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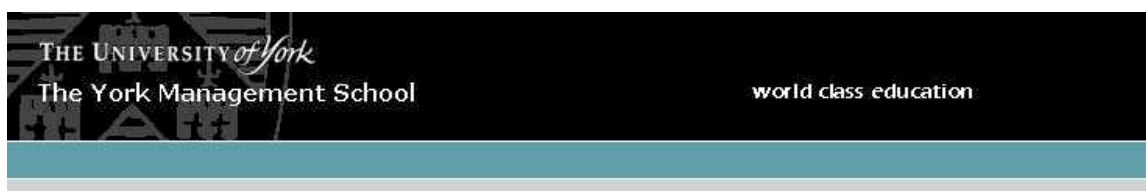
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Working Paper

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Working paper number 52.

University of York
The York Management School
Working Paper No. 52
ISSN Number: 1743-4041
March 2010

**Accounting and Labour Control at Boulton
and Watt, c. 1775-1810**

Steven Toms

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Abstract

The paper offers a new perspective on the management and accounting practices at this pioneering firm of the British industrial revolution. Using a historical materialist approach, it offers an alternative to the economic rationalist, Foucauldian and Marxist explanations in the prior literature. Based on preliminary archival research, it shows how the business practices of Boulton and Watt reflected the norms of the eighteenth century and before rather than overtly capitalist methods and used accounting to solve the problems of pricing their product and the supervision and control of labour.

Introduction

Boulton and Watt (B&W) was a pioneering firm in the British Industrial Revolution (BIR) in terms of technical and administrative innovation. Its activities were closely linked to key scientific and technical advances of the late eighteenth century. Unsurprisingly, it has been the focus of considerable historical research and has played an important role in the debates on the role of accounting in the BIR (Fleischman et al 1996). Foucauldians, Marxists, and economic rationalists (who follow selective doctrines of Adam Smith),¹ tend to propagate the enduring and unerring wisdom of their chosen philosopher, which is also an unfortunate trend in much modern academic writing. So, although, this paper takes Marx as a starting point, it recognises his ideas were incomplete as far as accounting is concerned, and takes a Marxian approach to develop them, working with historical fact and subsequent theory as appropriate.

The perspective offered below differs from the economic rationalist perspective by arguing that the regime of capital accumulation, as opposed to market pressures, was the second important determinant of accounting change. In common with the Foucauldian perspective it attaches fundamental importance to the process of monitoring and controlling labour.² It differs from the Foucauldian perspective by arguing that a crucial but neglected element of the labour process is the valorisation stage, in which controllable labour outputs are converted into appropriable economic values. Labour control is not just a problem for theory in the Marxian framework. It is also central to the Foucauldian, Economic Rationalist

¹ Stressing the invisible hand and ignoring the labour theory of value. For example, ‘The annual labour of every nation is the fund which originally supplies it with all necessaries and conveniences of life which it annually consumes...’ Smith, A. (1976) *An Enquiry into the Nature and Causes of The Wealth of Nations* 1976, vol.2, p.10, Campbell, R. H. and Skinner, A.S. (eds), Oxford: Oxford University Press.

² For general aspects of the Foucauldian position on accounting history, see Hoskin, K. and Macve, R. (2000), ‘Knowing more as knowing less? Alternative histories of cost and management accounting in the U.S. and the U.K.’, *Accounting Historians Journal*, 27: 91-149.

and Marxist perspectives on modern management.³ For the Foucaudians control is exerted through a disciplinary gaze, facilitated by the use of accounting information. For the economic rationalist, innovation in accounting and managerial technique follows from competitive market pressures and from innovations in the productive base of activities and the associated organisation of the labour process. In the Marxian interpretation, supervision arises because there is exploitation.

For simplicity, the paper deals with only the Marxian and economic rationalist perspectives of the evolution of industrial capitalism and associated developments in accounting. North and Thomas developed an economic rationalist explanation of the transition from feudalism to capitalism. In doing so, they pointed out that the Marxian interpretation for a long time was the only consistent attempt to theorise the transition consistently, and propose an alternative institutional economics based perspective.⁴ Although the property rights literature is generally hostile to Marxism, it nonetheless offers insights that allow a productive reformulation of Marx's basic propositions on exploitation, technical labour, and the problems of supervision. At the same time, such a reformulation offers the opportunity for a renewed critique of institutional economics.

³ For the Foucauldian and economic rationalist perspectives, see Fleischman, R.K., Hoskin, K.W., and Macve, R.H. (1995), "The Boulton & Watt Case: The Crux of Alternative Approaches to Accounting History?" *Accounting and Business Research*, Vol. 25, No. 99: 162-176. For the Marxist perspective see Bryer R.A. (2005) 'A Marxist accounting history of the British industrial revolution: a review of evidence and suggestions for research', *Accounting, Organizations and Society* 30: 25–65. The perspective offered in this paper is similar to Bryer, but there are also important differences. It is beyond the scope of the present discussion to speculate about which of these corresponds closest to Marx. For convenience, 'Marxian' refers here to the general line of argument followed by the present author and some Marxist scholars.

⁴ North, D.C. and Thomas, R.P. (1971), 'The Rise and Fall of the Manorial System', *Journal of Economic History*, 31, 777-803. For example by commuting labour dues into fixed money payments, which came to be accepted as the customary price, lords were able to transfer natural risk to the peasant (pp.794-5).

Such a reformulation of Marx allows the assimilation of accounting categories into a historical materialist framework. To a certain extent, the advocated approach is similar to Bryer's recent study, for example encompassing Marxian categories such as the valorisation of the labour and the socialisation of capital.⁵ Instead of arguing, like Bryer, that these categories provide historical reference points for a Marxist theory of accounting, and offer evidence of a modern 'capitalist mentality', the paper explores the extent to which accounting technique and accountability are responsive to changes in the productive base and associated changes in the accumulation and ownership of capital.

These arguments are tested using the evidence available in the extensive archives of Boulton and Watt. To examine the labour process elements of the argument, particular attention is paid to the indentures and service agreements for piece and day rate employees. To examine the capital accumulation elements of the argument attention is concentrated on the financial accounts, in particular the partners' capital accounts and cash flows associated with profits from operations, capital appropriation and reinvestment. In concentrating explicitly on these areas it is hoped to offer new perspectives on an important set of debates about the role of accounting in the BIR.

New Marxian Perspectives on The Labour Process

Historical materialism and accounting: The key variables

The Marxian approach suggested here examines the interaction of technological development and appropriation of surplus. Marx correctly identifies the effects of technology and the motive of exploitation as determinants of early capitalisms dynamism. His model admits for variation in the extent to which these tendencies pervade actual practice and their rate of

⁵ Bryer 'A Marxist accounting history of the British industrial revolution.'

influence. In the 1830s and 1840s in particular, a time when international competitive pressures led to a decline in real wages in Britain, the pressure for greater exploitation of labour became more intense.⁶ Lazonick's interpretation of Marx, as being a model of where 'capitalists essentially get their way'⁷ reflects the time perhaps when Marx developed his ideas, but is not necessarily correct if the objective is to develop a historical materialist model of accounting change over a longer period.⁸

The history of the early nineteenth century and of the class struggle more generally, is one of capital seeking to overcome barriers to its efficient exploitation of resources. Its attempts to do so can either enhance or retard the development of the productive forces. It is not concerned with efficient development per se, only with the efficient exploitation of labour. In order to achieve this, it must overcome the problem of supervision. Although the problem of supervision is perennial, it appears in different guises according to the social relations of production. As feudalism develops the steward, capitalism develops the foreman.⁹ Accounting information and accountability is modified in the same way, so that the court

⁶ Foster, J. (1974), *Class struggle and the industrial revolution*, London: Methuen.

