Economic planning, computers and labour values

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Abstract

At the time of the collapse of the Soviet Union it seemed to many that the socialist calculation debate was essentially over, with a decisive verdict in favour of the market. Recent instabilities in the world market are again prompting questions as to whether some form of concious regulation of economies may be appropriate. We argue that the increasing power of modern computer technology along with the use of Ricardian-Marxian labour values opens up new possibilities for economic planning.

1 Introduction

The collapse of the socialist economies of Eastern Europe at the end of the 1980s, along with the arguments of the Austrian school (Hayek, Mises), has established a strong presumption that there exists no viable alternative to capitalism and the free market. From this perspective, socialist planning appears as a utopian dream.

It is not surprising that neoclassical economists are content to follow the march of history as it appears today—that is, that they have lost all interest in the socialist calculation debate as such, and have switched their attention to the problems of transition to a market system in the formerly socialist states. Even socialist theorists, seem, in the majority to have rejected planning in favour of some form of market economy. The almost universal abandonment of the idea of planning among socialists stems from a genuine conviction that it is simply impracticable. We hope to show that this is simply not true, that despite the collapse of the soviet system, democratic and efficient systems of planning are possible.

Scanning the last few years' issues of journals such as *Socialist Review*, *Rethinking Marxism*, *Socialism and Democracy*, *New Left Review*, *Economy and Society* and the *Socialist Register*, one finds that the only writer offering a defence of socialist planning—apart from the present authors (Cockshott and Cottrell, 1989)—is Ernest Mandel, in his (1986, 1988) rejoinders to Alec Nove and his (1991) piece on the Soviet Union. In the latter, Mandel argues, like ourselves, that the downfall of Soviet planning does not indicate the failure of socialist planning in general. But his grounds are rather different from ours.

In particular, we are uncomfortable with his claims that "socialism never existed in the USSR" (1991: 194); and that "the specific forms of Soviet central planning had [the extension of the dimensions, power and privileges of the Stalinist bureaucracy] as their main social purpose" (197). Such claims seem to preserve socialism's theoretical virginity, so to speak, at the cost of severing socialist ideas from historical reality. Better, in our view, to admit that the USSR was socialist, but to argue that it did not represent the only possible model of socialism.

2 Outline of our proposals

First of all, it will be useful to set out the general conditions which are required to operate an effective system of central economic planning, leaving aside for the moment the issue of whether they can actually be realized in any feasible system. Taking an input–output perspective on the economy, effective central planning requires the following three basic elements:

1. A system for arriving at (and periodically revising) a set of targets for final outputs, which incorporates information on both consumers' preferences and the relative cost of producing alternative goods (the appropriate metric for cost being left open for the moment).

2. A method of calculating the implications of any given set of final outputs for the the required gross outputs of each product. At this stage there must also be a means of checking the feasibility of the resulting set of gross output targets, in the light of the constraints posed by labour supply and existing stocks of fixed means of production, before these targets are forwarded to the units of production.

The provision of these elements involves a number of preconditions, notably an adequate system for gathering and processing dispersed economic information and a rational metric for cost of production. We should also note at once the important and entirely valid point stressed by Nove (1977 and 1983): for effective central planning, it is necessary that the planners are able to carry out the above sorts of calculations in full disaggregated detail. In the absence of horizontal market links between enterprises, management at the enterprise level "*cannot* know what it is that society needs unless the centre informs it" (Nove, 1977: 86).[1] Thus if the centre is unable to specify a coherent plan in sufficient detail, the fact that the plan may be 'balanced' in aggregate terms is of little avail. Even with the best will in the world on the part of all concerned, there is no guarantee that the specific output decisions made at the enterprise

[1] With one reservation. If, say, the central plan calls for enterprise A to supply intermediate good x to enterprise B, where it will be used in the production of some further good y, and if the planners apprise A and B of this fact, is there not scope for 'horizontal' discussion between the two enterprises over the precise design specification of x? (That is, even in the absence of market relations between A and B.)

level will mesh properly.This general point is confirmed by Yun (1988: 55), who states that as of the mid-1980s Gosplan was able to draw up material balances for only 2,000 goods in its annual plans. When the calculations of Gossnab and the industrial ministries are included, the number of products tracked rises to around 200,000, still far short of the 24 million items produced in the Soviet economy at the time. This discrepancy meant that it was "possible for enterprises to fulfill their plans as regards the nomenclature of items they have been directed to produce, failing at the same time to create products immediately needed by specific users".

Our argument below involves grasping this particular nettle: while we agree that "in a basically non-market model the centre must discover what needs doing" (Nove, 1977: 86), and we accept Yun's account of the failure of Gosplan to do so, we dispute Nove's contention that "the centre cannot do this in micro detail" (*ibid.*).

Our basic proposals can be laid out quite simply, although we ask the reader to bear in mind that we do not have space here for the necessary refinements, qualifications and elaborations (these are developed at length in Cockshott and Cottrell, 1993). In schematic form the proposals are as follows.

2.1 Labour time as the basic social unit of account and metric of cost

The allocation of resources to the various spheres of productive activity takes the form of a social labour budget. At the same time the principle of labour-time minimization is adopted as the basic efficiency criterion. That is, we are in agreement with Mises (1935: 116) that rational socialist calculation requires "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."[2]" We disagree, of course, with Mises' subsequent claim that even labour-time cannot, after all, play the role of 'objective unit of value'. We have countered his two arguments to this effect—namely, that labour-time calculation necessarily leads to the undervaluation of non-reproducible natural resources, and that there is no rational way (other than via a system of market-determined wage rates) of reducing labour of differing skill levels to a common denominator—in another publication [3]. We can only summarise out responces here. If one uses *marginal* labour time as a cost metric, that takes into account the growing difficulty in obtaining non-reproducible resources. In addition, planners could decide to devote resources to the research into alternatives, the use of solar power instead of oil for instance. Furthermore, there is no reason to believe that any real market furnishes an optimal solution to such problems. As for the non-homogeneity of labour. One can

[2]L. Mises, "Economic calculation in the socialist commonwealth", F. Hayek, éd., *Collectivist Economic Planning*, London, 1935, p. 116.

