deploy given resources so as to maximize the resulting useful effect. This involves some kind of 'judgment of value' (i.e. assessment of useful effect). In the case of final consumer goods (in Mises terminology, 'goods of a lower order') this is quite straightforward, and requires no real calculation as such: "As a rule, the man who knows his own mind is in a position to value goods of a lower order" (1935: 96). And in very simple economic systems, this immediate valuation may be extended to the means of production:

> It would not be difficult for a farmer in economic isolation to come by a distinction between the expansion of pasture-farming and the development of activity in the hunting field. In such a case the processes of production involved are relatively short and the expense and income entailed can be easily gauged (1935: 96).

Or again:

> Within the narrow confines of household economy, for instance, where the father can supervise the entire economic management, it is possible to determine the significance of changes in the processes of production, without such aids to the mind [as monetary calculation], and yet with more or less of accuracy (1935: 102).

In these cases we may speak of planning in kind, without the intermediary of some accounting-unit such as money (or labour time). The point is that 'apples and oranges' *can* be compared at the level of subjective use-value, and in cases where the connection between the allocation of means of production and the production of specific use-values is readily apparent, this may be sufficient for achieving efficiency.

The limits of such planning in kind are set by the degree of complexity of the production processes. At some point, it becomes impossible to achieve a synoptic appreciation of the relevant interconnections; beyond this point, rationality in the allocation of resources requires the use of some objective 'unit' in which costs and benefits may be expressed. Interestingly from our point of view, the impossibility of planning in kind for complex systems is explicitly argued in terms of the capabilities of the human mind:

> [T]he *mind of one man alone*—be it never so cunning, is too weak to grasp the importance of any single one among the countlessly many goods of a higher order. *No single man* can ever master all the possibilities of production, innumerable as they are, as to be in a position to make straightway evident judgments of value without the aid of some system of computation (1935: 102, emphasis added).

So might the employment of means other than human minds make possible planning in kind for complex systems? The main pro-planning argument in this paper involves the use of labour time as a unit of account (and hence does not fall in the category of pure planning in kind), but nonetheless we wish to suggest that

certain advances in artificial intelligence, in particular recent work on neural nets, may be relevant to this question.[4]

Mises is in effect arguing that optimization in complex systems necessarily involves arithmetic, in the form of the explicit maximization of a scalar objective function (profit under capitalism being the paradigmatic case). But arithmetical calculation can be seen as a particular instance of the more general phenomenon of computation or simulation. What a control system requires is the ability to compute, whether the control system in question be a set of firms operating in a market, a planning agency, an autopilot on an aircraft or a butterfly's nervous system; it is by no means necessary for the computation to proceed by arithmetical means. The important point is that the control system is able to model significant aspects of the system being controlled. Firms do this by means of stock control and accountancy, in which marks on paper model the location and movement of commodities. In preparing these marks the rules of arithmetic are followed; the applicability of arithmetic to the problem relies upon number theory being a model for the properties of commodities.

On the other hand, consider an example of a neural control system. A butterfly in flight has to control its thoracic muscles to direct its movement towards objects, fruit or flowers, that are likely to provide it with sources of energy. In so doing, it has to compute which of many possible wing movements are likely to bring it nearer to nectar. Different sequences of muscle movements have different costs in terms of energy consumption and bring different benefits in terms of nectar. The butterfly's nervous system has the task of optimizing with respect to these costs and benefits, using non-arithmetical methods of computation. The continued survival of the species is testimony to its computational proficiency. It appears that neural networks are capable of producing optimal (or at least highly efficient) behavior, even when faced with exceedingly complex constraints, *without* reducing the problem to the maximization (or minimization) of a scalar.

A planning agency is likely to make widespread use of arithmetic and indeed, if one wants to make localized decisions on the optimal use of resources by arithmetic means, then Mises' argument about the need to convert different products into some common denominator for purposes of calculation is quite correct. If, however, one wishes to perform global optimizations on the whole economy, other computational techniques, having much in common with the way nervous systems are thought to work, may be more appropriate, and these can in principle be performed without resort to arithmetic.

Of course it would be anachronistic to fault Mises for failing to take into account developments in computer science which took place long after he wrote. He and Hayek were doubtless correct to argue that the proposals for planning in kind offered in 1919 by the likes of Neurath and Bauer, on the basis of the experience of the war, were highly problematic in peacetime conditions.[5] But it is fair comment on contemporary critics of socialism, that they should not repeat uncritically pronouncements on planning in kind made prior to the scientific understanding of the nature of computation.[6]

[4]Recent results in the theory of neural nets, also known as parallel distributed processing, are presented in Rumelhart *et al.* (1986). A useful summary of the issues involved is given by Narayanan (1990). Donald Hebbs (1949) is commonly credited with the origination of this line of thought, but it could not be practically implemented at that time.

[5]See Hayek (1935: 30–31). Mises mentions Neurath on p. 108 of the same work. They refer to books by Neurath and Bauer (*Durch die Kriegswirtschaft zur Naturalwirtschaft* and *Der Weg zum Sozialismus* respectively, both published in 1919) which do not appear to be available in translation.

[6]Cockshott (1990) presents a specific proposal for the balancing of an economic plan in the presence of constraints in the form of stocks of specific means of production, drawing on the idea of 'simulated annealing' from the neural net literature. His proposal does in fact involve the use of arithmetic—essentially the minimization of a loss function in relation to a desired vector of final outputs—but it points the way to application of artificial intelligence techniques to the task of economic planning.

2.3 Use of labour values

Having rejected the possibility of planning in kind, Mises considers the possibility that the socialist planners might be able to make use of an 'objectively recognizable unit of value', i.e. some measurable property of goods, in performing their economic calculations. The only candidate Mises can see for such a unit is labour content, as in the theories of value of Ricardo and Marx.[7] Mises ends up rejecting labour as a value unit; he has two relevant arguments, each purporting to show that labour content cannot provide an adequate measure of the cost of production. These arguments concern the neglect of natural resource costs implicit in the use of labour values, and the inhomogeneity of labour. We shall deal with these two points here, leaving other arguments concerning the adequacy of labour values to section 4.2. First, though, it is worth making the general point that Mises' critique of labour values is very brief and sketchy. Two pages or so of substantive argument appear in Mises (1935) and are reproduced in Mises (1951). In *Human Action* (Mises, 1949) the topic is dismissed in two sentences. This doubtless reflects the fact that although Marx and Engels had laid great stress on planning as an allocation of labour time, this conception had been more or less abandoned by Western socialists by the time Mises was writing. We return to this point below.

2.3.1 The neglect of natural resource cost

Mises accepts that the Marxian concept of labour value does, in one sense, make allowance for the consumption of natural resources:

> On a first impression calculation in terms of labour also takes into consideration the natural non-human conditions of production. The law of diminishing returns is already allowed for in the concept of socially necessary average labour-time to the extent that its operation is due to the variety of the natural conditions of production. If the demand for a commodity increases and worse natural resources must be exploited, then the average socially necessary labour-time required for the production of a unit increases too (Mises, 1935: 113).

But he immediately argues that this is not enough. It is not rational that the 'material factors of production' should enter the calculation *only* insofar as they cost labour time to extract from nature. Mises gives an example of two commodities, P and Q, each of which requires a total of 10 hours of labour to produce. Both goods require some raw material, a, in their production, and a in turn requires one hour of labour per unit produced. Commodity P is produced with 8 hours of direct labour and two units of material a, while Q requires 9 hours direct labour and only one unit of a. In terms of labour calculation, the two commodities 'cost' the same, but Mises asserts that P must truly be more valuable than Q on account of the fact that it embodies more of the natural raw material.

At first sight this might appear a *non sequitur* (what if the material a is effectively inexhaustible?), but it becomes apparent in the conclusion to Mises' argument that he is talking of a material that is "only present in such quantities that it becomes an object of economizing" (1935: 114), i.e. a *non-reproducible* resource. Lavoie (1985: 69–70) emphasizes the point, arguing that "there is no direct way [labour-time] calculation can cope with non-reproducible natural conditions of production." Socialist planners "presumably would have to develop some kind of proxy for the value of nonreproducible resources in units of labour hours. It is difficult to imagine how this could be done in a way that would not be completely arbitrary."

We do not wish to deny there is a problem here. We do, however, find it rather remarkable that Mises (and his expositor, Lavoie) should talk as if the problem solves itself under capitalism. Neither offers any criticism of the classic Ricardian theory, according to which the market price system also fails to take into

[7] From a modern, formal-mathematical point of view the singling out of labour for such a role may seem arbitrary. Wouldn't any basic commodity, which enters either directly or indirectly into the production of all others, do just as well as the value basis? Farjoun and Machover (1983) provide a trenchant discussion of this point, and an effective defence of the choice of labour as basis.

account non-reproducible resources. For Ricardo, natural resource constraints manifest themselves in the price system via rising marginal cost of production, i.e. just the effect which Mises takes to be inadequate. For the intra-marginal output, price is indeed above labour value, but at the margin rent is zero and the exploitation of natural resources comes free. (There is a difference here: if labour value is defined as *average* socially necessary labour time, then the labour-value calculation will 'undervalue' certain products relative to Ricardian prices, but this could be overcome by evaluating the relevant products at their marginal labour content.)