⁷ Lazonick, W. (1979), 'Industrial relations and technical change: the case of the self acting mule', *Cambridge Journal of Economics*, 3: pp. 231-262, p.231. In introducing new divisions of labour and machinery and in intensifying work they meet with the resistance of workers (Marx, 1967, pp. 367, 427), but the power of capital triumphs by virtue of the very technologies at its disposal (Marx, 1967, p. 43 Iff.). Lazonick argues that this did not happen because the social division of labour, in the form of internal subcontracting *ex ante* the introduction of new technology acted as a barrier to deskilling effects of machinery.

⁸ For other examples see: Toms, S. (2005), 'Financial Control, Managerial Control and Accountability: Evidence from the British Cotton Industry, 1700-2000', *Accounting Organizations and Society*, Vol.30, pp.627-653; Toms, S. (2010) 'Calculating profit; a Historical Perspective on the Development of Capitalism, *Accounting, Organizations and Society* 35 (2010) 205–221

⁹ These social modes of accountability parallel Marx's famous quote on the development of the productive forces... 'The hand-mill gives you society with the feudal lord; the steam-mill, society with the industrial capitalist'. *Poverty of Philosophy*, chapter 2.

rolls and ledgers of the earlier period are replaced in the later period with the budgets and production reports. Only under capitalism is there a further role for accounting, which associated with its technical dynamism, is the problem of obsolescence and associated revaluation of the productive forces. In turn these revaluations interact with the trade cycle and disrupt the social relations of production.¹⁰

At the same time, technical development reorders the problem of the supervision of labour. Supervision is costly, a point that Marx recognised, and there are options available to the capitalist in response. As this article will argue, these responses are historically contingent, and depend to some extent on the prevalence of a priori social relations and their subsequent dissolution by the development of the productive forces. They are also contingent on the precise technical composition of the productive forces, and the consequent level of monitoring costs.

The inter-relations between the base and superstructure are shown in figure 1. Accounting mediates the interaction between base and superstructure, which is a historical process. A set of productive forces at any given point in time (productive base 1) requires accounting to assign values to the outcomes of its activities. In this sense, valorisation connects the labour process in the productive base, as the transmission of physical and mental energy into commodities, to the distribution of value in the form of wages and surplus. Surplus is reinvested into the base to create a subsequent set of productive forces (productive base 2). Marx regarded science as a direct force of production and the mental effort of the worker as part of the labour process.¹¹ In other words these are part of the productive base rather than the superstructure of social relations insofar as they are connected to the function

¹⁰ Bryer, R. (1998), 'The laws of accounting in late Nineteenth Century Britain, *Accounting History*, 3: 55-94.

¹¹ Marx, *Grundrisse*, pp.540, 699, 706; Marx, *Capital I* p.174 Pelican ed. p.284.

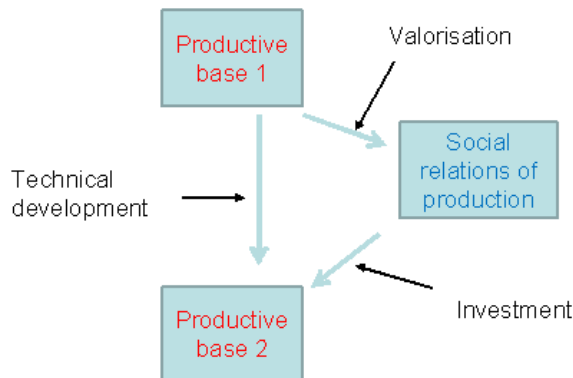
of production. Other factors such as geographical influences on the location of production (for example proximity to markets of sources of supply) tend to affect the origin of profit, and therefore constitute components of the productive base. It is the social relations of production that affect the distribution of surplus wealth. Earned surplus and its distribution, whether accumulated within the same business unit, accumulated through personal wealth or accumulated through interactions between different industries or economic sectors has a crucial impact on the character of and rate of economic growth. Accounting responds to these requirements as well as responding to changes in productive organisation.

The social relations of production therefore determine the distribution of the product of the labour process.¹² In these respects the role of accounting is clear. It is to assign values to the assets arising from the labour process in the form of prices of production¹³ and to regulate the distribution of those values between surplus, wages and rents. Because through time the character of the productive base is itself transformed through qualitative changes in the knowledge base, organisational learning and technical development, accounting is required to assign values to modified activity concomitantly with the normal circulation of capital. Productive base 2 therefore reflects the interaction of these processes.

¹² Godelier, M. (1978), 'Infrastructures, society and history', *New Left Review*, 112, 84-96.

¹³ By adding the average rate of profit to the cost of production.

Figure 1: Base and superstructure, historical materialism and accounting



The origins of financial risk in the labour process

Capitalist profit is a payment for the use of the factor of capital, for the capitalist's management expertise, or as an incentive for the capitalist to risk investment, ie as a cost of production rather than a social surplus.¹⁴ Categorisation between wages and surplus is problematic where elements of the surplus appear as payments for necessary production costs. If all the surplus can be defined in this fashion, then Marx's notion of exploitation also disappears. Roemer argues that for exploitation to occur there must be a practical alternative where workers are better off and capitalists are worse off. Under these conditions profits are only exploitative if they are above the price workers would need to pay to obtain the capital they require to continue production on their own.

¹⁴ Rigby, S. (1998), *Marxism and History: A Critical Introduction*, (Manchester: MUP, 2nd Edition), p.21.

An independent workers' co-operative would arguably face the same business and financial risk as a capitalist enterprise. Business risk for example might arise as a result of fluctuations in demand for the product or service and financial risk from the use of third party fixed interest loan finance in some ratio to the capital advanced by the owners of the business. These classes of risk have a cost and are worth paying to avoid, in the form of lower wages in the case of business risk or higher dividends to capital providers in the case of financial risk. If risk can be priced accordingly it is possible to compute the normal profit or return to capital necessary to avoid the workers being worse off.

We begin by assuming an atomised economy where all workers are entrepreneurs and all are self employed, so that all are likewise risk takers. For now, labour is the only cost. The only assumption necessary at this stage is that financial risk arises from transactions between individuals and does not correspond to an ex ante differentially distributed stock of wealth and is in other words a zero sum game. A parallel concept applied to risk in general rather than financial risk in particular, is Beck's notion of manufactured risk as the product of human activity.¹⁵ Similarly, where markets in risk are created, for example derivatives markets, they are zero sum games.¹⁶

Using these assumptions, on average participants' profits are the risk free rate plus the market risk premium, which is based on the aggregate risk faced by all entrepreneurs. In return for such risk, entrepreneurs demand a rate of return at a premium to the risk free rate, lest they simply earn the risk rate by withdrawing from entrepreneurial activity. Risk can also be avoided by an entrepreneur agreeing to become an employee of another, insofar as an

¹⁵ Beck, U. (1992), *Risk Society: Towards a New Modernity* (London: Sage).