[3]A. Cottrell et P. Cockshott, "Calculation, complexity and planning: the socialist calculation debate once again", *Review of Political Economy*, no.1 de 1993.

in principle treat skilled labour in the same way as any other product, evaluated in terms of the training time required to produce it.

2.2 Labour-token system of distribution

From Marx[4] we take the idea of the payment of labour in 'labour tokens', 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: accumulation of means of production, public goods and services, support of those unable to work). We envisage a basically egalitarian pay system; but insofar as departures from egalitarianism are made (i.e. some kinds of work are rewarded at more than, and some at less than, one token per hour), the achievement of macroeconomic balance nonetheless requires that the total current issue of labour tokens equals the total current labour performed. We also suggest that the most suitable system of taxation in such a context is a flat tax per worker—a uniform membership fee for socialist society, so to speak. This tax (net of transfers to non-workers) should, in effect, 'cancel' just enough of the current issue of labour tokens so as to leave consumers with sufficient disposable tokens to purchase the output of consumer goods at par. (This point is further developed below.)

2.3 Democratic decisions on major allocation questions

The allocation of social labour to the broad categories of final use (accumulation of means of production, collective consumption, personal consumption) is suitable material for democratic decision making. This might take various forms: direct voting on specific expenditure categories at suitable intervals (e.g. on whether to increase, reduce or maintain the proportion of social labour devoted to the health care system); voting on a number of pre-balanced plan variants; or electoral competition between 'parties' with distinct platforms as regards planning priorities.

2.4 Consumer goods algorithm

Our proposal on this count might be described as 'Lange plus Strumilin'. From

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.[6] In the next step of the process, the planners examine the ratios of market-clearing price to labour value across the various consumer goods. (Note that both of these magnitudes are denominated in labour-hours; labour content in the one case, and labour tokens 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.[7]

In each period, the plan should be balanced, using either input–output methods or an alternative balancing algorithm.[8] That is, the gross outputs needed to support the target vector of final outputs should be calculated in advance. This is in contrast to Lange's (1938) system, in which the very coherence of the plan—and not only its optimality—seems to be left to 'trial and error'. Our scheme, however, does not impose the unreasonable requirement that the pattern of consumer demand be perfectly anticipated *ex ante*; adjustment in this respect is left to an iterative process which takes place in historical time.[9]

The proposed scheme as a whole is set out in synoptic form in Figure 1.

This scheme meets the objection of Nove (1983), who argues that labour values cannot provide a basis for planning even if they gave 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,[10] but it only means that we need an independent measure of consumers' valuations; and the price, in labour tokens, 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: 196ff). 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 of production were

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

[7] Naturally, an element of demand forecasting is also called for here: the current ratios provide a useful guide rather than a completely mechanical rule.

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

[9] In his later reflection on the socialist calculation debate, Lange (1967) seems to suggest that an optimal plan can be pre-calculated by computer, without the need for the real-time trial and error he envisaged in 1938. Insofar as this would require that consumer demand functions are all known in advance, this seems to us far-fetched.

[10] 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)

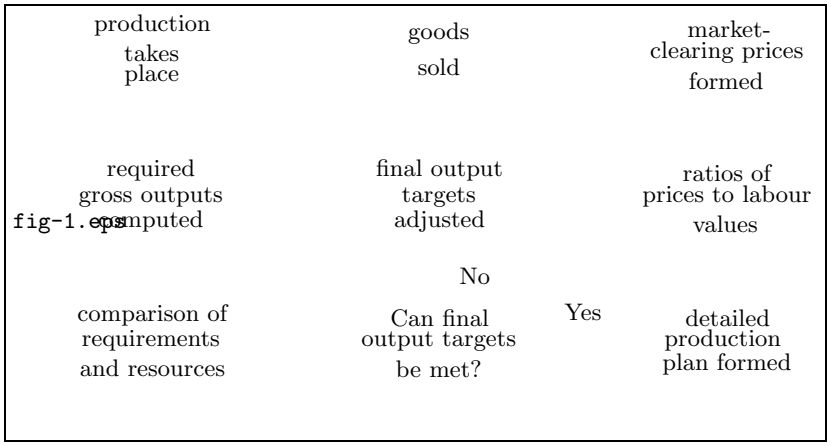

Figure 1: Outline of planning mechanism

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.

3 Feasibility of calculation

3.1 Calculation of labour values

The proposals above rest on the assumption that it is possible to calculate the labour content of each product in the economy. The problem is in principle solvable since one has n unknown labour values related by a set of n linear production functions. The difficulty is not one of principle but of scale. When the number of products gets up into the millions, the calculation involved is nontrivial.

If we were to represent the problem in classic matrix terms, with an n by $(n + 1)$ matrix, where the rows represent products and the columns represent produced inputs plus direct labour, analytic solution of the equations using Gaussian elimination gives a problem requiring n^3 multiplication operations and a slightly larger number of additions and subtractions. Table1 gives the computer requirements for this calculation assuming differing sizes of economy. We assume that the uniprocessor is capable of 10^8 multiplications a second, and that the multiprocessor can perform 10^{10} multiplications per second.

It can be seen that, taking compute time alone into account, even the multiprocessor would take 10^1 seconds, or over three thousand years, to produce a solution for an economy of 10 million products. As if this were not enough,

Number of products	Multiplications	Time taken in seconds: *Uniprocessor*	*Multiprocessor*
1,000	1,000,000,000	10	0.1
100,000	10^{15}	10^{7}	100,000
10,000,000	10^{21}	10^{13}	10^{11}

Table 1: Gaussian solution to labour values

the situation would be further complicated by the memory required to store the matrix, which grows as n^2. Since the largest currently feasible memories are of the order of 10^{10} words, this would set a limit on the size of problem that could be handled at about 100,000 products.