In fact, matters are not infrequently worse under capitalism. The fact that a certain resource is ultimately exhaustible does not necessarily mean that it is subject to diminishing returns in the short run. In the westward expansion of American agriculture, for instance, the (geographically) marginal land was actually the most productive. In such cases the market provides no incentive whatever for resource conservation; the results were painfully evident in the Dust Bowl of the 1930s. We are not claiming that labour-time calculation would necessarily do better in cases where the market fails to conserve resources. We do contend, however, that socialist planners should be able to take more far-sighted decisions on resource conservation than profit-maximizing firms.[8] We cannot argue this point at length here; two observations will have to suffice.[9]

First, the planning authority could make it a principle that whenever it employs technologies that consume non-reproducible resources, it invests in research into the production of substitutes. The amount of such investment that should be undertaken cannot be decided by any simple algorithm (in market or planned systems), but once a decision is reached, the cost of the research could be 'charged' to the resource-consuming industries (i.e. the planners would pro-rate the labour time required in this endeavour across the products of these industries). Here is a non-arbitrary way of bringing resource considerations into the domain of labour-time accounting. But second, we should emphasize that we do not regard labour-time calculation as providing a mechanical decision procedure for all planning questions. A socialist society might open up democratic debate on specific technologies or projects with substantial environmental impacts, and might allow environmental considerations to override 'efficiency' measured in terms of labour-minimization. We have no problem with the idea that environmental considerations and labour-time accounting are not necessarily reducible to a scalar common denominator, and that the balancing of these considerations may require political judgment on which opinions can differ. Mises, to his credit, is also quite willing to admit that important environmental issues cannot be brought within the ambit of *monetary* calculation either—witness his discussion of the decision whether to build a waterworks which might destroy the natural beauty of a waterfall, which is designed to illustrate the general point that money "can never obtain as a measure of those value-determining elements which stand outside the domain of exchange transactions" (1935: 98–99). Whether the conservation of Mises' waterfall can better be trusted to a private landowner, voluntarily eschewing the maximization of profit, or to a National Parks Board, is a matter of judgment: we incline to the latter.

2.3.2 The inhomogeneity of labour

In Mises' words, "the second defect in calculation in terms of labour is the ignoring of the different qualities of labour" (1935: 114). Mises notes Marx's claim that skilled labour counts as a multiple of, and hence may

[8] It has recently become clear that the socialist regimes of Eastern Europe have a dismal record of environmental destruction, comparable to that of nineteenth century capitalism. It appears to us, however, that this had more to do with a lack of democratic accountability, and an historically specific emphasis on the rapid development of heavy industries at any cost, than with the nature of socialist calculation as such.

[9] The relationship between labour-time accounting and environmental/resource considerations is treated more fully in Cockshott and Cottrell (in press).

be reduced to, 'simple labour', but argues that there is no way to effect this reduction short of the comparison of the products of different labours in the process of market exchange. As he poses the problem:

> What must be conclusive in deciding the question whether reckoning in terms of labour is applicable or not, is whether it is or is not possible to bring different kinds of labour under a common denominator without the mediation of the economic subject's valuation of their products (*ibid.*).

Mises maintains that this is not possible. Wage differentials might appear to offer a solution, but the equalizing process in this case "is a result of market transactions and not its antecedent." Mises assumes that the socialist society will operate an egalitarian incomes policy, so that market-determined wage rates will not be available as a guide to calculation. The conclusion is then that "calculation in terms of labour would have to set up an arbitrary proportion for the substitution of complex by simple labour, which excludes its employment for purposes of economic administration" (1935: 115).

True, labour is not homogeneous, but there is no warrant for the claim that the reduction factor for complex labour has to be arbitrary under socialism. Skilled labour may be treated in the same way that Marx treats the means of production in *Capital*, namely as a produced input which 'transfers' embodied labour to its product over time. Given the labour time required to *produce* skills and a depreciation horizon for those skills, one may calculate an implied 'rate of transfer' of the labour time embodied in the skills. If we call this rate, for skill i, r_i, then labour of this type should be counted as a multiple $(1 + r_i)$ of simple labour, for the purpose of 'costing' its products. Of course the labour input required for the production of skills is likely to be a mixture of skilled and simple, which complicates the calculation of the skill multipliers. An iterative procedure is needed: first calculate the transfer rates as if all inputs were simple labour, then use those first-round transfer rates to re-evaluate the skilled labour inputs, on this basis recompute the transfer rates, and so on, until convergence is reached.[10]

Aside from the issue of skills which require labour for their production, we also recognize that not all workers of a given skill level accomplish the same work in an hour. In cases where it is possible to assess individual productivity with some degree of accuracy, labour of a given skill level might be graded into different productivity categories (say, above-average, average and below-average) and appropriate multipliers could be determined empirically for these grades. Workers might, for instance, be evaluated periodically (by themselves and their peers) and assigned a productivity grade. Unlike the case of skilled versus simple labour, the multipliers in this case might reasonably be used for determining differential rates of pay. Not every worker need be a *stakhanovite*; one might choose an easier pace of work while accepting a somewhat lower rate of pay.

To conclude this section, we find that Mises' two specific objections to the use of labour-time accounting are less than compelling. We should also note the marked asymmetry in Mises' treatments of market prices and labour-time calculation. When discussing market prices, he is quite willing to concede that "monetary calculation has its inconveniences and serious defects"—he even discusses some of these at length—yet he concludes that "for the practical purposes of life", such calculation "always suffices" (1935: 109). When discussing labour-time calculation, he draws attention to two defects, but instead of concluding that such calculation is then only approximately valid, or that there is a need for further thought on how the issues he raises might be dealt with in the context of labour-time accounting, he takes these defects as grounds for complete dismissal of the idea, and claims that the socialists therefore have no means of economic calculation whatever.

[10] This procedure is discussed at greater length in Cockshott and Cottrell (in press).

2.4 Use of market prices

In his discussion of market prices, Mises is concerned to establish two points: the adequacy of market prices as a means of rational calculation under capitalism, and their necessary unavailability under socialism. We shall take these points in turn.

It is clear that market prices *do* provide a basis for calculation under capitalism. By reference to prices, firms are able to decide on cost-minimizing technologies, and to decide between producing different products on the basis of their profitability. And we don't feel any need to dispute Mises' claim that the price system provides for a reasonably effective coordination of economic activities. Indeed, this was explicitly recognized, even emphasized, by Marx and Engels as we shall see in section 4.1 below; despite their critique of the 'anarchy' of the market, they saw the price mechanism as leading to an (imperfect, but better than arbitrary) adjustment of the supplies of commodities in line with demand, while enforcing convergence on production methods which require no more than the socially necessary labour time. Neither would we care to assert that the minimization of monetary cost of production or the maximization of profit have *nothing* to do with achieving efficiency in the satisfaction of human wants. But the two criteria are much less closely identified that Mises allows. Consider the following passage:

> Anyone who wishes to make calculations in regard to a complicated process of production will immediately notice whether he has worked more economically than others or not; if he finds, from reference to the exchange values obtaining in the market, that he will not be able to produce profitably, this shows that others understand how to make a better use of the higher-order goods in question (Mises, 1935: 97–8).

The person Mises refers to may 'immediately notice' whether he has worked more *profitably* than others or not, but the implicit assertion of identity between what is most profitable and what is most 'economical,' or simply 'better,' is unjustified.[11] Certainly, capitalists cannot make profits by producing something nobody wants, or producing with gratuitous technical inefficiency, but that is not enough to sustain Mises' claim. Is it not possible to reduce monetary cost of production by recklessly exploiting natural resources, cheap for the time being, yet ultimately exhaustible? If the production of luxury cars proves more profitable than simple housing, does that show that the cars represent a better use of resources? The list of questions could go on...

One point that socialists have typically urged, as undercutting the alleged identity of the pursuit of profit and the satisfaction of needs, concerns the inequality of incomes under capitalism. Mises' response to this argument is interesting; he claims that the very notion of a 'distribution of income' under capitalism is misleading, on the grounds that "incomes emerge as a result of market transactions which are indissolubly linked up with production" (1951: 151).[12] There is no question of 'first' producing output and then 'distributing' it. Only under socialism could we speak of a 'distribution of incomes', decided politically as a separate matter from the production plan. But to adopt Mises' position—that the allocation of purchasing-power under capitalism is an endogenous element in the productive system—is to admit that the production of commodities for profit is *not* governed by the 'maximal satisfaction of human wants', unless one tries to argue that human wants themselves are generated in miraculous correlation with money incomes.

It is not our intention here to produce yet another critique of capitalism, of which there are enough and more in the socialist literature. We merely wish to point out that Mises cannot have it both ways. If he is offering the realistic, hard-headed, dynamic defence of capitalism that Lavoie detects and applauds,

[11] This assertion is made quite explicitly in *Socialism*: "To direct production towards profit simply means to direct it to satisfy other people's demand... Between production for profit and production for needs there is no contrast" (Mises, 1951: 143).