¹⁶ Telser, L.G. (1981), 'Why There are Organised Futures Markets', *Journal of Law and Economics*, Vol.XXIV No. 1, pp.1-22. Derivatives are defined for current purposes as instruments of circulation rather than part of the means of production and are not therefore part of the process of value creation.

employment contract can be written that guarantees a wage regardless of the level of activity and achieved sales revenue and is an incomplete contract in terms of the specification of work.¹⁷

If these conditions are met, risk is transferred from the employee ex-entrepreneur to the employing entrepreneur. The degree of risk transfer is determined by the aggregate ratio of fixed to variable cost. Because total risk is a zero sum game, and value has a linear relationship to risk, the fixity of labour cost produces a proportionate increase in the required rate of return needed to induce the entrepreneur to employ a labourer. Meanwhile the entrepreneur cum labourer will accept less value in return for less risk. If the employer imposes a variable and complete contract of employment so that the labourer bears all the risk, the labourer has no incentive to remain and will revert to self employment.

Meanwhile there is a corollary that the risk free rate corresponds to a market wage rate which is just sufficient to prevent employees defecting to self-employment in conditions of perfect contract variability and specificity. Or put simply, because the employment conditions are unattractive, and the employee bears the full risk of the economic cycle, wage compensation needs to rise to prevent defection. The implication would be that if the base interest rate is say 5% and total sales and total assets are indexed to 100 and employment is the only cost and is completely variable then the wage bill will be 95, so that the wage: profit split is 95:5. However, suppose the expected profit ratio is 20%, to which the corresponding expected wage bill is 80, it would follow that there is a risk premium of 15%, the difference between the rate of profit and base interest rates. Of the wage cost of 80, 60 must be fixed in contractual terms, since this would allow profit to vary with sales in the ratio 4:1. The

¹⁷ For discussion of earlier and comparable arguments, see Bohm Bawaerk, *The Positive Theory of Capital*, trans. William Smart (London and New York: MacMillan and Co., 1891), p.83, and implicit contract theory, Rosen, S. (1985), *Implicit Contracts: A Survey*, *Journal of Economic Literature*.

employee is much safer in this scenario and their proportion of average value appropriated falls from 95% to 80% of the total, whilst the corresponding shift to profit corresponds to the shift in risk. An individual firm with a greater proportion of fixed cost than the average of 60/80 would attract a proportionately greater risk premium and correspondingly the entrepreneur would demand a higher rate of return.

In this zero-sum game world, it is clear that wealth is being redistributed as an exact *quid pro quo* for the transfer of risk between labour and capital. Of course, if ex ante wealth endowments are now assumed to be unequal, and friction in markets and the adjustment process described above are introduced, exploitation becomes possible. To impose exploitation, the capitalist has two alternatives. The first is the temptation, in the absence of organisation amongst the working class, to drive down wages to the lowest possible level. The second, which has been less extensively considered hitherto, is to ensure that the workers bear the full risks of productive activity. Marx makes frequent mention of the risk of industrial accidents and ill health faced by different groups of under-protected workers including children. As far as business risk is concerned, this can also be transferred to the workers in the form of piece rates and penalties. Marx again quotes examples of such practices, but does not make an explicit theoretical link between risk and exploitation. Unpaid labour is the source of entrepreneurial wealth. In the new formulation presented here, entrepreneurs can also exploit by requiring others to take risk on their behalf, and earning profits at the rate commensurate with them taking the risk themselves. To impose such unequal bargains, the capitalist requires, in the absence of direct coercion, either enforceable contracts or transparent supervision. Workers can avoid being made worse off in these circumstances in cases of task complexity where contracts can be only partially specified or through shirking in the absence of direct supervision.

Although providing the conceptual tools, neither Marxian nor mainstream economics has re-examined the labour process as stochastic. According to this view,¹⁸ there is a direct relationship between the scale of monitoring problem, the contractual response and the risk transmitted to financial markets and the consequent valuation of capital. For example if the labour process is technically complex, difficult to monitor by non-expert supervisors, and where labour is paid a fixed wage, then profit will vary in greater amplitude with variations in the level of output. In addition to the inverse relationship between supervision cost and surplus value, there is therefore also an inverse relationship risk inherent in the labour process and the marketable value of capital. The higher the risk, the greater the implied supervisory cost required to achieve the average rate of profit. Where risk is high and profits low in the absence of adequate supervision, either labour can appropriate rent or its output is sold above value.

The link between the labour process and financial market valuation of capital presents a further perspective on the development of the productive base in technical terms and the characteristics of the superstructure of social relations. Where capital markets are not engaged in the production of fictitious capital and financial speculation they provide equilibrium values of the risky underlying profits of quoted firms. Marx's characterisation of the labour process as co-operation is set out in parallel to the process of valorisation. Accounting control is central to the valorisation process. The anti-managerialist representation of the Marxian labour process combines a technical base with a valorisation

¹⁸ Toms, S. (2006), 'Asset Pricing Models, the Labour Theory of Value and their Implications for Accounting' *Critical Perspectives in Accounting*, Vol.17, pp.947-965. Toms, S. (2010), 'The labour theory of value, risk and the rate of profit' *Critical Perspectives in Accounting*, 21, pp. 96-103. Toms, S. (2010), 'The social risk rent thesis: A reply to Harney' *Critical Perspectives in Accounting* 21, pp. 90-95. Toms, S. 'Value, profit and risk: accounting and the resource based view of the firm' *Accounting, Auditing and Accountability Journal* (forthcoming).

superstructure. Accounting is implicated in both, in the former as a mechanism for superintending the transformation of advanced constant capital through the application of labour, and in the latter as a determinant of the distribution of value between capital and labour. In the base, accounting has the function of recording changes in asset value arising from production. Double entry bookkeeping facilitates the recording of these asset values concomitantly with changes in wealth distributions in the superstructure. Supervision is not an end in itself, but merely one way to ensure that changes in asset value achieve appropriate changes in wealth.

Theorising supervisory costs and the labour process

For Marx, the industrial capitalist has a dual personality, as the owner and employer of capital. In the former case, he receives interest and in the latter, the profit of the enterprise.¹⁹ Any effort expended by the entrepreneur in the labour process is not proportionate to the extraction of surplus value, since that relies on arrangements for the exploitation of labour including supervisory arrangements. The wage labourer is accordingly compelled to produce his own wages and also the wages of supervision (Marx, III, p.386). Wages, including supervision costs, are separated from the profits of the enterprise.²⁰

Direct supervision is therefore only required where there is exploitation. Supervisory labour is accordingly unproductive labour as it is only a necessary condition for capitalist production, not production in general. It also follows that the rate of surplus value (s/v) is

¹⁹ Marx, *Capital*, III, Ch.23.

²⁰ In co-operative factories, managerial wages are part of the normal variable capital and such factories achieve a higher level of profit on the capital advanced independent of the magnitude of managerial wages (Marx, III, p.388). See also Ellison (1886).

inversely proportional²¹ to the costs of supervision, and that supervision costs are only zero in abstract perfect competition.²² Marxist categories of managerial, supervisory and unproductive labour are subject to definitional problems and are context determined. Accounting and accounting historians in particular can therefore provide further perspective and understanding of these problems.