If, however, we take into account the sparseness of the matrix (i.e. the high proportion of zero entries, when it is specified in full detail) the problem becomes more tractable. Let us suppose that the number of different types of components that enter directly into the production of any single product is n^k where $0 < k < 1$. If we assume a value of 0.4 for k, which seems fairly conservative,[11] we find that memory requirements now grow as $n^{(1+k)} = n^{1.4}$. If we can further simplify the problem by using iterative numerical techniques (Gauss–Seidel or Jacobi) to obtain approximate solutions, we obtain a computational complexity function of order $An^{1.4}$, where A is a small constant determined by the accuracy required of the answer.

This reduces the problem to one that is clearly within the scope of current computer technology, as shown in Table 2. The most testing requirement remains the memory, but it is within the range of currently available machines.

Number of products	Multiplications	Words of memory	Time taken in seconds: *Uniprocessor*	*Multiprocessor*
1,000	158,489	31,698	$1.6 \quad 10^{-3}$	$1.6 \quad 10^{-5}$
100,000	100,000,000	20,000,000	1	0.01
10,000,000	$6.3 \quad 10^{10}$	$1.2 \quad 10^{10}$	630	6.3

Table 2: Iterative solution to labour values (Assuming A=10)

From this we conclude that the computation of labour values is eminently feasible.

[11] This means, for instance, that in a 10 million product economy each product is assumed to have on average 631 direct inputs.

3.2 Resource Allocation

If we assume that the mix of net or final outputs required by the plan is specified, as are the available technologies and the stocks of means of production, how difficult is it to compute a feasible plan? By a feasible plan we mean one which produces at least the required outputs using the available resources. Following on from this, can we determine if the planned mix of outputs is infeasible given the resources?

The classic approach to this is to use linear programming, whose computational requirements are unfortunately forbidding for an economy with millions of products. But if we are willing to relax our requirements somewhat and settle for a 'good' rather than an optimal solution, we can perform a simplification similar to that described for labour-value calculations. One approach would be to start from the target list of final outputs, and work back to the corresponding required gross outputs (via the same sort of iterative solution method set out for labour values, and exploiting the sparseness of the input–output matrix in the same way). Given the vector of gross outputs, it is then straightforward to determine the overall requirements for labour and fixed means of production of various kinds. If the latter requirements can be met, well and good; and if not, then one trims the target list of final outputs and tries again. These steps are shown in the form of a loop at the bottom left of Figure 1. While it is computationally feasible, this method has the drawbacks of requiring a 'manual' adjustment of the target output vector each time round the loop, and of failing to ensure that all resources are used as fully as possible. A preferable alternative technique, which draws on ideas from the literature on neural nets, is set out in Cockshott (1990). This is of complexity $An^{(1+k)}$, as was the iterative solution for labour values. The computational requirements are thus essentially the same.

In what sense is the solution produced by the latter method a 'good' one? The procedure involves defining a metric for the degree of fit between the target set of final outputs and the computed feasible set, as constrained by existing stocks of means of production of various kinds, and by the available labour time. The algorithm then in effect searches the space of feasible plans, aiming to maximize this degree of fit. The nature of the search algorithm is such that it may settle at a local maximum rather than finding the global maximum; this is the price paid for computational tractability. Nonetheless, the fact that the solution is not the optimal plan, but merely a good feasible one, is not a serious problem when comparing planning to the market, since no real market achieves an optimal structure of production.

3.3 Comparison with existing computer technology

We have set out the scale of computer resources required either to compute labour values or to compute a feasible plan for a whole economy. From Table 3 (see Bell, 1992) we can see that the required memory and processing power are well within the capabilities of current machines. We have assumed

a multiprocessor capable of 10^9 multiplications a second; the peak rates of the machines shown in the Table range from 1.6 10^{10} to 3 10^{11} multiplications per second. One must allow some reduction in peak rates before arriving at a sustainable performance for a computer, but our target performance is clearly realistic. Memory requirements are also within the range of current products. With modern computers, one could envisage computing an updated list of labour values daily and preparing a new perspective plan weekly. This is somewhat faster than a market economy is able to react.

Machine	Number of processors	Peak Gflops	Price ($M)	Memory (GB)
Cray90	16	16	30	16
KSR1	1088	43	30	34
INTEL Paragon	4096	300	55	128
DEC Alpha	1024	150	20	32

Table 3: Characteristics of 1992 supercomputers

4 The argument for 'Bourgeois Pricing'

Following the first of a series of articles dealing with the use of labour values in socialist economic calculation [**?**], we were challenged by Duffy [**?**] as to why we proposed the use of labour values rather than prices of production as a basis for costing production techniques under socialism. Given that no hithertoo existing economy has directly used labour values in economic calculation this is a reasonable question. In this paper we look at whether it would be preferable to use prices of production or labour values as a measure of social cost.

To put this point in context, note first that straightforward labour values do provide a reasonably comprehensive measure of social cost, and should not be confused with the much narrower notion of 'labour cost' in a capitalist economy. Labour values include not only the direct labour entering the production of a commodity, but also materials, energy, machinery, buildings, etc.–the latter inputs being 'costed' in terms of the amount of social labour required to (re-)produce them. Nonetheless, two potentially important points are missed if one relies solely on labour values as a measure of social cost. First, some inputs to production may not be reproducible through the application of labour (finite natural resources), and secondly there is a time dimension to production which goes beyond the summation of the hours of labour required.