[12] This is not dissimilar to Marx's view that the distribution of income is governed by the mode of production (specifically the distribution of the means of production—see for instance Marx, 1974: 348). In both cases, the argument gives rise to a dismissive attitude towards schemes for the radical redistribution of incomes under capitalism.

he cannot smuggle in the claim that profit-maximization equals maximization of the satisfaction of human needs. If this claim were sustainable—which we of course dispute—it could only be by reference to the full apparatus of general equilibrium theory plus social welfare function, an apparatus which Mises advisedly avoids. Rather, Mises will have to be satisfied with the claim that capitalism 'works quite well' in certain ways, to which socialists can of course respond that it works rather badly in other ways.

We then come to the unavailability of prices as a means of economic calculation under socialism. Mises accepts that there may be markets, and hence market prices, for consumer goods in a socialist economy, but the problem comes with the means of production. "Production-goods in a socialist commonwealth are exclusively communal; they are an inalienable property of the community, and thus *res extra commercium*," writes Mises (1935: 91). And "because no production-good will ever become the object of exchange, it will be impossible to determine its monetary value" (92). For Mises, meaningful prices are necessarily the outcome of genuine market transactions between independent property-owners. The key feature of price or exchange-value is that it "arises out of the interplay of the subjective valuations of all who take part in exchange" (97); only by virtue of this fact does exchange-value "furnish a control over the appropriate employment of goods" (*ibid.*). We tend to agree with Mises on this. There may be other means of 'controlling the appropriate employment of goods,' but we accept his concept of *price* as the terms on which property-owners are willing to part with or acquire commodities. Lange, however, believed that Mises was vulnerable on precisely this issue, and made it the point of entry for his attack.

3 The actual response: Oskar Lange and neoclassical socialism

"[T]he term 'price'," says Lange,[13] citing the authority of Wicksteed, "has two meanings. It may mean either price in the ordinary sense, i.e., the exchange ratio of two commodities on a market, or it may have the generalized meaning of 'terms on which alternatives are offered.' ... It is only prices in the generalized sense which are indispensable to solving the problem of allocation of resources" (1938: 59–60). Lange bases his defence of socialism on the idea that a socialist economy can operate a price system in the generalized sense, emulating in certain ways the working of a market system, yet without having actual markets in means of production. His position is quite well known and does not require lengthy exposition here; we seek only to outline its main points in order to draw a contrast with our own proposals, and to provide a context for the Austrian counter-arguments which may also have some relevance to the latter.

Lange starts from the principles of Walrasian general equilibrium, emphasizing the point that the equilibrium price vector of a competitive economy is determinate on condition that it balances the supply and demand for all commodities, while (a) agents treat prices as parametric and (b) they optimize in a definite manner with respect to those prices. Given (a) and (b), each price vector maps onto a definite pattern of excess demands/supplies for all commodities, and only one price vector maps onto the zero vector of excess demands.[14] There is no reason, he argues, why a socialist economy cannot exploit this principle. What we require is that the planning authority sets 'accounting prices' for all means of production, and issues certain instructions to the managers of enterprises: treat the accounting prices as parametric; choose that combination of the factors of production that minimizes average cost of production at the given prices; and fix output such that marginal cost equals price of output. At the same time the managers of whole industries should follow the latter rule "as a principle to guide them in deciding whether an industry ought to be expanded (by

[13] Variations on the Lange theme were offered by H. D. Dickinson (1933), Abba Lerner (1934) and E. F. M. Durbin (1936) among others. But these other contributions, while differing on points of detail, are sufficiently similar to the better-known proposals of Lange that they do not require separate examination here.

[14] While he is aware that problems of multiple solutions and instability of equilibrium can arise under certain conditions, Lange assumes that a unique and stable general equilibrium is the norm.

building new plants or enlarging old ones) or contracted" (*ibid.*: 76–77). Consumers and workers, meanwhile, make their demand and labour supply decisions respectively, based on the parametric prices and wage rates they face.

There is no guarantee, of course, that the decisions made in the face of any given vector of accounting prices will be mutually compatible. In case of incompatibility, the planning authority performs the role of the Walrasian 'auctioneer', raising the accounting prices of goods in excess demand, and lowering the prices of those in excess supply. This should lead, over a number of iterations, to socialist general equilibrium. There is no denying the ingenuity of this 'solution'. Neither is it difficult to see its tactical advantage: neoclassical economists inclined to accept the Walrasian theory as an adequate account of the working of capitalist economies will, it appears, be forced to accept the validity of Langean socialism, *mutatis mutandis*.

3.1 Some Austrian counter-arguments

Against this brief outline of Lange, let us examine some of the objections raised by his Austrian critics. We identify three main points: the claim that Lange's proposal compromises the basic premises of socialism, the static nature of Lange's theory, and the problem of incentives.

Mises (1949: 701–2) states that on the traditional definition, socialism necessarily involves "the entire elimination of the market and catallactic competition." The presumed superiority of socialism rested on the "unification and centralization" inherent in the notion of planning.

> It is therefore nothing short of a full acknowledgment of the correctness and irrefutability of the economists' analysis and devastating critique of the socialists' plans that the intellectual leaders of socialism are now busy designing schemes ... in which the market, market prices for the factors of production, and catallactic competition are to be preserved.

Although Lange is not mentioned by name, it seems clear that schemes such as his are the target here. While we accept that much of the subsequent 'market socialist' literature *does* compromise socialism, several points might be made in defence of Lange. First, he stresses that in his system the distribution of income is under social control, and will be quite different from capitalism. Second, Lange argues that the socialist planners will take into account external costs and benefits which are ignored by private firms (though he does not say exactly how). Third, while his system emulates in certain ways a *competitive* economy, he points out that in *actual* capitalism "oligopoly and monopoly prevail" (1938: 107), leading to an inferior allocation of resources. Fourth, in his Appendix on the Marxist literature, Lange maintains that the classical socialist proposal of 'free sharing' of goods (Marx's 'to each according to his needs') "is by no means such economic nonsense as might appear at a first glance" (139). In a technically-advanced economy, the saturation point may be reached for certain goods (i.e. the point where the price is so low that demand becomes 'quite inelastic'). Lange speaks of a 'socialized sector' of consumption; initially this sector includes primarily 'collective wants', but he goes on: "It is quite conceivable that as wealth increases this sector increases, too, and an increasing number of commodities are distributed by free sharing until, finally, all the prime necessaries of life are provided for in this way, the distribution by the price system being confined to better qualities and luxuries" (141). Finally, we might make reference to Lange's (1967) essay in which he revisits his arguments of thirty years earlier. Here he situates his original market-like proposals as essentially means of solving a system of simultaneous equations (those of general equilibrium). Now that electronic computers are available, he says, why not solve the equations directly? "The market process with its cumbersome *tâtonnements* appears old-fashioned. Indeed, it may be considered as a computing device of the pre-electronic age" (1967: 158). In this light it may be more appropriate to label Lange's ideas as 'neoclassical socialism' rather than 'market socialism': it is clear that he thought of the market—even his artificial market of 1938—as merely one possible means of achieving a certain kind of optimization.

A second objection to Lange made by the Austrians concerns the static nature of his solution. Lavoie (1985, chapter 4) maintains that Lange answered a question which Mises regarded as trivial, while totally failing to engage with the difficult question of dynamics. Now there is no doubt that Lange employs a static equilibrium theory, but his method is at least *comparative* statics, and he does specify an adjustment mechanism which will supposedly converge on general equilibrium following any parametric change. When Mises denied that economic calculation was a problem under static conditions, on the other hand, he had in mind true *stasis*, where "the same events in economic life are ever recurring" (1935: 109). Whatever problems the Langean system may have, one may hardly claim that Mises refuted him in advance.

The more substantial point raised by Mises and Hayek, and later emphasized by Lavoie, involves the speed of adjustment following parametric changes. Hayek, for instance, noting that in the real world "constant change is the rule," states that "whether and how far anything approaching the desirable equilibrium is ever reached depends entirely on the speed with which the adjustments can be made" (1949: 188). Hayek goes on to argue that centrally-dictated prices cannot respond to change as flexibly as true market prices. The importance of this point goes beyond the assessment of Lange's particular argument. More generally, if the calculations required for socialist planning take too long, in relation to the pace of changes in consumer demand and technology, then planning is in trouble. We shall argue in section 4.2 that with present computing technology the relevant calculations can be carried out fast enough.