The first problem is that classification of these categories of labour has given rise to differences in Marxist thought, which can be characterised as managerialist and anti-managerialist (Rowlinson et al, 2006).²³ The anti-managerialist view is most typical of Marx's own writings on the subject, in which skilled labour is displaced by machinery and capitalist oversight is replaced by managers as a consequence of the inexorable advance of technology. In this view the supervisory process is constantly disrupted by technological change which must be adopted if the process of competition is to be survived. It is anti-managerialist in the sense that machinery is the key weapon, for the control of labour and for the progressive redundancy of the capitalist as a supervisor. In other words, capital triumphs over labour by virtue of the technologies at its disposal, not as a function of its *sui generis* social power of supervision. Marx's model can be described as purely Darwinian, viewing the adaptation of machinery and the refinement of tools as a response to the requirements of

²¹ For empirical evidence on the relationship between unproductive (including supervisory) labour and rates of profit, see Moseley, F. (1991) *The falling rate of profit in the postwar United States economy*, Macmillan.

²² In perfect competition the market is the only co-ordinating mechanism (Coase, 1937).

²³ M. Rowlinson, J.S. Toms and J.F. Wilson (2007) Competing Perspectives on the 'Managerial Revolution': From 'managerialist' to 'anti-managerialist', *Business History*, Vol. 49,4, pp.464-482. M. Rowlinson, S. Toms and J.F. Wilson (2005) 'Legitimacy and the capitalist corporation: cross-cutting perspectives on ownership and control,' *Critical Perspectives in Accounting*, Volume 17, Issue 5, July 2006, pp. 681-702. Some authors, for example de Vroey (1980, p.227), argue that 'managerialists' such as Burnham are not Marxists.

expanded production and the division of labour (Productive base 1 - Productive base 2; figure 1).

Such a view of is an incomplete representation of the Marxian approach based on historical materialism. Feudal monopoly and capitalist competition are in dialectical opposition, suggesting that the synthesis of modern monopoly contains transformed vestiges of feudal monopoly.²⁴ As far as the labour process is concerned, these include skilled labour and craft production, inherited from feudalism, which act as a historical break on the technical substitution of skilled labour. Marx makes his case using evidence from the cotton industry, which experienced rapid technical change in the period of publication of the *Poverty of Philosophy* and the first volume of *Capital* in 1865.

The second problem is historical variation. Marx refers to the ‘sweating system’, where piece wages allow the capitalist to make a contract with the most important worker, in manufacture, the chief of some group, who enlists and pays assistants. ‘Here the exploitation of the worker by capital takes place through the medium of the exploitation of one worker by another’.²⁵ Even in the cotton industry, where sweating and child labour were most prevalent, there is evidence that labour was able to resist the processes that Marx describes.²⁶ For Marglin, the adoption of the factory system was a response to the monitoring problems in the putting out system, notwithstanding technical improvements that boosted the efficiency of the domestic system.²⁷ The fundamental problem was the risk of embezzlement, against which severe legislation was insufficient sanction and control of the labour process by the direct

²⁴ Marx, *Poverty of Philosophy*, p.140.

²⁵ Marx, *Capital* Vol 1, p.695

²⁶ Lazonick, ‘Industrial relations and technical change,’ p.232.

²⁷ Marglin, S. (1980), The origins and functions of hierarchy in capitalist production, in Nicholls, T. (ed) *Capital and Labour*.

producer. Financial accounting, rather than management accounting evolved as a response to the governance problems created by the putting out system.²⁸ Although the internalisation of the productive process in the form of the ‘sweating system’ was the apparent solution to these problems, skilled labour retained some degree of control recruited into the factory system. For example, the social division of labour, in the form of internal subcontracting to family groups, *ex ante* the introduction of new technology, acted as a barrier to further deskilling effects of machinery.²⁹

As the case of the replacement of putting out with the factory system in the cotton industry makes clear, there was no simple solution to the problem of supervision from the capitalist point of view. Indeed, the problem of cost effective supervision has underpinned not just the debates within Marxism but also the development of transaction and agency cost literatures in mainstream economics. Of course, Marx never dealt directly with the role of accounting and as a consequence did not define its precise role in terms of his base and superstructure dichotomy.

Boulton and Watt

Feudal and proto-industrial elements of business practice

Marx’s history of primitive accumulation explains how unequal wealth endowments were generated before the industrial revolution and shows that peasants forced into industrial towns could readily be conscripted for want of alternative sources of livelihood. Social and political elements of the superstructure of social relations were an important influence on subsequent developments at B&W. there are several elements, the most important of which are the legal monopolies and custom and practice were important features of the Stuart and

²⁸ Toms, ‘Financial Control, Managerial Control and Accountability.’

²⁹ Lazonick, ‘Industrial relations and technical change,’

early Hanoverian economy.³⁰ Other elements of custom and practice include the notion of the just price, restrictions on usurious lending, and regulated wages. These practices evolved concomitantly with the putting out system.

Monopoly is an important theme in the development of B&W, whether through the use of blocking patents or taking control of supply chains or markets that were otherwise at risk. In 1785, Boulton was instrumental in forming the Cornish Metal Company, which until 1792 operated as a cartel³¹ which could be compared most closely to a Stuart monopoly of purchase and sale.³² This was not the first time Boulton had attempted to set up such a monopoly. In 1766, he petitioned parliament (unsuccessfully) to prevent the export of buckle chapes, in order to reinforce the market dominance of buckle manufacturers.³³

These developments had separate impacts on accounting. The application of patents at remote locations required extensive monitoring and explains the complex negotiations affecting royalty payments and the personalised and decentralised process of securing accountability from licensed contractees. For example books of the mines were liable to inspection by B&W.³⁴ Conversely the requirement to control supply necessitated the integration of production, and provided the rationale for the development of the Soho works and increased reliance on cost accounting. As Roll suggests: ‘the change in organisation

³⁰ Tawney (1926), *Religion and the Rise of Capitalism*, p.270) concludes that: ‘It is sometimes suggested that the astonishing outburst of activity, which took place after 1760, created a new type of economic character, as well as a new system of economic organisation. In reality, the ideal which was later to carry all before it, in the person of the inventor and engineer and captain of industry was well established among Englishmen before the end of the seventeenth century.’

³¹ Dickinson, H. W. (1936). *Matthew Boulton*. Cambridge: Babcock and Wilcox, Ltd. pp.131-32.

³² Pollard, *The Genesis of Modern Management*, p.20.

³³ Dickinson, *Matthew Boulton*, pp.31-33

³⁴ Watt to Boulton, 16th September 1778.

following on the taking over of the manufacture of steam engines, which brought the splitting up into departments, tended to raise the standard in the methods of accounting.³⁵

Another important influence of feudal social relations was the regulation of price. In the absence of the economic categories of capital and return to capital, and the universal acceptance of the labour theory of value, elements of feudal scholastic doctrine remained influential.³⁶ Just prices and fair wages were important principles.³⁷ In the eighteenth century, the price of bread in particular was an important determinant of social conflict, and is a good example of the enforcement of the 'moral economy'.³⁸ For example, the Assize of Bread calculated the Baker's allowance, which was determined according to the ruling price of wheat.³⁹ Market manipulations were legislated against, for example forestalling and withholding goods from the market in the expectation of forcing up prices, and infringements tended to provoke riots, seizures and redistribution at 'fair prices'.⁴⁰ These included threats to disrupt the networks distributing hoarded and unfairly priced goods, including the canals that B&W depended on for transportation to and from Soho.⁴¹ In Cornwall, which was the main

³⁵ Roll, (1930), *An early experiment*, p.244.

³⁶ Toms, 'Calculating profit'.