Marx developed the concept of 'price of production' in his theoretical analysis of capitalism. In Volume One of Capital he argued that the long run equilibrium prices of commodities under capitalism are determined by their labour values. But in Volume Three he admits a complication: different industries have different capital to labour ratios ('organic composition of capital' in Marx's ter-

minology), and it turns out that if commodities were to exchange in accordance with their labour values, then the more capital-intensive industries would show a lower rate of profit. Yet in company with the classical economists such as Smith and Ricardo, Marx held that there was a tendency for the rate of profit to be

Table 4: Predictions of Labour value theory versus price of production theory

Index	Labour theory of value	Price of production theory
$\psi = P/\Lambda$	narrow	wide
$r = S/(C+V)$	wide	narrow
$\varphi = P/\Pi$	wide	narrow
$o = C/(S+V)$	wide	wide
$s = S/(S+V)$	narrow	wide
Correlation $r:o$	negative	uncorrelated
Correlation $s:o$	uncorrelated	positive

prices of production involves the assumption that prices are set by the following equation[16] :

$$(1+r)(p^m\mathbf{A} + ma) = p^m \tag{1}$$

Where $\mathbf{A}$ is the matrix of produced means of production, a the row vector showing the level of employment in each industry, r is a uniform rate of profit, p^m a row vector of money prices and m the money wage rate.

The crucial assumption in this equation is the existence of a uniform profit rate r. This is clearly a rather forced assumption, since in practice the profit rate is a random variable both within and between industries. For instance for the UK economy in 1987 we find the distribution found in 5. In itself this not a particularly serious problem, provided that the rate of profit is statistically independent of the capital/labour ratio, or organic composition (o), in marxian terminology. It is this statistical independence of the rate of profit vis-a-vis the capital labour ratio that distinguishes price of production theory from the classical Ricardian labour value theory of prices. The latter had predicted, that industries with a high capital/labour ratio, would have a lower rate of profit than those with an average capital/labour ratio. In other words, that r and o would be negatively correlated. The predictions of the two theories are sumarised in Table **??**.

4.2 United Kingdom data

For the UK economy we find that dispersion of profit rates and rates of surplus value is more in consistent with the labour theory of value than with prices of production (see table 5[17]).

Significantly the UK economy shows a clear negative correlation between profit rates and organic compositions of capital as predicted by the classical labour theory of value. However, one shortcomming of the figures in table 6 is that they are computed using the input-output tables, which make no allowance for the capital stocks invested in different industries. Capital stock figures are somewhat easier to obtain for the USA.

[16] Steedman 1977

[17] Reproduced from Cockshott and Cottrell 1994

Table 5: Empirical distributions for the UK 1987

Summary statistics for empirical distributions

Distribution	Mean	Std. Dev.	C. V.
$o = C/(S+V)$	0.846	0.636	0.752
$r = S/(C+V)$	0.211	0.129	0.608
$s = S/(S+V)$	0.315	0.134	0.423
$\phi = P/\Pi$	1.000	0.114	0.114
$\psi = P/\Lambda$	1.000	0.104	0.104

Table 6: Correlations between market prices, values and prices of production for the UK in 1987, *reproduced from Cockshott and Cottrell 1994*.

Correlation matrix

	o	r	s	ϕ	ψ
$o = C/(S+V)$	1.000				
$r = S/(C+V)$	−0.288	1.000			
$s = S/(S+V)$	0.369	0.517	1.000		
$\phi = P/\Pi$	−0.224	0.930	0.491	1.000	
$\psi = P/\Lambda$	0.423	0.569	0.579	0.663	1.000

KEY
C = constant capital measured on a flow basis.
V = variable capital measured on a flow basis.
S = surplus value.
P = market prices
Π = prices of production
Λ = Labour values

Note: For a sample size of 96, the 1 per cent critical value of the correlation coefficent, $\hat{\rho}$, is 0.262.

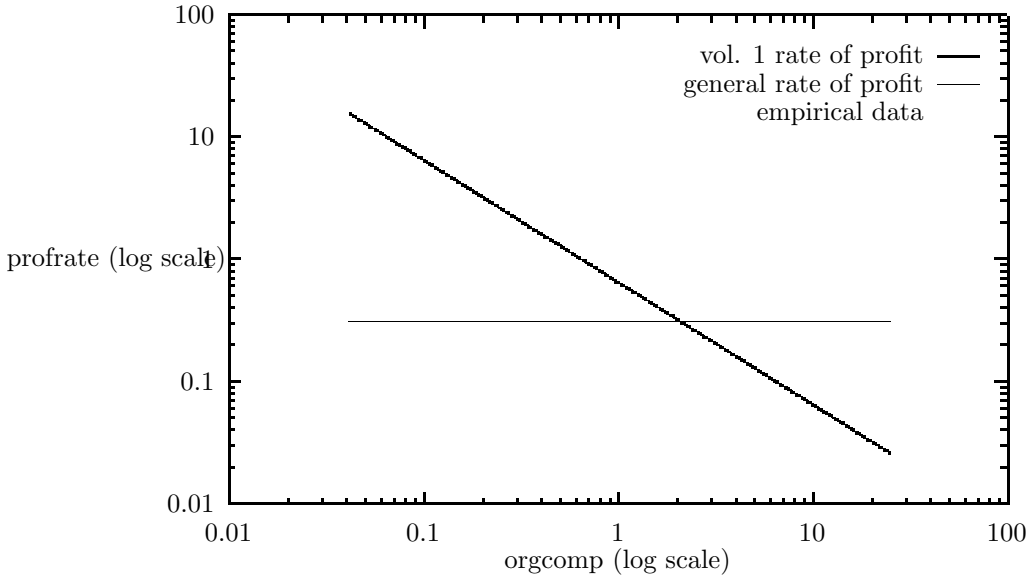

Figure 2: Graph of relation between profit rates and organic composition using buildings and structures as the estimate of constant capital

It can be seen that the observed rates of profit fall close to the rates that would be predicted by the Volume I theory. The exception is for a few industries with unusually high organic compositions > 10.