Perhaps we should pause on this question a moment longer. The charge that the 'static' nature of Lange's system robs it of any purchase on reality is the centrepiece of Lavoie's revival of the Austrian case, and although the positive proposals we present below are substantially different from Lange's they may be thought to be vulnerable to the same criticism. We don't wish to be accused of missing the point once again. Particularly relevant to our ideas is the claim of Mises and Hayek that the socialist planners cannot, outside of a static economy, have the full and up-to-date information on production possibilities which they need. To the extent that such claims are based on the limitations of communications and data-storage facilities, they are now simply out of date, but is there a further basis? Lavoie suggests that the problem lies not so much in data-*collection*, as in the *creation* of relevant data. True, if technology and consumer demand are changing over time, the best way of accomplishing any given end is not always (or even generally) known in advance. Experimentation is needed. To the extent that capitalist entrepreneurs carry out such experimentation, they perform an important social function. But the idea that only capitalist entrepreneurs are capable of performing this function seems to us baseless.[15] A socialist economy could set up an 'innovation budget', whereby an agreed fraction of social labour time is devoted to just such experimentation with new processes and products. Existing enterprises or groups of people with new ideas could apply for a share of this budget. The disposition of the budget might be divided between two or more parallel agencies, so that prospective innovators have more than one chance to have their ideas funded (hence lessening the risk of 'ossification' of the process). As the results of such experimentation come in, successful new products could be incorporated into the regular plan, and successful technologies 'registered' as an element of the regular input–output structure of the economy.[16]

The third objection concerns incentives, in connection with the social function of the capitalists. Lange has his socialist managers following certain rules in order to achieve an optimal allocation of resources. Mises responds that while it might seem reasonable to draw a parallel between such socialist managers and the salaried managers of a capitalist joint-stock company, the whole argument overlooks the vital role of the *capitalists* themselves, which cannot be emulated by salaried functionaries. The dynamic adjustment of a

[15]The valid point that a dynamic economy must be constantly in search of new methods and products, and hence 'production function' information is not given once and for all, tends to shade over, in Mises and Hayek, into what one might call a 'mysticism of the entrepreneur'—a radical subjectivism for which we can see no scientific justification.

[16]We are not quite ready yet to define 'success' in this context, but we shall do so in section 4.2.2 below.

capitalist economy requires

> that capital should be withdrawn from particular lines of production, from particular undertakings and concerns and should be applied in other lines of production.... This is not a matter for the managers of joint stock companies, it is essentially a matter for the capitalists—the capitalists who buy and sell stocks and shares, who make loans and recover them, ... who speculate in all kinds of commodities (Mises, 1951: 139).

Furthermore, Mises argues, "no socialist would dispute that the function which capitalists and speculators perform under Capitalism ... is only performed because they are under the incentive to preserve their property and to make profits which increase it or at least allow them to live without diminishing their capital" (*ibid.*: 141). Maybe so, but the import of the argument here is not entirely clear. At one level, Mises is arguing against market socialism, claiming that the *market* system cannot work without capitalists. This may well be true, but as we have already remarked, 'market socialism' may not be an accurate label for Lange's system. Then again, he may be saying that major investment decisions, decisions to wind up or consolidate enterprises and so on, cannot be reduced to following simple rules. This is also true, and perhaps does cut against Lange. If, however, Mises is claiming that such decisions may be made conscientiously, with due attention to risk but without excessive conservatism, *only* by individuals motivated by the prospect of great personal wealth (in case of success) or personal financial ruin (in case of failure), then we flatly disagree.

We do not have space to expand here on the institutions required for the planning of major investments and structural economic change under socialism; a brief comment must suffice. We agree with Mises that this function will not be entrusted to pseudo-capitalists; it must involve a combination of expert opinion and democratic methods.[17] We can expect that the 'experts' who are called upon to exercise their judgment in such matters will gain in prestige and garner the admiration of their peers if successful, and will be demoted and lose influence if unsuccessful. It is important that there should be a climate of open debate and accountability, but not that the winners should amass great fortunes and the losers be cast into penury. (No more, one might say, than the prospect of great personal wealth was required to induce Mises and Hayek to put forth their best efforts in the intellectual defence of capitalism!) One further point should be stressed here: the other side of the coin of successful innovation is that the planners must have the right to close down uneconomic enterprises. While guaranteed employment is of course a basic socialist principle, there can therefore be no guarantee of permanent employment in any particular industry or trade. David Granick (1987) has argued that *de facto* job rights of this sort were a major brake on the development of the Soviet economy, and Kornai's analysis of 'soft budget constraints' points in the same direction. As for the criterion for assessing whether a given enterprise is 'uneconomic', we return to this point in section 4.2.2 below.

3.2 Further objections and conclusion

In the preceding section we concentrated on those Austrian objections to Lange with which we disagree. Some points made by the Austrians, however, are quite close to those we wish to make: we share their scepticism over Walrasian theory, both as an account of capitalism and as a guide to socialist planning.

There is a crucial ambiguity in Lange's notion of a socialist *tâtonnement*. In 1938, this appeared to be a process which takes place in real, historical time; in 1967 he suggests that it could take place in 'less than a second' on a computer. Either way, there are severe problems. The problem with the historical time version is pointed out by Lavoie (1985: 97–8), in his discussion of trading at 'false prices'. Unless the economy is held in continuous general equilibrium, there will always be inconsistencies among the optimal plans of dispersed economic agents. A real market system can live with such inconsistencies (it has the rule that

[17] Democratic methods may enter indirectly, in the selection of the personnel entrusted with these decisions, or in some cases directly, as rival programs put forward by teams of experts are put to a popular vote.

commodities go to those willing to pay the most), but there is a danger that they might reduce a socialist economy to incoherence. What actually happens in a Langean economy in the face of excess 'demands' (*requests* might be a better term, as there is no real market) for specific means of production? How is the planning authority supposed to avoid cascading disruptions to supply? It would seem that the production of a balanced, coherent plan (never mind *optimality*) must await the termination of the 'trial and error' process.

Here we touch on a more general problem for planning—an issue on which Mises, ironically, is willing to concede too much to socialism. For all his denials of the possibility of rational calculation under socialism (in the sense of finding the most effective means for achieving given aims), Mises does not question the ability of the planners to plan:

> It is true that production would no longer be 'anarchical.' The command of a supreme authority would govern the business of supply. Instead of the economy of 'anarchical' production the senseless order of an irrational machine would be supreme (Mises, 1951: 120).

More recent critics of the Soviet economy have taken a very different view. Nove (1977), for instance, lays great stress on the difficulty of constructing a balanced plan: the planners did not (and he says, could not) have the means to calculate the required output of intermediate goods in full detail, in order to support any given targets for final outputs (see also Ellman, 1971). As a result the plan was always ill-formulated: instructions to enterprises were excessively aggregated, specific supplies and demands failed to match, and a good deal of informal barter and 'fixing' (socialist 'anarchy', so to speak) was required to achieve even a rough approximation to balance. We disagree with Nove's view that such problems are inescapable (see section 4.2 below), but in order to avoid them there must be a means of ensuring plan-consistency even as the economy iterates towards optimality, and we don't see this in the historical-time version of Lange's system.

What then of the computer-time version? On this interpretation the rounds of the *tâtonnement* are simply successive approximations, permitting no new external information input at each step, so that all the relevant information must be assembled in advance. Here Mises has a valid objection. Lange's system involves delivering an optimal vector of consumer goods outputs (in the historical-time version, the responses of consumers to the prices of these goods were part of the 'trial and error'), but surely it is unrealistic to suppose that the planners could have a complete specification of consumer demand functions. As Mises says,

> for a utilization of the equations describing the state of equilibrium, a knowledge of the gradation of the values of consumers' goods in this state of equilibrium is required. This gradation is one of the elements of these equations assumed to be known. Yet the director knows only his present valuations, not also his valuations under the hypothetical state of equilibrium (1949: 707).[18]

Certain important calculations *can* now be done in computer time, but we agree with Mises that *ex ante* solution for Walrasian general equilibrium is not feasible.

A final comment on Lange will serve to lead into our presentation of the 'absent response' to Mises. In an Appendix to his 1938 paper, Lange considers 'The Allocation of Resources Under Socialism in Marxist Literature'. Against Mises, he argues that it is "very much exaggerated to say that the Marxian socialists did not see the problem and offered no solution" (141). On the other hand he agrees with Mises that labour values cannot provide an adequate basis for socialist planning: "The truth is that [the Marxians] saw and solved the problem only within the limits of the labour theory of value, being thus subject to all the limitations of the classical theory." In addition, Lange cites Kautsky on the impossibility of calculating the labour content of commodities (of which more below). We disagree, and hold that labour values provide a more robust foundation for planning than Lange's neoclassical conceptions.

[18] 'The director' is Mises' idiosyncratic personification of the planning authority.

4 The absent response: a calculus of labour time

As we have noted, the classical Marxian conception of planning in terms of labour time was effectively abandoned by western socialists in the period of the calculation debate, if not before. Two issues arise in relation to labour values: the economic rationality of using labour time as a basic metric in socialist planning, and the technical feasibility of so doing. We wish to reopen the argument on both of these points. We contend that the alleged irrationality of labour time as a basis for calculation was never properly established, and indeed that this conception can be sustained only by reference to an unreal standard of perfect rationality which has little to do with actual market economies. We also argue that calculation in terms of labour time is now feasible (although admittedly it was not at the time of the original debate). Before presenting our own arguments to this effect it will be useful to 'excavate' the classical Marxian arguments which had been forgotten or rejected by the 1920s, as these form the starting point of our thinking on the matter. Lest we be misunderstood, however, we should stress that our own proposal for labour-time accounting is not made out of deference to Marx. Rather, we happen to agree—subject to the qualifications registered in section 2.2 above—with Mises's claims (in the epigraph to this essay) that socialist planning requires an 'objective unit of value', and that labour time is the only serious candidate for such a unit. The precise mode of employment we propose for the calculus of labour values will be spelled out in section 4.2.2 below.