³⁷ E.P. Thompson, 'The moral economy of the English crowd in the eighteenth century' *Past and Present* 50, 1971, pp.76-136. Hobsbawm, *Labouring Men*, London: Weidenfeld and Nicholson, 1968, pp.347-50. Huberman, *Escape from the Market*, p.20.

³⁸ Thompson, 'The moral economy of the English crowd'.

³⁹ Webb, S and Webb, B. (1904), 'The Assize of Bread', *Economic Journal*, 14.

⁴⁰ Thompson, 'The moral economy of the English crowd'. Part of this practice was to account for the profit to the offender, calculated according to what would have been earned had 'fair prices' been charged in the first place.

⁴¹ Josiah Wedgwood had heard it "threatened ... to destroy our canals and let out the water", because provisions were passing through Staffordshire to Manchester from East Anglia: J. Wedgwood, *Address to the Young Inhabitants of the Pottery* (Newcastle, 1783), pp.12-13.

focus of B&W's operation between 1775 and 1795, the tin miners were particularly robust at enforcing fair prices through direct action and bringing recalcitrant merchants to book.⁴²

These influences were therefore especially felt in the years following the establishment of the B&W partnership. In this period, installing engines in the mines of Cornwall accounted for a significant proportion of their business.⁴³ Boulton and Watt were able to cheapen the costs of production in mining but did not seek to maximize profits. Rather they sought a mechanism that was 'quite fair',⁴⁴ which split the savings in fuel cost between B&W and the mine adventurers 1:2. The principle adopted is similar to the 'three rents' notion from Cantillon's *Essai* of 1755.⁴⁵ Although the principle used reflected traditional methods of division dating back to at least Petty in the 1660s,⁴⁶ the method of measurement was new and more controversial. Watt sought to measure these savings precisely using his talent as an instrument maker. Although the negotiations were difficult and Watt's methods distrusted, resulting in a simpler method for calculating the royalty, B&W resisted taking control of production. It was therefore by 'force of circumstance'⁴⁷ that they took shares in certain mining companies.

⁴² Rule, J.G. (1970), 'Some Social Aspects of the Cornish Industrial Revolution', *Industry and Society in the South-West*, ed. Burt, R. (University of Exeter,), pp. 90-1.

⁴³ From 1777 to 1782, Cornish engines accounted for more than 40% of Boulton & Watt's total business. Tann J. (1996), Riches from Copper: the Adoption of the Boulton and Watt Engine by Cornish Mine Adventurers, *Transactions of the Newcomen Society*, vol.67,27-51; p. 29).

⁴⁴ Dickinson, H. W. (1936). *Matthew Boulton*. Cambridge: Babcock and Wilcox, Ltd, p.96.

⁴⁵ Cantillon, R. [1755] 1959. *Essai sur la Nature du Commerce in Général (Essay on the Nature of Trade in General)*, London, Frank Cass. The three rents were split, 1/3 costs of the farmer, 1/3 profit of the farmer, 1/3 rent to the landlord. In the position of patent holder, analogous to the landlord, B&W took 1/3 of the savings.

⁴⁶ Tribe, K (1978), *Land, Labour and Economic Discourse*, London: Routledge and Kegan Paul, pp.92-93.

⁴⁷ Dickinson, *Matthew Boulton*, p.131.

Table 1: Internal Rates of Return on Patented Engines

	B&W	Client	Total
Cost of engine	435*	525	525
Annual Premium at £3.85 per HP per year for 8 hp engine = 30.8	30.8	61.6	92.4
Internal rate of return (IRR)	4.96%	10.84%	17.27%

Source: Calculated from Roll, 1930, appendix

Note: *Calculated using selling price minus total IRR %, so that the cost is shown at production cost to B&W and selling price including margin to the client.

Table 1 shows the internal rate of return (IRR) arising from the 1:2 split of realised savings. The table shows the IRR implied for an 8 HP engine with an invoice cost of £525. Returns for Boulton and Watt might certainly be described as ‘fair’, and indeed surprisingly low when the difficulties associated with disputes and arbitration through the courts are also factored. It is difficult to conclude that B&W did other than exploit the patent insofar as was reasonable within the social norms and expectations of the time.

Charging of interest on capital represented a further aspect of the specific application of the social relations of production. The introduction of official rates in 1571 and their subsequent regulation followed Calvinist doctrine of the tolerance of moderate usury. Businessmen being able to charge reasonable rates for the loan of their capital became an

important norm for the puritan and non-conformist business groups that typically established enterprises outside the jurisdictions of the chartered towns in areas such as the Black Country and Birmingham.⁴⁸ These attitudes also explain the addition of the percentage for a 'reasonable return' referred to by Bryer and of 'fair prices' referred to by Bryer and Fleischman et al.⁴⁹ As was conventional in profit sharing agreements between partners, interest was charged on capital. In the case of Boulton and Watt, a rate of 5% on opening capital was used in the example cited by Roll for 1806.⁵⁰ Partners could quite easily make such charges without any requirement to maximise profits or earn a higher figure than 5% as a target rate.

Control of labour

Previous studies stress the relative sophistication of the accounting and costing practices at B & W.⁵¹ B&W was an 'astonishingly fertile pioneer of scientific management practices'⁵² The control of the labour process has been used to illustrate why this was the case.

Methods of labour control at B&W reflected earlier norms arising from a priori social relations of production. External sub-contracting of labour in particular was problematic from

⁴⁸ Dickinson, *Matthew Boulton*, p.21. Usury laws were increasingly evaded but remained in force notwithstanding growing recognition of their limiting effect on business (BPP, *Report of the Select Committee on the Usury Laws*, 1818), for example *ev. D. Ricardo*, pp.5-6.

⁴⁹ Bryer, 'A Marxist accounting history of the British industrial revolution', p.52, Fleischman, Hoskin, and Macve, 'The Boulton & Watt Case', p.171.

⁵⁰ Roll, *An Early Experiment*, p.259.

⁵¹ Roll, *An Early Experiment*; Dickinson, 1937 and 1967; Pollard, S. (1965). *The Genesis of Modern Management: A study of the Industrial Revolution in Great Britain*, London: Edward Arnold. Fleischman and Parker (1991) qualitatively rated B&W excellent in all four of the cost accounting activity areas that they identified—cost control, overhead accounting, decision-making and standard costing.

⁵² Pollard, *The Genesis of Modern Management*. pp.79, 248.

an accountability point of view. As far as the cotton industry was concerned, supervisory costs were low, when domestic workers were required to account for goods booked in and out on consignment. Risks of embezzlement, shoddy work and late delivery were correspondingly high. Out-workers would embezzle, substitute inferior materials or otherwise renege on agreements, and trade off effort for leisure time.⁵³ As in the case of bread prices, systems of arbitration were administered and used to settle disputes about price and quality.⁵⁴ As a consequence of policing the outwork system, profit rates were low, and appropriations of rents by workers in the form of low effort and leisure time were high. According to Marglin, entrepreneurs adopted the factory system because monitoring costs were high in putting out, not because the factory system offered greater technical efficiency.⁵⁵

After 1795 B&W faced similar management problems of how to ensure efficient production and how to guarantee effective supervision of the labour process. Boulton and Watt's decision to internalise production at Soho in 1795 provided new opportunities. In general the preferred solution to the efficiency problem was to use standard prices and relate bonuses to output, particularly where output can be easily measured at low cost.⁵⁶ Although there is some evidence of less formal piece working agreements in the early 1790s,

⁵³ Pollard, *The Genesis of Modern Management*. Marglin, S. (1976) [1986] What do bosses do? The origins and function of hierarchy in capitalist production. In Putterman (Ed.) *The Economic Nature of the Firm*. Cambridge: Cambridge University Press, p.34. E.P. Thompson, 'Time, work-discipline and industrial capitalism', *Past and Present* 38, 1967, pp.56-97, p.73. Landes, D. (1969). *The Unbound Prometheus*. Cambridge: Cambridge University Press, p.59. Reid, D.A. (1976), 'The Decline of Saint Monday 1766-1876', *Past & Present*, No. 71, pp. 76-101. Toms (2005), 'Financial Control, Managerial Control and Accountability'.