But what are these industries? It transpires that they fall into two categories, each arguably "exceptional". First there are the regulated utilities, electricity supply and gas supply. Electricity supply has an organic composition of 23.15, and displays a rate of profit half way between that predicted by the simple labour theory of value and that predicted by the price of production theory. The gas utilities have a rate of profit of 20% on an organic composition of 10.4; the labour theory of value would predict a profit rate of 7% and the production price theory 32%. In each case the industry is regulated, and of course the regulatory system builds in the assumption that the utilities should earn an average rate of profit. Second, there are industries of high organic composition in which rent plays a major role. At an organic composition of 16.4, the crude petroleum and natural gas industry has a rate of profit substantially in excess of that predicted by the labour theory of value, and approximating more closely that predicted by an equalization of the rate of profit. But an industry like this would, on the basis of the Ricardian theory of differential rent, be expected to sell its product above its mean value, and hence report above average profits. In a similar position we find the oil refining industry with an organic composition of 9.4. Oil production and oil refining have similar rates of profit, at 31% and 32%. Since the industry is vertically integrated, this would indicate that the oil monopolies chose to report their super profits as earned pro-rata on capital

employed in primary and secondary production. In both cases, however, the super profit can be explained by differential rent.

4.5 Conclusion on the applicability of production prices

We consider, that the available data, does not make a convincing case for production prices being a more accurate, as a predictor of market prices, than labour values are. Thus if it were judged economically inefficient for a socialist economy to base its economic calculus on labour values rather than upon prices of production, the same inefficiency would appear to affect leading capitalist economies. In particular, the industries which, in the USA, conform most closely to the theoretical model of production price theory are those under government regulation. To that extent, production price theory may find its true application in state regulated capitalism.

4.6 Samuelson: labour values and prices of production in planned economies

Samuelson and Weizsacker set the scene for their argument by noting the way in which a positive rate of profit disturbs the basic labour theory of value:

> In an economic system where all goods are ultimately producible by labor, i.e., in which any one good is produced with direct labor and one or more of the goods in the system (including possibly itself), if the rate of profit or interest were always zero, the competitive equilibrium prices would be exactly equal to the total embodied labour required for each good... If, however, there is a positive interest or profit rate, labor will not receive a real wage large enough to buy all the consumption goods producible by labor in the stationary synchronised equilibrium. ...[W]ith positive interest the prices will no longer be proportional to the respective embodied labor contents. Thus, if the same historic labor total, say 1 labor, is needed for either a liter of grape juice or for a liter of wine, but for wine the labor is needed 2 time-units earlier rather than only one time-unit earlier as for grape juice, the ratio of wine price to grape juice price will not be $P_2/P_1 = 1/1$, but will instead vary with the profit rate per period r, being $P_2/P_1 = 1(1+r)^2/1(1+r) = (1+r)$... Thus grape juice and wine have equal "values" since they both involve unit labor inputs; but their bourgeois "prices" differ from the Marxian values because the former calculate labor requirements, dated by when they occur and carried forward at nefarious compound interest. (Samuelson, 1972, p. 312)

They then go on to argue that in a rationally planned society, where class exploitation is abolished, all goods should be "valued" or "priced" at their true "synchronised needed labor cost". And they contend that such rational plan prices will, in general, not be proportional to straight labour-contents, but will

be expressible in the manner of 'bourgeois' prices, provided that an appropriate 'profit rate' is used.

The essence of the Samuelson argument can be expressed in terms of our own approach, by considering the labour-token prices of given commodities which will succeed in 'clearing the market', given the number of labour-tokens currently being issued and spent. This concept appears to correspond precisely with Samuelson's 'synchronised needed labour cost'. Although Samuelson carries through the argument with the full generality of matrix algebra, the basic idea can be understood by analyzing an economy producing a pure consumer good, and no intermediate output.

Suppose we take for example the two alternative consumer goods mentioned by Samuelson, grape juice and wine, with the technologies as he defines them (each requires a unit labour input, but the grape juice, G, requires it one period in advance of consumption, while the wine, W, requires it two periods in advance). To investigate the rational plan prices, perform the thought experiment of having the economy specialise entirely in each of these commodities in turn.

We use the following notation:

L_t = total labour supply at time t, equal to number of labour tokens issued at that time (and spent, within the same period).

$C_{j(t)}$ = quantity of commodity j available for consumption at time t, in physical units.

$P_{j(t)}$ = market-clearing price of commodity j at time t, defined as $L_t/C_{j(t)}$. This price is expressed in labour-tokens per physical unit, and balances the quantity of the commodity currently available against the total expenditure of tokens in the same period.

Let us now consider a rational pricing policy in the cases considered by Samuelson and Weizsacker.

First Case: *Population and labour supply are growing at a compound percentage rate g, while production technology is static.*

As of time t, given the unit labour requirements for each commodity, we have

$$C_{G(t)} = L_{t-1}$$
$$C_{W(t)} = L_{t-2}$$

$$P_{G(t)} = L_t/C_{G(t)} = L_t/L_{t-1} = \gamma$$

$$P_{W(t)} = L_t/C_{W(t)} = L_t/L_{t-2} = \gamma^2$$

and the 'rational' wine/juice price ratio is not 1:1, but rather:

$$P_{W(t)}/P_{G(t)} = \gamma^2/\gamma = \gamma$$

Here the 'rational prices' or 'synchronised needed labour costs' are equal to the labour contents marked up at a compound rate of $\gamma = (1 + g)$. These

prices diverge from straight labour values, but are equal, as Samuelson puts it, to 'bourgeois prices', using a 'profit rate' of g.

Synchronised labor costs, as defined here, are seen to be interpretable as the ordinary embodied labor requirements for a fictitious system in which every... [input] coefficient of the actual system is blown up by the growth factor $(1+g)$. What is the rationale for this expansion?