4.1 Labour-time calculation in classical Marxism

Among the writings of Marx and Engels, there are two kinds of arguments relevant to our theme. First, there are arguments relating to the planning of *production* with reference to socially necessary labour time and second, arguments relating to the *distribution* of consumer goods in accordance with the labour contribution made by individual workers. We shall examine these in turn.

4.1.1 The proportional distribution of social labour and the planning of production

Of course most of the discussion of the labour theory of value in *Capital* is oriented towards the nature and dynamics of capitalism (theory of capitalist exploitation, theory of the tendency for the rate of profit to fall, and so on). But there are several passages which elaborate a more general conception of the proportional distribution of labour time as a basic necessity facing any form of economy, and which put the labour theory of value into context as the specific 'form of manifestation' of this necessity under the conditions of capitalism. Such passages are scattered, but if we collect them together they reveal a substantial 'vision' of the economy as a system of allocation of labour time to different productive purposes—a vision which is as relevant to the organization of a socialist economy as it is to any other system.

Perhaps the most striking statement of this general view is contained in Marx's letter to Kugelmann of 11 July 1868:

> Every child knows that any nation that stopped working, not for a year, but let us say, just for a few weeks, would perish. And every child knows, too, that the amounts of products corresponding to the differing amounts of needs demand differing and quantitatively determined amounts of society's aggregate labour. It is self-evident that this necessity of the distribution of social labour in specific proportions is certainly not abolished by the specific form of social production; it can only change its form of manifestation. (Marx and Engels, 1988: 68, original emphasis removed)

This view is amplified in various passages from Volume III of *Capital*. For instance:

> For a commodity to be sold at its market-value, i.e. proportionally to the necessary social labour contained in it, the total quantity of social labour used in producing the total mass of this commodity must correspond to the quantity of the social want for it, i.e. the effective social want (Marx, 1972: 192).

A passage from p. 636 of the same work similarly expands on the law of value as it applies to "each total product of the particular social spheres of production made independent by the division of labour": what is required is that

> not only is no more than the necessary labour-time used up for each specific commodity, but only the necessary proportional quantity of the total social labour-time is used up in the various groups. For the condition remains that the commodity represents use-value. But if the use-value of individual commodities depends on whether they satisfy a particular need then the use-value of the mass of the social product depends on whether it satisfies the quantitatively definite social need for each particular kind of product in an adequate manner, and whether the labour is therefore proportionately distributed among the different spheres in keeping with these social needs, which are quantitatively circumscribed.

Our final citation in this vein is from Volume 1 of *Capital* (Marx, 1976: 169 ff.). Marx begins with a Crusoe story, pointing out that "Nature itself compels [Robinson] to divide his time with precision between his different functions. Whether one function occupies a greater space in his total activity than another depends on the magnitude of the difficulties to be overcome in attaining the useful effect aimed at." After discussing the counterpart to the Robinsonian calculations in feudal and primitive societies, Marx comes to the case of socialism.

> Let us finally imagine, for a change, an association of free men, working with the means of production held in common, and expending their many different forms of labour-power in full self-awareness as one single labour force. All the characteristics of Robinson's labour are repeated here, but with the difference that they are social instead of individual. ... The total product of our imagined association is a social product. One part of this product serves as fresh means of production and remains social. But another part is consumed by the members of the association as means of subsistence.

In such a socialized economy, the (direct) apportionment of labour time "maintains the correct proportion between the different functions of labour and the various needs of the associations," and here "the social relations of the individual producers, both towards their labour and the products of their labour, are ... transparent in their simplicity."[19]

These themes are also to be found in the well known text on planning from *Anti-Duhring* (Engels, 1954: 429–30). Engels states that under socialism, "when society enters into possession of the means of production and uses them in direct association for production, the labour of each individual, however varied its specifically useful character may be, becomes at the start and directly social labour." Then it is no longer necessary to express the labour-content of goods in the 'roundabout' form of their *exchange-value*. Rather, "society can simply calculate how many hours of labour are contained in a steam-engine, a bushel of wheat of the last harvest, or a hundred square yards of cloth of a certain quality." Using this knowledge, "the useful effects of the various articles of consumption, compared with one another and with the quantities of labour required for their production, will in the end determine the plan. People will be able to manage everything very simply, without the intervention of much-vaunted 'value'."[20]

The other type of argument with direct relevance to the use of labour-time calculation in the planning of production is that given in chapter 15 of *Capital*, I (Marx, 1976: 515–7).

[19] It is interesting that even socialist commentators feel obliged to distance themselves from this kind of statement. Robin Blackburn (1991), for instance, maintains that in this text Marx is "at least half-playful", and dubs the conception of central planning which it appears to suggest "the synoptic fallacy".

[20] Nowadays, of course, this passage is commonly quoted only to show Engels's "myopia and economic illiteracy" (as in Ramsay Steele, 1981: 12). True, Engels was too sanguine (as was Marx) concerning the 'simplicity' of measuring the labour content of goods, and he does not venture any specifics on how 'useful effects' are to be compared, but if such statements are taken as a *starting point* for elaboration of a socialist argument they are quite reasonable, as we shall show below.

> The use of machinery for the exclusive purpose of cheapening the product is limited by the requirement that less labour must be expended in producing the machinery than is displaced by the employment of that machinery. For the capitalist, however, there is a further limit on its use. Instead of paying for the labour, he pays only the value of the labour-power employed; the limit to his using a machine is therefore fixed by the difference between the value of the machine and the value of the labour-power replaced by it.

In Marx's theory, of course, the value of a worker's labour-power over any given period, as determined by the labour content of the necessary means of subsistence, is less than the actual labour performed in that period (the difference constituting surplus value). So Marx argues that the capitalists necessarily fail to economize on labour to the fullest extent. The passage cited above is followed by various examples of, as Marx puts it, "the shameless squandering of human labour-power", which is at its worst when wages are lowest, and the divergence between economy of labour and economy of money cost therefore greatest. A footnote draws the inference that "the field of application of machinery would therefore be entirely different in a communist society from what it is in bourgeois society." Implicitly, the communist society will make rigorous use of the principle of economizing labour time in its planning decisions, and this constitutes part of its superiority over capitalism.

Hence we see a dual role for a labour-time calculus in the classical Marxian approach to the planning of production. First, the basic economic task of the socialist 'association' is conceived in terms of an allocation of social labour in accordance with the proportional production of the use-values obtained from the various branches of the division of labour. This proportionality is to be achieved *directly*, as opposed to the indirect mechanism of the 'law of value' under capitalism. This requires, among other things, the measurement of the labour required to produce specific goods and services. Second, one general objective of socialist planning must be the economization of labour time—the progressive reduction of the labour necessary for the production of specific use-values, or in other words the progressive augmentation of the quantum of use-value which can be produced with any given expenditure of social labour.

4.1.2 Critiques of 'labour money' and the Critique of the Gotha Programme

Before examining Marx's positive proposals regarding the role of labour time in the *distribution* of consumer goods under socialism, we briefly consider the Marxian critique of 'labour money' schemes; for there may appear to be a tension between the latter critique and Marx's own proposals. Indeed, the 'critique of labour money' is open to a (mis)reading which takes it as critical of any attempt to *depart from* the market system, towards a direct calculus of labour time. As we shall see, it appears that this reading has been made by writers as far apart as Karl Kautsky and Terence Hutchison.

The basic object of Marx and Engels's critique might be described as a 'naïve socialist' appropriation of the Ricardian theory of value. If only, the reformers argue, we could impose the condition that all commodities really exchange according to the labour embodied in them, then surely exploitation would be ruled out. Hence the schemes, from John Gray in England, through a long list of English 'Ricardian socialists', to Proudhon in France, to Rodbertus in Germany, for enforcing exchange in accordance with labour values.[21] From the standpoint of Marx and Engels, such schemes, however honourable the intentions of their propagators, represent a Utopian and indeed reactionary attempt to turn back the clock to a world of 'simple commodity production' and exchange between independent producers owning their own means of production. The labour-money utopians fail to recognize two vital points. First, capitalist exploitation occurs though the exchange of commodities in accordance with their labour values (with the value of the special

[21] Marx criticizes Proudhon's scheme in his *Poverty of Philosophy* ([1847] 1963), and deals with John Gray in his 1859 *Contribution to the Critique of Political Economy* (the relevant section of which is reprinted as an Appendix to Marx, 1963), while Engels tackles Rodbertus's variant in his 1884 Preface to the first German edition of *The Poverty of Philosophy* (again, in Marx, 1963). Between Marx in 1847 and Engels in 1884 we find a consistent line of attack on such proposals.