⁵⁴ For example in the textile trade. Daniels, G.W. (1915). The early records of a great Manchester cotton spinning firm. *Economic Journal* 25, 175-188.

⁵⁵ Marglin, 'The origins and functions of hierarchy in capitalist production'.

⁵⁶ Lazear, E. (1986) 'Salaries and piece rates', *Journal of Business*, 59 (3), pp.405-31. B&W developed precise calculations (theorems) to relate labour time to different sized units of output (Roll, *An Early Experiment*, pp.205-06).

formalised piece rates were only made possible by the internalisation of all engine part production at Soho.⁵⁷ Roll gives the example of fitting nozzles on valves, for which there is a standard price of 22s per inch.⁵⁸ In the illustration, the number of days required to complete the task at the standard labour rates results in a cost of production lower than the standard price, which is recorded as ‘men’s profit’. The notion of a bonus as men’s profit is indicative of B&W’s solution to the supervision problem, which was to utilise internal subcontracting. In the case of the nozzles, the work was essentially sub-contracted to ‘Joseph Turner & Co’, a group consisting of John Turner, Joseph Turner and William Smallwood. Joseph Turner Jr. was an assistant paid at a lower rate for his time only (4s per day), which was added into the cost of production, but the share of the resulting profit (the difference between the cost of production and the standard price) was only shared between the senior members of the team.⁵⁹

The methods used depended on the specific aspect of the labour process. Inventive employees such as Murdoch were offered shares in the partnership or alternatively high salaries in return for conceding to the firm property rights associated with inventions and improvements.⁶⁰ Although these concessions reflected the realities of the scale of the supervision problem and the scarcity and power of skilled labour, they were not the result of

⁵⁷ Roll, *An Early Experiment*, p.194.

⁵⁸ Roll, *An Early Experiment*, p.198.

⁵⁹ A further important aspect of internal contracting was the maintenance of cash accounts between James Watt and certain employees, see for example Boulton and Watt Collection, MS/3147/54 Cash account abstract, July, 1810-1827.

⁶⁰ Macleod, C. (1999), ‘Negotiating the rewards of invention: the shop floor inventor in Victorian Britain’, *Business History*, 41(2), pp.17-36; p.22.

managerial weaknesses.⁶¹ The method used for fitting nozzles and elsewhere at B&W is quite similar to the system used in cotton factories where mule minders played a supervisory role.⁶² In this respect B&W used the same solution as the cotton factory masters to the problem of integrating undisciplined family groups into a factory environment.

There were also some important differences. Unlike the fiercely competitive cotton industry, B&W enjoyed a monopoly before and after the expiry of the patent, certainly in terms of the quality of their engines.⁶³ Labour shortages created constraints on manufacturing capacity, so B&W used piece rates and bonuses to ensure that scarce labour was used as productively as possible. At the same time, B&W engines were expensive and there was an incentive to reduce piece rates, in order to make the firm more competitive.

A serious problem for B&W was the availability of less efficient but much cheaper technology available to the industrialists of the rapidly developing cotton industry. Marx's theory of differential rent uses the example of steam and water powered factories.⁶⁴ Watt jnr

⁶¹ Boswell described Boulton as 'an iron captain in the midst of his troops.' M Mantoux, (1962), *The Industrial Revolution in the Eighteenth Century*, New York: Harper and Row. p.376.

⁶² At B&W, Roll interprets it as a continuation of the journeyman system (*An Early Experiment*, p.201).

⁶³ BPP, *Report from the Select Committee on the Law Relative to Patents for Inventions*, 1829, p.32 Ev. Mr J. Fahey, It was not until many years after the expiration of Watt's patent than others developed the requisite knowledge to produce equivalent standard steam engines. There is some evidence that competition was increasing in the late 1790s, although certain industries, for example coal mining, needed different types of engine. Williams, R. (1999) Management accounting practice and price calculation at Boulton and Watt's Soho Foundry: a late 18th Century Example, *Accounting Historians Journal*, 26: 65-87, esp, pp.72-76.

⁶⁴ Marx *Capital III*, (1983, pp.641-48). In his example, the average rate of profit is 15% and water powered factories have a cost of production of 90 and steam powered factories a cost of production of 100. Steam power regulates the market price at 115, allowing the water powered factory (the cost-leader) to earn a rent of 10 and profit of 15. A steam power entrepreneur could pay the owner of the waterfall £10 and still be no worse off producing using water power. The rent is differential and does not enter into the determination of the production price of commodities (Marx, *Capital*, III, p.646.)

acknowledged that cheaper engines, whether Newcomen, Savery, water mills, or copies of Boulton and Watt designs, were available at discounts of £2-300.⁶⁵ In the five years after the opening of Soho, the average size engine supplied to the cotton industry was 18.2hp. The cost of an 18hp engine was £585 with a profit mark up of £292.5 (50%), giving a total price of £877.5.⁶⁶ These figures imply that any attempt to compete with the cheaper manufacturers would have left B&W with no contribution to indirect costs and serious losses. In the early 1790s the wages on offer by B&W in any case compared unfavourably with the cotton industry.⁶⁷ Cutting piece rates would have been as difficult as cutting prices, in view of the shortage of skilled engineering labour. It would also be the case that significant cuts in rates would have made no difference to the firm's competitive position, since labour costs accounted for only a small proportion of total cost. Even the most labour intensive activity, engine fitting, accounted for only a small percentage.⁶⁸

Boulton and Watt's strategy was therefore to charge high prices for high quality and relatively low volume activity. They did not try to penetrate the Lancashire market other than the larger manufacturers, whose scale could justify the expense of the investment.⁶⁹ The consequence was that the foundry investment generated profits substantially better than had been achieved in the consulting engineering phase (table 1).

⁶⁵ Musson, A.E. and Robinson, E. (1958), 'The early growth of steam power', *Economic History Review*, 13(2), p.423.

⁶⁶ Calculated from figures in Edwards, M. (1967), *The growth of the British cotton trade, 1780-1815*, (MUP), p.204, and 'Price lists', B&W Collection 3147/4/76.

⁶⁷ Roll, *An early experiment*, p.190.

⁶⁸ For example on a 3hp engine the cost of fitting was 20.94% of the total cost. 3 hp engine for Mr Clark of Bath, 1800, B&W Collection 'Engine costings', 3147/4/76. See also figure 2. Fitting was also the area that attracted the greatest attention in terms of setting and administering piece rates.

⁶⁹ Edwards, *The growth of the British cotton trade*, p.206.

Table 2, Profitability, profits and wages, 1787-1801.