In each time interval the population is larger, and if we make the assumptions that:

a) there is no saving,

b) total income is equal to total labour expended,

c) the length of the working week is unchanged,

then it follows that the total expenditure of income in each time period will be greater than the labour hours used in production during the previous period. This will induce an inflation of prices above their values. (Samuelson, 1972, p. 313)

It should be noted that this argument rests on considerations of the circulation process and implicitly of money. To sustain this rise in total income a growing sum of new money must be thrown into the circulation process each time interval. It also follows that under conditions of declining population, or when there is a reduction in the working week, the quantity g will be negative, and hence the price of wine will be less than that of grape juice.

Second Case: *The population and labour supply are static, but 'labour-augmenting' technical change is proceeding in such a way that the labour input requirement for each commodity is falling at a compound rate of b per period.*

This implies that starting out with a unit labour requirement at time T_0, the requirement at T_t is given by β^{-t} where $\beta = (1+b)$, and the quantity of output per unit labour input at T_t is β^t.

We then have:

$$C_{G(t)} = L_{t-1}\beta^{t-1}$$

$$C_{W(t)} = L_{t-2}\beta^{t-2}$$

Since in this case $L_t = L_{t-1} = L_{t-2} = ... = L$, we have

$$P_{G(t)} = L/C_{G(t)} = \frac{L}{L\beta^{t-1}} = \frac{1}{\beta^{t-1}} = \beta^{1-t}$$

$$P_{W(t)} = L/C_{W(t)} = \frac{L}{L\beta^{t-2}} = \frac{1}{\beta^{t-2}} = \beta^{2-t}$$

and the wine/juice price ratio is $P_{W(t)}/P_{G(t)} = \beta$

As Samuelson points out, in this case the 'rational' prices are precisely equal to the historic embodied labour contents. Wine is more expensive than grape

juice by the factor $\beta = (1 + b)$; correspondingly the wine currently available for consumption was produced (involved a labour requirement) at an earlier date, i.e. at a time when the productivity of labour was lower. This result depends upon the same assumptions about the circulation process as the first one.

Samuelson also points out that the same 'rational' prices can be retrieved by taking the labour requirement as of the current state of technique and marking it up at a 'profit rate' of b. For instance, in the case of wine at T_t the current technique labour requirement is β^{-t}, but as the labour was applied two periods ago this is marked up by the factor β^2, yielding

$$P_{W(t)} = \beta^2 \beta^{-t} = \frac{1}{\beta^{t-2}}$$

which agrees with the market-clearing labour-token price calculated above. Samuelson refers to this again as the 'bourgeois price', applying profit rate b. This is questionable.

1. Is it really the 'bourgeois' procedure to mark up costs computed at the current state of technique, rather than to mark up on historic costs?

   Clearly, if one does mark up on historic costs, then the prices so derived will diverge systematically from the rational plan prices. E.g., we will have

   $$P \quad W(t) = \beta^2 \beta^{-(t-2)} = \frac{1}{\beta^{t-4}}$$

   and similarly we will get $P_{G(t)} = 1/\beta^{t-2}$, and hence we obtain a price ratio $P_{W(t)}/P_{G(t)} = \beta^2$, which does not agree with the 'rational' price ratio of β.

2. Is it reasonable to identify the rate of growth of productivity with the bourgeois profit rate?

   The bourgeois rate of profit depends upon both the division of the social product between capital and labour and what Marx termed the organic composition of capital. The rate of growth of productivity depends upon different factors: scientific progress, discovery or exhaustion of mineral reserves etc. There may be some degree of interaction between the two, in that productivity growth may foster a higher rate of surplus value[18], but this does not justify an identification of the two.

Third Case: *This simply combines the two previous cases, growth in labour supply at rate g and technical progress at rate b.*

We then have:

$$C_{G(t)} = L_{t-1}\beta^{t-1}$$

$$C_{W(t)} = L_{t-2}\beta^{t-2}$$

[18]The production of relative surplus value analysed by Marx in Vol I of Capital.

$$P_{G(t)} = L_t / L_{t-1}\beta^{t-1} = \gamma/\beta^{t-1}$$
$$P_{W(t)} = L_t / L_{t-2}\beta^{t-2} = \gamma^2/\beta^{t-2}$$

and the relative price of wine is $P_{W(t)}/P_{G(t)} = \gamma\beta$.

For a numerical illustration, suppose we start out with static population and technology, and a wine/juice price ratio of 1:1. Now if population starts growing at 2% while labour productivity starts advancing at 4% per period, then the optimal price ratio of wine to grape juice will shift to (1.02)(1.04):1, that is wine should cost 6.08% more than grape juice.

Again, Samuelson points out that these rational prices are equivalent to prices derived by marking up labour contents as required by current technique, using as 'profit rate' R, where

$$(1 + R) = \gamma\beta.$$

What should we make of these arguments? First, despite Samuelson's use of the term 'bourgeois prices', this discussion is not very relevant to the debate over the relative merits of capitalism and socialism, as actual pricing in capitalist economies is far removed from the kind of rationality upon which Samuelson insists. The 'equilibrium' rate of profit is far from uniform, and the rate of interest is subject to irrational fluctuations.

On the other hand, the Weizsacker-Samuelson arguments may be relevant to the procedures that should be followed by a rational planning authority. If the planning authorities have at their disposal all the input-output coefficients, and are using these to calculate labour-values from direct labour requirements, then it would not be very difficult to re-calculate modified values along the lines suggested by Samuelson, by first 'blowing up' all the input coefficients by an appropriate factor. This procedure is discussed in the Samuelson quote under the 'first case' above, but is also relevant in the general case where population growth and technical progress are combined. We have suggested that goods ought to be marked with their actual labour content, but for the purposes of determining 'target prices'–in order to apply the consumer goods algorithm[19] –there may be some merit in this alternative. At least one could carry out sensitivity analysis, to see how much difference it would make to the workings of the consumer goods algorithm, and other plan decisions such as choice of technique in order to minimise social cost.