commodity labour-power determined by the labour content of the workers' means of subsistence). Second, although labour content governs the *long-run equilibrium* exchange ratios of commodities under capitalism, the mechanism whereby production is continually adjusted in line with changing demand, and in the light of changing technologies, under the market system, relies on the *divergence* of market prices from their long-run equilibrium values. Such divergences generate differential rates of profit, which in turn guide capital into branches of production where supply is inadequate, and push capital out of branches where supply is excessive, in the classic Smith/Ricardo manner. If such divergence is ruled out by fiat, and the signalling mechanism of market prices is hence disabled, there will be chaos, with shortages and surpluses of specific commodities arising everywhere.[22]

One point which emerges repeatedly in the Marxian critique is this: according to the labour theory of value, it is *socially necessary* labour time which governs equilibrium prices, and not just 'raw' labour content (Marx, 1963: 20–21, 66, 204–5). But in commodity-producing society, what is socially necessary labour emerges only through market competition. Labour is first of all 'private' (carried out in independent workshops and enterprises), and it is validated or constituted as social only through commodity exchange. The social necessity of labour has two dimensions. First of all, we are referred to the technical conditions of production and the physical productivity of labour. Inefficient or lazy producers, or those using outmoded technology, will fail to realize a market price in line with their actual labour input, but only with the lesser amount which is defined as 'necessary' (with respect to either average productivity or best-practice technique—Marx is not always consistent on precisely which). Secondly, as the passages quoted from *Capital* III above testify, there is a sense in which the social necessity of labour is relative to the prevailing structure of demand. If a certain commodity is over-produced relative to demand, it will fail to realize a price in line with its labour value—even if it is produced with average or better technical efficiency. The proponents of labour money want to short-circuit this process, to act as if all labour were *immediately* social. The effects within commodity-producing society cannot but be disastrous.

Now the lessons which Marx and Engels read to the labour-money socialists, concerning the beauties of the supply/demand mechanism under capitalism and the foolishness of the arbitrary fixing of prices in line with actual labour content, are obviously rather pleasing to the critics of socialism. Terence Hutchison (1981: 14–16), for instance, lauds Engels for his recognition of "the essential role of the competitive market mechanism" as displayed in his critique of Rodbertus. "Mises and Hayek," writes Hutchison, "could hardly have made the point more forcefully." But as Hutchison's praise is merely a preface to his denunciation of Engels for failing to realize that the very same critique cuts the ground from under his and Marx's own proposals for socialist planning, we must be careful to define the limits of the Marxian critique of labour money. Of greater importance for the history of the debate, it appears that Kautsky also read the critique of labour money as casting doubt on the Marxian objective of direct calculation in terms of labour content, so that by the 1920s the figure widely regarded as the authoritative guardian of the Marxian legacy in the West had effectively abandoned this central tenet of classical Marxism.[23] Against this background, one can appreciate why Mises was able to get away with a brief and rather offhand dismissal of planning by means of labour values.

From the account of the critique of labour money we have given above, the limits of that critique should

[22] Direct quotation is hardly necessary to establish these points. See for instance Marx (1963: 17–20, 60–61, 66–9, 203–6).

[23] In his book *The Social Revolution* (1902: 129–33), Kautsky offers a brief and rather ambiguous discussion of the 'law of value' and socialism, which combines statements of the classical Marxian theses with strangely incongruous comments on the 'indispensability' of money. In his later work, *The Labour Revolution* (1925: 261–70) the formulations of Marx and Engels are dropped in favour of a general argument for the necessity of money and prices. This argument appears to owe something to the 'critique of labour money' discussed above; it also draws on the idea that the measurement of labour content is impracticable—it "could not be achieved by the most complicated State machinery imaginable" (267). Incidentally, Kautsky (1925) is highly critical of Neurath's 'planning in kind' on very much the same grounds as Mises and Hayek.

be apparent. What Marx and Engels are rejecting is the notion of fixing prices according to actual labour content *in the context of a commodity-producing economy* where production is private. In an economy where the means of production are under communal control, on the other hand, labour *does* become 'directly social', in the sense that it is subordinated to a pre-established central plan. Here the calculation of the labour content of goods is an important element in the planning process. And here the reshuffling of resources in line with changing social needs and priorities does not proceed via the response of profit-seeking firms to divergences between market prices and long-run equilibrium values, so the critique of labour money is simply irrelevant. This is the context for Marx's suggestion for the distribution of consumer goods through 'labour certificates'.

This suggestion appears in its fullest form among Marx's critical comments on the Gotha Programme of the German Social Democratic Workers' Party of 1875 (Marx, 1974: 343–8). First, against the claim that each worker should receive 'the undiminished proceeds of labour', Marx points out that a socialist society must allocate a substantial part of the total product to cover depreciation, accumulation of means of production, social insurance, administration, the communal satisfaction of needs (schools, health services, etc.), and for the needs of those unable to work. Nonetheless, this leaves a portion of the total product for distribution as means of personal consumption. As to the nature of this distribution, Marx talks of two stages in the development of communism. At some future point, when 'all the springs of cooperative wealth flow more abundantly' it will become possible to 'cross the narrow horizon of bourgeois right' and institute the famous principle of 'from each according to his abilities, to each according to his needs,' but in the first stage of communism Marx envisages a situation in which the individual gets back—after the deductions noted above—what he has given to society.

> What he has given it is his individual quantum of labour. For instance, the social working day consists of the sum of the individual hours of work. The individual labour time of the individual producer thus constitutes his contribution to the social working day, his share of it. Society gives him a certificate stating that he has done such and such an amount of work (after the labour done for the communal fund has been deducted), and with this certificate he can withdraw from the social supply of means of consumption as much as costs an equivalent amount of labour (346).

The labour certificates Marx talks of here are quite different from money. They do not circulate, rather they are cancelled against the acquisition of consumer goods of equivalent labour content. And they may be used for consumer goods alone; they cannot purchase means of production or labour power, and hence cannot function as capital.

The *logic* of the Marxian position is clear: 'labour money' in a commodity-producing society is a utopian and economically illiterate notion, but the allocation of consumer goods via labour certificates under socialism is quite a different matter; it is one possible mode of distribution of (a certain portion of) the social product in a system where the mode of production has itself been changed through the socialization of the means of production and the institution of planning. Whether this conception is *persuasive*, however, depends on whether it is possible to elaborate convincingly the notion of the planned mode of production. We now turn to this task.

4.2 Socialist planning and labour time: some new proposals

Let us begin with the relatively easy issue. It is clearly a precondition for implementing the conceptions of planning discussed above, that it should be possible to measure the required labour content of the goods to be produced in the socialist economy. Despite Marx and Engels's statements on the 'simplicity' of this task, Marxists from Kautsky to Charles Bettelheim have been sceptical, while critics of central planning have

readily assumed that the job cannot be done.[24] If the sceptics are right, the rest of our argument falls, so it is important to establish at the outset that labour-calculation is feasible.

4.2.1 The technical feasibility of labour-time calculation

If we assume, as a first approximation, that the conditions of production may be represented as a linear input–output system, then the problem of calculating labour values[25] for all the goods in the system appears as the task of computing the inverse Leontief matrix. The labour value of good i is given by the equation:

$$v_i = \lambda_i + a_{i1}v_1 + a_{i2}v_2 + \cdots + a_{in}v_n$$

where v_i is the value of good i, λ_i is the direct labour required to produce one unit of good i, and a_{ij} is the technical coefficient representing the input of product j required to produce one unit of good i. The complete vector of labour values is therefore given by:

$$V = \Lambda + AV,$$

where V denotes the $(n \times 1)$ vector of labour values, Λ denotes the $(n \times 1)$ vector of direct labour coefficients, and A denotes the $(n \times n)$ matrix of technical coefficients. It then follows that

$$V = (I - A)^{-1}\Lambda,$$

where I is the $(n \times n)$ identity matrix. So the values vector may be obtained, given knowledge of A and Λ, provided we are able to generate the inverse Leontief matrix,

$$(I - A)^{-1}.$$

So far as brute computational complexity goes, this is the hard nut to crack in socialist planning. But notice that if it *can* be cracked, it opens up further possibilities: besides giving the labour values of all goods,[26] this is just what is needed to calculate the vector of gross outputs of all products which is required to support any given vector of desired final outputs, for consumption and accumulation of means of production. In other words, this is what we need to produce a coherent, balanced plan.

The standard *analytical* method for matrix inversion is Gaussian elimination. This procedure has a time-order (in the sense of complexity theory) of n^3, where n is the number of products in the system (Sedgewick, 1983). Now if the matrix in question is to be usable for actual planning purposes, as opposed to a purely theoretical exercise, it must represent the economy in full detail. It has been estimated that in the Soviet economy, for instance, the number of separately identifiable products is of the order of 10 million (Nove, 1983: 33). If $n = 10^7$, the time order of Gaussian elimination is then 10^{21}. This figure represents the approximate number of elementary calculations to be performed. Suppose that each calculation requires 10 computer instructions. We then have 10^{22} instructions to carry out. On a commercially available super-computer of mid-1980s vintage, with a speed of around 200 million (2×10^8) instructions per second (Lubeck

[24] Kautsky's views have been alluded to above. Bettelheim's sceptical comments—cited approvingly by Nove (1983: 27–8)—are to be found in his *Calcul économique et formes de propriété* (1971: 30).