	ROCE	Profit*	Wages	Total
1787-1794	-5.83%	-348.25	2401.00	2052.75
1795-1801	10.97%	2158.00	4050.80	6208.80
Overall	1.55%	666.40	3457.77	4124.17

Source: Calculated from Roll, 1930, appendix,

Notes: * profit refers to profit before the payment of interest on partners' capital.

Table 2 shows that the profits in ROCE terms were quite modest following the development of the new foundry. Comparing the figures with those in table 1, the returns were perhaps higher than compared to the old arrangements on the Cornish contracts. They are nonetheless low for a firm in a monopoly position. If these profits are contextualised by the earlier discussion, it seems likely that B&W were trying to do two things. First, achieve satisfactory returns that would avoid public criticism. Matthew Robinson Boulton wrote to James Watt Jnr in 1798, that without the precaution of price reductions ... we shall have much difficulty in steering clear of Disputes on this subject and certainly not succeed in accomplishing the alteration without exciting public attention'.⁷⁰ Second, and related, sacrifice possible profit in order to solve the supervision problem.

The piece work examples at B&W illustrate the combined impact of developments in the productive forces and the pre-existing social relations of production. Bryer argues that

⁷⁰ M.R. Boulton to J. Watt jnr. Cited in Williams, 'Boulton and Watt's Soho factory', p.78.

piece rates are attractive ‘if the capitalist can dominate production and draw up standard labour costs, when they become “the most fruitful source of reductions of wages and capitalistic cheating”’.⁷¹ At the same time, piece rates were just as important in the putting out system,⁷² or when using external sub-contractors, for example Harrison was charged out at standard cost when doing off-site work.⁷³ So although piece rates and bonuses in a factory setting were innovative, accounting for labour time *per se* was nothing new. As Thompson points out, in the mid-seventeenth century substantial farmers calculated their expectations of employed labour, using the example of Henry Best) in "dayworkes" - "the Cunnigarth, with its bottomes, is 4 large dayworkes for a good mower", "the Spellowe is 4 indifferent dayworkes", etc,⁷⁴ Referring to the Crowley Ironworks, Thompson concludes, ‘we are entering here, already in 1700, the familiar landscape of disciplined industrial capitalism, with the time-sheet, the time-keeper, the informers and the fines’, arising as a natural evolution of the puritan ethic.⁷⁵

Bryer, Marx, and Boulton and Watt

⁷¹ Marx, *Capital III*, p.552 cited by Bryer, ‘A Marxist accounting history of the British industrial revolution.’

⁷² Marx, *Capital I*, p.695.

⁷³ B&W collection, Engine costings, 3147/4/76, Mr Clark of Bath, 1800. Harrison was charged according to his time and a 40% overhead added. Mr Clark was charged only the standard price for Harrison and his associated overheads, so B&W did not pass on the risk of overruns to the customer.

⁷⁴ Thompson, ‘Time, work-discipline and industrial capitalism’, p.61. Thompson also quotes a Lancashire assessment from 1725: "They shall work from five in the morning till betwixt seven and eight at the night, from the midst of March to the middle of September" - and thereafter "from the spring of day till night", with two half hours for drinking, and one hour for dinner and (in summer only) half hour for sleep: "else, for every hour's absence to default a penny" (cited *Annals of Agriculture*, xxv, London, 1796).

⁷⁵ Thompson, *ibid*, pp. 82, 86-94.

Bryer re-analyses B&W from a Marxist perspective and argues that the accounting evidence supports Roll's conclusion that BW's management was fully modern.⁷⁶ The analysis above supports this conclusion for the post 1795 period. For Bryer modern methods are equated with capitalism and the capitalist mentality. Accordingly, Matthew Boulton and James Watt were capitalists and that this explains their technological, organisational and accounting innovations. In Bryer's interpretation, it is the capitalist mentality of individuals such as Boulton and Watt that drives them to develop accounting methods. In contrast, the interpretation offered above is that accounting methods are the outcome of the interaction of technical and organisational development in the productive base and the circulation of valorised capital according to the social relations of production. As the development of the productive forces determines the social relations of production, and therefore accounting, this approach does not require the definition of specific individuals as capitalists.

In Bryer's approach, by contrast, raises the empirical question of whether B&W were capitalists. In this respect, it is surprising that Bryer notes that Watt professed a hatred of business and particularly keeping accounts, and that he wrote to a friend that he "would rather face a loaded cannon than settle an account or make a bargain".⁷⁷ Bryer then argues that this did not mean he did not share Boulton's capitalist mentality since his father was a general merchant and part owner of several ships, as well as being a builder, contractor, shipwright and undertaker a person of substance who was Greenock's chief magistrate. However, in Bryer's interpretation being a merchant is not a sufficient condition for a capitalist mentality since as he notes on the previous page, merchants of this time were

⁷⁶ Bryer, 'A Marxist accounting history of the British industrial revolution', p.27.

⁷⁷ Bryer, 'A Marxist accounting history of the British industrial revolution', p.47, citing L.T.C. Rolt, *James Watt*, London: Batsford, 1962, p.53.

‘essentially feudal’.⁷⁸ Boulton meanwhile ‘was an example of Marx’s revolutionary capitalist manufacturer who was also a merchant’.⁷⁹ It is not clear therefore whether his love of Watt’s ‘money getting ingenious project’⁸⁰ arose from his merchant background or capitalist mentality. As far as Dickinson is concerned, whom Bryer cites as an authority for the quote, there is an important caveat: ‘The order of adjectives should be reversed: the project had to be first and foremost “ingenious” to enable him to exercise sufficiently his eminently agile and inventive brain; “money-getting” was only important to him in that it afforded the wherewithal to launch out into further schemes’.⁸¹

If a merchant background is not sufficient to establish a capitalist mentality, Bryer also suggests that accounting practice might be indicative. It is worth reviewing the evidence to see whether the capitalist mentality follows from accounting practice, or, as has been argued above, accounting practice follows inter alia from the forces and social relations of production, and their interaction (figure 1). Bryer offers evidence of Boulton’s capitalist intent at the formation of his partnership with Watt in 1775, suggesting that he wished to take control of production to cheapen its cost and make the maximum profit.⁸² In the years following the establishment of the partnership, installing engines in the mines of Cornwall accounted for a significant proportion of their business.⁸³ It is true that Boulton and Watt were able to cheapen the costs of production in mining but did not seek to maximise profits.

⁷⁸ Bryer, ‘A Marxist accounting history of the British industrial revolution’, p.46.

⁷⁹ Bryer, ‘A Marxist accounting history of the British industrial revolution’, p.46.

⁸⁰ Bryer, ‘A Marxist accounting history of the British industrial revolution’, p.46. 2005, p.47, citing Dickinson, *Matthew Boulton*, p.53.

⁸¹ Dickinson, *Matthew Boulton*, p.195.

⁸² Bryer, ‘A Marxist accounting history of the British industrial revolution’, p.47.

⁸³ From 1777 to 1782, Cornish engines accounted for more than 40% of Boulton & Watt’s total business (Tann, 1996, p.29).