5 The ditching example

Nonetheless, we are not prepared to concede that 'bourgeois pricing' is superior to the use of labour values in general terms. To pursue the point further, it may be useful to take simple illustration of the social superiority of labour time accounting. The example concerns two methods of digging a ditch, each requiring different amounts of direct and indirect labour. One technique uses

[19] See Cottrell and Cockshott 1993, Chapter 8

equal quantities of direct labour and means of production, the other saves on labour but at the cost of additional implements. For instance a contractor might employ 2 men with pneumatic drills to dig the ditch, or one man with an earth moving machine. The table below gives the cost of the two techniques in labour time.

method	direct labour	indirect labour	Total time
old	100	100	200
new	50	125	175

It is clear that in terms of labour time accounting the new method is superior. It saves society 25 hours labour. If we cost this in money terms we get a different result. We will assume that an hours labour adds a value equivalent to £7.50 to the product and that a labourer is paid £3.00 per hour. These were fairly realistic values for British industry in the late 1980s. We then find that in terms of money cost we obtain:

method	direct labour		indirect labour		Total money cost
old	100	£3	100	£7.50	£1050.00
new	50	£3	125	£7.50	£1087.50

In monetary terms the old technique is cheaper. This is because the contractor pays only for part of the labour expended by his workers whilst he pays for the whole cost of the labour embodied in machines. The use of bourgeois calculation is here socially irrational though privately profitable.

Suppose that direct labour is applied one period in advance of output, and indirect labour two periods in advance, and suppose we apply the Samuelsonian criterion, using a 'profit' parameter R. Then the respective costs of the two methods are: $\begin{matrix}\text{old} & 100(1+R)+100(1+R)^2 \\ \text{new} & 50(1+R)+125(1+R)^2\end{matrix}$ and the condition for the social superiority of the new method is then

$$50(1+R)+125(1+R)^2 < 100(1+R)+100(1+R)^2$$

dividing by 25 we get

$$2(1+R)+5(1+R)^2 < 4(1+R)+4(1+R)^2$$

$$\Leftrightarrow \quad (1+R)2 < 2(1+R)$$

$$\Leftrightarrow \quad (1+R) < 2 \Leftrightarrow \quad R < 1$$

i.e., if the parameter R is less than 100%, then the new method is socially superior, otherwise the old method remains superior, on this criterion. This particular result obviously depends upon the figures that we have chosen for initial costs. But for any set of comparative costs there would be a corresponding critical figure for R.

Now return to the capitalist calculation. To generalise it, let the wage rate, W, and the amount of value created per hour, H, be considered as variables (in the illustration these were set at £3.00 and £7.50 respectively). The capitalist costs of the two methods are then: $\begin{matrix}\text{old} & 100W+100H \\ \text{new} & 50W+125H\end{matrix}$ so the new method

is more profitable if and only if

$$50W + 125H < 100W + 100H$$

$$) \quad 2W + 5H < 4W + 4H$$

$$) \quad 2(W/H) + 5 < 4(W/H) + 4$$

$$) \quad 1 < 2(W/H) \;) \quad W/H > .50$$

But $W/H > .50$ says that the workers get back in wages more than half of the value of their output, i.e. the rate of surplus value is less than 100plan parameter R plays an equivalent role to the rate of surplus value in the capitalist calculation.

This can be shown to hold more generally. Let d_0 and i_0 denote respectively the direct and indirect labour requirements for the old method, and d_1 and i_1 denote the direct and indirect requirements for the new. By the same reasoning as above we arrive at the following criteria for the superiority of the new method over the old, in the planned system using parameter R and the capitalist profitability calculation: planned: $(d_0 \quad d_1)/(i_1 \quad i_0) > 1 + R$ capitalist: $(d_0 \quad d_1)/(i_1 \quad i_0) > H/W$ That is, $(1 + R)$ and H/W play an equivalent role, but

$$1 + R = H/W \Rightarrow R = H/W \quad 1 = (H \quad W)/W$$

and, given the definitions of H and W, $(H \quad W)/W$ corresponds to the rate of surplus value.

However a problem is raised by this. In our example we use plausible UK data with a rate of surplus value in excess of 100 per cent. Now if Samuelson's R is defined as above, i.e.

$$(1 + R) = \gamma\beta$$

where g is the rate of growth of labour supply and b is the rate of labour-saving technical progress, then R is clearly much less than 100% (probably less than 5%). So it would appear that new direct-labour saving methods which satisfy the social R criterion are quite likely not to satisfy the capitalist profitability criterion.

The obvious ideological sleight of hand in Samuelson's case is to go from a rate of interest equal to the rate of growth of the economy to say that this is the 'bourgeois' method of economic calculation. It would only be the same under very restrictive assumptions:

1. if all profits went to finance new investment, and
2. if technology did not change ,and
3. if the working population grew at the same rate as the stock of capital.

This would effectively be a von Neumann growth model[**?**].

These criteria are clearly unrealistic. A substantial part, perhaps the greater part of surplus value, goes to meet the extravagant lifestyle of the upper classes and contributes not one whit to technical progress or economic growth. This is what is at the heart of the discrepancy. The R that would be used in a rational calculation is comparatively small, perhaps 5%, whereas the rate of surplus value is much higher than this. This means that a labour-saving technique which passed the R test might still appear expensive in an economy where the rate of surpus value was at a more realistic figure of 100% to 200%.