[25] We have noted that Marx and Engels do not speak of 'values' under socialism. While their point that labour content does not assume the form of *exchange value* in a socialist economy is well taken, we nonetheless find it useful to employ the term 'labour value', or simply 'value', as a shorthand for the sum of direct plus indirect labour content.

[26] This is not quite accurate, insofar as it ignores the problem of joint production. Where two goods are produced jointly and in a fixed ratio from the one production process, the individual labour values of the goods will be undefined. It turns out, however, that given the particular use which we propose for labour values within the planning process (see section 4.2.2), the issue of joint production can be dealt with quite readily, as shown in the Appendix to this paper.

et al., 1985), the calculation as a whole would take something like 5×10^{13} seconds, or about 1.5 million years. Perhaps this is what Nove (1983) has in mind when he asserts that such calculations are completely impossible.

If brute-force analytical inversion of a $10^7 \times 10^7$ matrix is out of the question, that is not, however, the end of the story. First, as is widely recognized, there are iterative approximation methods which are substantially more efficient (the Gauss–Seidel and Jacobi methods—see Varga, 1962). Here the time-order is n^2r, where r is the number of iterations required to produce a satisfactory approximation. With $r = 20$, repetition of the above calculations gives a running time of 10^8 seconds, or about 3 years. While this now looks closer to feasibility, it is still clearly much too slow to be of practical use.[27] The remaining step, however, is to recognize that the matrix of technical coefficients is likely to be very *sparse*, when specified in such detail. There may be 10 million products in the system, but the average number of direct inputs for each product will surely be very much smaller—perhaps in the tens or hundreds. This fact can be exploited by representing the input–output system in the form of a *linked-list* data-structure (Sedgewick, 1983) rather than in matrix form. In that case the time-order of the iterative solution procedure reduces to nmr, where m is the average number of direct inputs for each product. Under the same assumptions as above, but setting $m = 100$, we arrive at a running time of around 10^3 seconds, or 17 minutes.[28] Given a careful choice of data-structures and algorithms, it would appear that the timely production of the inverse Leontief matrix, for a system specified in full detail, is well within the capacity of present-day computational technology.

Admittedly, the above argument says nothing about the task of *gathering* the vast amount of data required to implement such a calculation—an issue of which Mises and Hayek make a great deal. We do not have space to address this issue here, but we have argued elsewhere (Cockshott and Cottrell, 1989, Appendix) that this should also be feasible, using an economy-wide network of cheap personal computers, running spreadsheets representing the conditions of production in each enterprise, in conjunction with a national Teletext system and a system of universal product codes.

One further relevant point should be mentioned here. Our argument for the technical feasibility of labour-time calculation clearly depends on both computer hardware and algorithms of fairly recent origin. It follows that those (both socialists and critics of socialism) who were arguing in the first half of the twentieth century that such calculation was impracticable, were probably quite correct at the time. It is interesting to note that in the Soviet Union, where adherence to the classical Marxian conceptions was more tenacious than in the West, practicability was the stumbling block. In 1920 S. G. Strumilin advocated the use of the *tred* (from the Russian *trudovaya edinitsa* or 'labour unit') as the common denominator for planning, but the USSR Central Statistical Administration could not manage the task (Manevich, 1989; Zauberman, 1967). With the construction of the first Soviet input–output model in 1960, Soviet planners came one important step closer to realizing Strumilin's aim, but this model distinguished only 157 products, and hence was of little use for practical purposes.[29] We return to the implications of this point in our conclusion.

[27] Geoff Hodgson (1984) uses this variant of the calculation to dismiss the possibility of effective central planning. He arrives at a much longer running time, as he employs a now-obsolete computer for his standard of speed.

[28] Note that there is a margin for error built into these calculations by the choice of a mid-1980s commercially-available fast computer as the benchmark. Machines are now available with speeds two orders of magnitude faster, such as the Meiko 'computing surface' at Edinburgh University, and of course progress in this field continues apace.

[29] The Economic Research Institute of Gosplan carried out some labour value calculations based on the 1960 table, and as Treml (1967: 79) notes, this "was hailed as an important addition to more traditional tools of labour planning in the Soviet Union". But these pioneering studies do not seem to have been followed up. The limits of computational power and data-gathering in the Soviet Union restricted the practical use of input–output methods to fields such as inter-regional analysis (Ellman, 1971, 1989).

4.2.2 The economic rationality of labour-time calculation

If labour-time calculation is now technically feasible, as we have claimed, the next issue which arises is the economic rationality of such calculation. We have already countered the two objections raised by Mises, namely the neglect of natural resource costs and the inhomogeneity of labour (see section 2.3). In this section we touch on two additional points, concerning the time dimension of production and the need to incorporate consumers' evaluations of products respectively. Examination of the latter point leads to our proposal of a 'consumer goods algorithm' as a means whereby consumer choice may be allowed to determine the allocation of that portion of the social labour time devoted to means of personal consumption.

As to the time dimension of production, this is a complex point and we don't have space to offer a detailed treatment of it here. Our main purpose in this paper is to defend socialism against Mises' critique, and since Mises doesn't raise the point we will be brief, giving only the gist of our conclusions on the matter.[30]

The issue is whether labour content, summed without regard to its phasing over time, is an adequate measure of cost, or whether rational planning requires that labour inputs be dated, with past labour being 'marked-up' at some specific rate. Samuelson and Weiszäcker (1972) offered an influential analysis of the question, under the provocative title 'A new labour theory of value for rational planning through use of the bourgeois profit rate.'[31] Their conclusion was that simple labour values are applicable only in a stationary system: otherwise a rational plan should call for a set of modified values, which could in principle be obtained by the expedient of 'blowing up' every coefficient in the input–output system by a factor $(1 + b)(1 + g)$, where b denotes the rate of labour-saving technical progress and g denotes the rate of growth of labour supply. Samuelson's spurious polemical identification of such a plan parameter with the 'bourgeois profit rate' apart,[32] the suggestion has some merit, and could perhaps be implemented. Nonetheless, we hold that the 'errors' arising from the use of simple labour values are not likely to be serious (particularly, as Samuelson himself notes, if population growth is slow and historic labour content is used in defining values).

Besides, the divergence between simple and Samuelsonian values becomes really significant only in the case of long-term projects, and it is here that the rationality of discounting calculations is most questionable. On the obverse it seems to make sense that we would prefer to have output now rather than later, but the converse is that the needs of the future are considered relatively unimportant—a less attractive implication of discounting. Critics of the British government's economic assessment of a barrage across the Severn (for the purpose of electricity generation using tidal power) have objected that the discount rate applied makes the generation of virtually free power thirty years hence almost completely irrelevant to the calculation. Similarly, the huge potential costs of decommissioning today's nuclear power stations are routinely shrunk to insignificance by the use of a positive discount rate. We believe that such issues call for judgment: while the time element should not be ignored, it is false to suppose that it is 'taken care of' by a simple application of Present Discounted Value calculation.[33]

So: we have argued that labour-time accounting is technically feasible, and have indicated how one might counter the principal objections to the idea that labour values give a reasonable measure of cost of production. But within what kind of planning framework should labour-time calculation be placed? If decisions on the allocation of social labour to the broad categories of final use (accumulation of means of

[30] Some arguments supporting these conclusions may be found in Cockshott and Cottrell (1989). A lengthier and more technical treatment of the question is available from the authors on request.

[31] The Samuelson–Weiszäcker argument forms the starting point (and, one might say, ending point too) for more recent treatments of the topic such as Jon Elster (1985).

[32] The plan parameter has the same formal properties as a rate of profit, but their magnitudes would be equal only in a world in which the bourgeoisie selflessly devoted all of its income to accumulation!

[33] Mises harps on the point that socialists are supposedly unable to reduce economic decisions to the comparison of scalar (monetary) magnitudes. On the contrary, we consider it a virtue that socialism is able to define certain issues as matters of *judgment*—judgment that is informed, of course, by relevant numbers, but not reducible to one-dimensional maximization.

production, collective consumption, personal consumption) are material for democratic politics, and if the principle of labour-time minimization is adopted as the basic efficiency criterion (as in Marx), what of the detailed pattern of consumer goods output?

Our proposal here might be described as 'Marx plus Lange plus Strumilin'. From Marx we take the idea of the payment of labour in 'labour certificates', and the notion that consumers may withdraw from the social fund goods having a labour content equal to their labour contribution (after deduction of taxes to offset the communal uses of labour time). From Lange we take up a modified version of the 'trial and error' process, whereby market prices for consumer goods are used to guide the re-allocation of social labour among the various consumer goods. From the Soviet economist Strumilin we take the idea that in a socialist equilibrium the use-value created in each line of production should be in a common proportion to the social labour time expended.[34]

The central idea is this: the plan calls for production of some specific vector of final consumer goods, and these goods are marked with their social labour content. If planned supplies and consumer demands for the individual goods happen to coincide when the goods are priced in accordance with their labour values, the system is already in equilibrium. In a dynamic economy, however, this is unlikely. If supplies and demands are unequal, the 'marketing authority' for consumer goods is charged with adjusting prices, with the aim of achieving (approximate) short-run balance, i.e., prices of goods in short supply are raised while prices are lowered in the case of surpluses.[35] In the next step of the process, the planners examine the ratios of market-clearing price to labour value across the various consumer goods. (Notice that both of these magnitudes are denominated in labour-hours; labour *content* in the one case, and labour *certificates* in the other). Following Strumilin's conception, these ratios should be equal (and equal to unity) in long-run equilibrium. The consumer goods plan for the next period should therefore call for expanded output of those goods with an above-average price/value ratio, and reduced output for those with a below-average ratio (although, naturally, an element of demand forecasting is also called for here: the current ratios provide a useful guide rather than a completely mechanical rule).