Consider the effect of a uniform reduction of wages by 30% in an economy with an initial split of the working day 60/40 wages to surplus value: the rate of surplus value would rise from 66labour intensive activities–sweated trades, fast food outlets, telephone cleaning services and assorted skivvying–would become economically viable. This would have taken place without any alteration in d (the rate of exogenous technical change) or in r (the rate of growth of the labouring population). Thus on rational grounds there would be no basis for switching labour into these labour intensive activities, it comes about solely due to the change in the distribution of income between classes in society. The example is not fanciful, one saw it work in reverse between 1939 and 1950 when a rise in the share of income going to workers meant that the middle classes could no longer afford private servants and encouraged the market for domestic appliances. Hoovers and washing machines had been available technically, with little change, since the turn of the century but it was not worth buying them so long as maids could be hired for 2 a week.

This rise in wages did not mean that the rate of growth of the economy slowed down, on the contrary a higher cost of labour encourages the use of more machinery which in turn accelerates technical change. Historically therefore one could as well argue for an inverse correlation between the rate of surplus value under capitalism and the rate of technical improvement. The classic example of this must be the 19th century USA where the free availability of land held wages up and encouraged labour saving innovations which in turn let to the US having the highest labour productivity in the world.

By contrast in a socialist economy, the rate of surplus product and the rate of growth of the economy might be more closely related, since we can assume that the wasteful consumption of the rich has been done away with. If we are dealing with an economy undergoing extensive growth, as in the USSR during initial socialist industrialisation, then there will be a strong positive correlation between the two. If the rate of surplus product extraction is high, we might assume that R will also be. Under these circumstances, it may be rational to use techniques that are more labour intensive than a simple undated labour time calculation would justify.

The large scale irrigation work done in China in the 60s, was largely accomplished using mannual labour even though it might have been cheaper on a labour cost basis to use bulldozers. But the point was, that the bulldozers did not exist whereas the labour power did. Even a simple planning in kind would reveal this. Consider what would happen if China had been using our

proposed planning mechanism. The local communes would propose to build a dam and calculate the cheapest way of doing it in terms of labour. This could involve half a dozen JCBs and 10 workers. They submit this plan to the planning computers. These perform a physical balance operation and come out with the result that the activity is to be operated at a zero intensity level because there are not enough JCBs to go round all the communes that want them. The commune then puts in for a second attempt suggesting the use of 50 workers with picks and wheelbarrows. Since there are no material resource constraints, this is allowed to go through. What this shows is that the most labour saving alternative technique for a given task may not be feasible in an economy with severe shortages of machinery, so that local attempts to optimise the use of labour time may have to be overridden by global resource constraints.

In a developed industrial economy the situation is rather different. R is likely to be much lower than in an economy undergoing extensive industrialisation as the size of the labour force does not change so fast. In this case, errors due to using labour values for an initial calculation of what is the cheapest technique, will be much smaller. They will certainly be far less than those induced by a 100% rate of surplus value in a capitalist economy.

Let us consider what the effect of these errors will be: Goods with a long production period–wine in Samuelson's example–will sell for the same price as goods with a short period–grape juice. Use of our marketing algorithm will result in somewhat more wine being produced than would be optimal if

(a) the rate of non technical growth r is ¿0; or

(b) the rate of technical growth is ¿0 and we use current costs rather than historic costs.

If on the other hand we assume that r is relatively close to zero and that we use historic labour costs, then the use of labour values will produce a resource allocation that is almost identical to the Samuelsonian optimum.

The issue is obviously only serious when planners are dealing with projects with a very long time horizon–the Channel tunnel versus a new ferry and a tidal barrage versus a coal fired power station. In these cases, the bourgeois method of calculation as used by the electricity authorities can lead to some very conter intuitive results. For instance advocates of the severn barrage say that using conventional accounting techniques the difference between assuming that the

2) In an economy with a stable population the errors are small and can be removed by using historic labour costs.

3) These 'errors' are with respect to a standard that itself produces some anomalous results in evaluating long term proposals and are likely to be ecologically benign errors.

4) The errors are far far less than those induced by the exploitation of cheap labour in a capitalist pricing system.

6 Conclusion

A question may well suggest itself to the reader of the above arguments: Are we not being supremely arrogant is supposing that we have come up with an adequate scheme for central planning where the 'best minds' in the USSR failed over a period of, say, 25 years? (That is, from 1960 or so, when the issue of reform of the planning system emerged, until the late 1980s, when this whole conception was abandoned in favour of a transition to the market.) Our answer is, Not really, it's not that we think ourselves smarter than the Soviet economists, rather we are not operating under the same constraints. The two main intellectual inputs into our scheme are (a) a critical, non-dogmatic Marxism and (b) modern computer science. It was very difficult to combine these in the old USSR, where 'Marxism' so often served an obscurantist, anti-scientific function. Our views would probably have been considered deviationist by the guardians of orthodoxy... and at the same time naively socialist by those whose view of socialism was formed in the cynical Brezhnev years, and to whom Marxism was therefore nothing but a fossilized dogma.

A further point merits at least brief mention in conclusion. The material in section 3 above relates only to the technical feasibility of our planning proposals; political feasibility is another matter altogether under current conditions. But we have two remarks to make on this. First, although it lacks any clear political articulation at present, there remains a reserve of popular support for some form of socialism in Russia, according to the research cited in Kotz (1992).[20] Secondly, we would point out that although our own proposals are further removed from current conventional wisdom than market socialist proposals, so far as feasibility of implementation is concerned the market socialists are essentially in the same boat as ourselves: if the principal means of production are privatized, socialism of any sort is off the agenda, and probably for a long historical period.

Whatever might be the prospects for implementing the sort of planning scheme we have outlined in the foreseeable future, we hope that these arguments will provoke a further reconsideration of the socialist calculation debate. We hope, that is, to have shown that the collapse of the Soviet system cannot in itself be taken as proof of the validity of the Austrian, or any other, case for the

[20] As of May 1991, a poll conducted in Russia showed 12% of respondents in favour of "a socialist society along the lines we had in the past", plus 43% favouring "a more democratic kind of socialism". Only 20% favoured "a free market form of capitalism such as found in the U.S. or Germany".

general impossibility of effective socialist planning.

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