In each period, the plan should be *balanced*, using either input–output methods or an alternative balancing algorithm.[36] That is, the gross outputs needed to support the target vector of final outputs should be calculated in advance (so if the achievement of balance requires an iterative process, *this* iteration should be performed in 'computer time'). We have already alluded to this necessity by way of criticism of Lange's system, in which balance seems to be left to chance. Our scheme, however, does not impose the unreasonable requirement that the pattern of consumer demand be perfectly anticipated in advance—adjustment in this respect is left to a 'trial and error' process which takes place in historical time.

This scheme meets the objection of Nove (1983), who argues that labour values cannot provide a basis for planning even if they give a valid measure of cost of production. Nove's point is that labour content of itself tells us nothing about the use-value of different goods. Of course this is true,[37] but it only means that we need an independent measure of consumers' valuations; and the price, in labour certificates, which roughly balances planned supply and consumer demand provides just such a measure. By the same token, we can answer a point made by Mises in his discussion of the problems faced by socialism under dynamic conditions (1951: 196 ff). One of the dynamic factors he considers is change in consumer demand, *à propos* of which he writes: "If economic calculation and therewith even an approximate ascertainment of the costs

[34] This point—a basic theme of Strumilin's work over half a century—is expressed particularly clearly in his (1977: 136–7).

[35] With market-clearing prices, as we have observed, the goods go to those willing to pay the most. Given an egalitarian distribution of income, we see no objection to this.

[36] An alternative algorithm which makes allowance for given stocks of specific means of production is given in Cockshott (1990).

[37] As was clearly understood by Marx: "On a given basis of labour productivity the production of a certain quantity of articles in every particular sphere of production requires a definite quantity of social labour-time; although this proportion varies in different spheres of production and has no inner relation to the usefulness of these articles or the special nature of their use-values." (1972: 186–7)

of production were possible, then within the limits of the total consumption-units assigned to him, each individual citizen could be allowed to demand what he liked. . . " But, he continues, "since, under socialism, no such calculations are possible, all such questions of demand must necessarily be left to the government". Our proposal allows for precisely the consumer choice that Mises claims is unavailable.

Returning briefly to some concerns raised in section in section 3.1 above, we are now in a position to state the basic criterion for a 'successful' innovation, on the one hand, and for an 'uneconomic' production process on the other. 'Success' means that the product is one for which people are willing to pay, in the form of labour certificates, at least as much of their labour time as the product embodies. An 'uneconomic' process—which should be closed down, and its resources redeployed—is one for which there is no scale of operation at which this condition is satisfied.

5 Conclusion

What, one might ask, is the relevance of these arguments at a time when socialism has either been rejected or is in crisis everywhere? Doesn't this brute reality show, despite our strenuous protestations to the contrary, that Mises and Hayek were basically right all along? Or alternatively, if socialism is a dead duck, what does it matter whether the specific arguments made by Mises in 1920 were correct or not?

First, it is instructive to exercise one's sense of history. It is little more than fifty years since it was widely accepted that the Great Depression showed the historic bankruptcy of capitalism. Even among those who did not subscribe to such a claim, many economists were willing to concede the basic superiority of socialism.[38] If such a judgment could be so thoroughly reversed over the post war years, it is surely not impossible that further reversals may occur in future. Second, one cannot assume that because socialism is in dire trouble today, this somehow vindicates the Austrian critique. This is not the place for an account of the complex historical reasons behind the crisis of Soviet socialism, but our investigations enable us to identify one component of the problem: *the material conditions (computational technology) for effective socialist planning of a complex peacetime economy were not realized before, say, the mid-1980s*. If we are right, the most notorious features of the Soviet economy (chronically incoherent plans, recurrent shortages and surpluses, lack of responsiveness to consumer demand), while in part the result of misguided policies, were to some degree inevitable consequences of the attempt to operate a system of central planning 'before its time'. The irony is obvious: socialism was being rejected at the very moment when it was becoming a real possibility.

Don Lavoie concludes his 1985 study of the socialist calculation debate with the observation that the debate was never really resolved, and with the hope that his book "may help to stimulate contemporary advocates and critics of central planning to return to this intellectual rivalry that so enriched the profession of economics in the 1930s." We agree that the Marxian case was effaced rather than 'updated' in the problematic positions of the neoclassical socialists. If market socialism is the best the Left can offer, we would have to agree that Mises won the debate. The hour is late, but we hope we have shown how Mises' challenge—his case that socialism cannot operate a rational economy—can be met.

[38] A. C. Pigou is a striking case in point. While he stops short at a cautious Fabian position himself, his discussion in *Capitalism Versus Socialism* (1954) represents a noteworthy admission, from the leading proponent of neoclassical economics in inter-war England, of the powerful arguments in favour of socialist planning.

Appendix: Labour values and prices under joint production

In this appendix we substantiate the claim made in the text that joint production does not pose a serious problem for the sort of labour-based optimisation algorithm we propose for socialist planning, despite the fact that in this case the *individual* labour values of the jointly-produced goods will be undefined.

Consider a process that produces two goods, a and b, in a fixed ratio of x units of a to y units of b, $x/y = k$. (The following argument may be readily generalized to more than two jointly-produced goods, but we illustrate with the simplest case.) Let us define a composite good, c, composed of x units of a plus y $(= x/k)$ units of b. The labour value of c, written $v(c)$ is, we assume, well defined. The process is to be operated at an intensity $s > 0$ or not at all, where s is measured in units of c. Hence at an intensity $s = s_0 > 0$ outputs $s_0 x$ and $s_0 x/k$ are produced of goods a and b respectively.

Let $p(a)$ and $p(b)$ denote the market-clearing prices of goods a and b respectively, these prices being stated in labour certificates. Then the corresponding price of the composite good, c, is a weighted sum of $p(a)$ and $p(b)$, namely

$$p(c) = xp(a) + (x/k)p(b).$$

The price-value optimization procedure discussed in the text then sets a goal of

$$v(c) = p(c) = xp(a) + (x/k)p(b) \tag{A.1}$$

i.e. the market-clearing price of the composite good should equal its labour value. It is reasonable to suppose that the individual market-clearing prices $p(a)$ and $p(b)$ are both declining functions of the scale of operation of the joint process, s. For the sake of argument we write these as simple linear relations:

$$p(a) = a_1 + a_2 s \tag{A.2}$$

$$p(b) = b_1 + b_2 s \tag{A.3}$$

where $a_1, b_1 > 0$ and $a_2, b_2 < 0$. Substituting from (A.2) and (A.3) into (A.1) yields

$$v(c) = x(a_1 + a_2 s) + (x/k)(b_1 + b_2 s)$$

which may be solved for optimal s as below:

$$s^\star = [v(c) - (a_1 + b_1/k)x]/(a_2 + b_2/k)x.$$

The above expression gives the optimum intensity of operation of the joint process as a function of the labour value of the composite good, the technical ratio of the joint outputs, and the demand parameters. It also implies, via (A.2) and (A.3), optimal prices for the individual goods, namely

$$p^\star(a) = a_1 + a_2 s^\star$$

and

$$p^\star(b) = b_1 + b_2 s^\star.$$

The optimal values $s^\star$, $p^\star(a)$ and $p^\star(b)$ may be obtained directly only if the demand parameters are known in advance. In the text we point out that this should probably not be assumed. We therefore fall back to the real-time iterative solution: As $p(c)$ exceeds (falls short of) $v(c)$, expand (contract) the process incrementally—i.e. adjust s upward or downward respectively—while seeking (approximately) market-clearing prices $[p(a), p(b)]$ at each stage of the process. The latter prices are used to recalculate $p(c)$ at each stage.

The only special problem that may arise in the case of joint production is that the 'equilibrium' price of one of the products may turn out to be negative. The symptom of this in the context of iteration towards equilibrium would be that $p(c)$ remains in excess of $v(c)$ even when the scale of output is such that the market-clearing price of one of the goods (say, b) has gone to zero. It may then be that at yet higher output levels b becomes a nuisance (at the margin), such that people would have to be paid to accept any more of it. If a surplus of good b can be dumped or somehow recycled at low cost, the solution would be to expand production (s) until $p(a) = v(c)$, distribute b as a free good, and dump any surplus of b over consumer demand. If it is costly to dispose of surplus output of b, this cost will have to be factored into the labour value of the composite good, $v(c)$, which will then result in a lower optimal intensity of operation of the joint process.

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