Rather they sought a mechanism that was ‘quite fair’,⁸⁴ which split the savings in fuel cost between B&W and the mine adventurers 1:2. Bryer suggests that the patent was thus exploited in ‘feudal fashion’, although why such arrangements were feudal is not explained.⁸⁵ Nor is feudal exploitation consistent with Bryer’s argument elsewhere that: ‘Boulton knew he would need to make “heavy capital investment and that many years might pass before the new business would yield an adequate return on that capital”’.⁸⁶ According to Rolt, the need for such returns were the motive for Boulton securing the extension to the patent in 1775.⁸⁷ Applying Bryer’s reasoning to these facts, the capitalist mentality (evidenced by maximising the return on capital) drives B&W to extend the patent, but it is then applied in Cornwall in ‘feudal fashion’.

The actual application of the patent in Cornwall reflected extant legislation and the engineering expertise of the firm. Accordingly, Boulton organised the credit and supply chains for the remote operations, whilst Watt sought to measure the savings achieved by the engines and influence contract prices and royalties by using his talent as an instrument maker. Although the negotiations were difficult and Watt’s methods distrusted, resulting in a simpler method for calculating the royalty, B&W resisted taking control of production. It was therefore by ‘force of circumstance’⁸⁸ that they took shares in certain mining companies.

⁸⁴ Dickinson, *Matthew Boulton*, p.96.

⁸⁵ Bryer, ‘A Marxist accounting history of the British industrial revolution’, p.47.

⁸⁶ Bryer, ‘A Marxist accounting history of the British industrial revolution, p.47, citing Rolt, *James Watt*, p.58.

⁸⁷ Rolt, *James Watt*, p.58. B&W engines were protected by the patent for the separate condenser obtained by Watt in 1769, which an Act of Parliament of 1775 had prolonged until 1800.

⁸⁸ Dickinson, *Matthew Boulton*, p.131.

If notwithstanding these actions, Boulton is allowed to be a capitalist, then, according to Bryer 'The capitalist mentality pursues the rate-of-return on capital employed in production by extracting surplus value from the sale of commodities or services produced by wage labour, and the capitalist keeps balance sheets and profit and loss accounts'.⁸⁹ As far as Boulton and Watt are concerned, Bryer believes that there is evidence for such behaviour in the examples of costing and pricing for engine fitting supplied by Roll.⁹⁰ According to Bryer to direct costs 'BW added a *return on capital employed*. This hallmark of the capitalist mentality had not changed since the birth of the firm in 1775'.⁹¹ In the example calculation a 40% mark up is added to the directly absorbed overheads, which included Interest of Capital expended in the shed and machinery, which according to Bryer represented a return on the capital employed in the fitting shed and its machines.⁹² However if this is a charge for interest at 5% there can be no suggestion that is sufficient for, or consistent with, the maximisation of the rate of return. In Roll's appendix the mark up is at a rate of 50% of metal material costs, differing from the 40% used in fitting.⁹³ Moreover, until the late 1790s, prices were set in the context of the application of the patent and were allowed to vary from one customer to another according to the fuel savings potential of the individual engine. Prices therefore varied according to engine horse power and local coal prices.⁹⁴ Boulton and Watt aimed to obtain a fixed share of the fluctuating savings and shared the risk with their customers, so that

⁸⁹ Bryer, 'A Marxist accounting history of the British industrial revolution', p.28.

⁹⁰ Roll, *An early experiment*, pp.247-48 and Appendix XIX.

⁹¹ Bryer, 'A Marxist accounting history of the British industrial revolution', p.52, emphasis added.

⁹² Bryer, 'A Marxist accounting history of the British industrial revolution', p.53.

⁹³ Roll, *An early experiment*, Appendix XIX.

⁹⁴ Roll, *An early experiment*, pp.141-42.

for example no premium was paid when the engines were shut down. Boulton and Watt's business policy therefore reflected traditional doctrine by earning high profits only as a reward to risk and personal effort, and certainly did not aim for usurious returns on risk free investments, which still attracted disapproval from the Calvinist business community. Prices and hence mark ups and profits therefore varied according to risk and by customer.

Figure 2 shows the methods used by B&W to establish the price charged by the customer. The extract in figure 2a is the same as used in Roll and which is relied upon by Bryer as the only evidence that B&W were interested in the return on capital employed. As can be seen from figure 2a, 40% (£15) is added to fitting costs. As Roll explains, the adjustment is to cover indirect overheads.⁹⁵ It is not a return on capital employed calculation, nor is it a profit mark up on cost calculation. Interest on capital is charged to production cost as an indirect overhead and is included in the £15. As figure 2b shows, a mark up is charged at 50% on the total production cost. The purpose of these calculations was not to manage or maximise the return on capital employed. Rather, as Roll suggests, it was designed to produce the same level of profit as under the patent premium method.⁹⁶ As table 1 above shows, the profits under this system were modest, notwithstanding the patent protection and in keeping with the standards of business practice of the time.

It is clear from figure 2 that there are no calculations of return on capital employed, and so for Bryer, no 'hallmark of the capitalist mentality'. There is no corresponding attempt to measure the capital employed, and there is no indication of the required rate of profit as distinct from the other indirect charges included in the mark up, and a mark up calculation

⁹⁵ 'An allowance is made in the fitting for hemp, tallow, oil, candles, coals, and interest of capital expended in the shed and machinery for trying the engines,' statement of the Oil and Candles consumed at Soho Foundry from 1 October 1799 to 1 October 1806 and from April 1808 to Feb 1809, cited in Roll, *An early experiment*, p.249.

⁹⁶ Roll, *An early experiment*, pp.238-39, appendix, XIX.

cannot be converted to a return on capital employed measure unless both of these elements are known. Such a calculation is even more problematic where the mark up varies by customer.

Figure 2a: Standard cost calculation

	£.s.d
Wm Harrison's charge for the total fitting, turning, boring and labour exclusive of packing £20 = 400s; 2s 6d = 160 days	20.0.0
Charge for use of tools, say 6d per day on 160	4.0.0
Charge for use of machinery, say 1s per day	8.0.0
Charge for weighing and loading	1.0.0
	33.0.0
Plus 40%	15.0.0**
	48.0.0
or say	45.0.0*

Source: calculation of cost of fitting, 9th October 1801. M.R. Boulton copy of agreement with W. Harrison for fitting the small engines 1801 (3147/4/76).

Figure 2b: Soho Engine Costings

3 hp engine for Mr Clark of Bath, 1800.

	£.s.d	£.s.d
List of material parts (6 pages)		132.16.3
Cost of fitting the governor		2.2.0
Labour cost (fitting)	40.13.7	
40% on 40.13.7	16.5.5	
		56.19.0
Total per invoice of the cost		191.7.3
Invoice (including boiler)		206
Deduct extra charge of fitting:		
	56.19	
Standard cost	45*	
		11
		195.2
Add mark-up (50%)		97
Engine price		292
Say		295

Source: B&W Collection 3147/4/76 Calculations of costs and prices of small engines (reproduced in Roll, 1930, p.248, and Bryer, 2005, p.52).

If there is no evidence of return on capital employed measures, are there other aspects of accounting technique that might explain a capitalist mentality? A further reference by Bryer is to the capitalist mentality at the birth of the firm in 1775, evidenced by the fourth point of the informal partnership agreement, explained in subsequent Watt's letter to Boulton, where there is a reference to interest being deducted before a balance is struck. For Bryer, such post interest profit amounts to 'residual income' which is 'the hallmark of Marx's capitalist mentality.'⁹⁷ However, this calculation does not resemble what would normally be understood by residual income. As was conventional in profit sharing agreements between partners, interest was charged on capital. Rates were fixed in line with the legal maximum permitted under the usury laws and used in contemporary case law to differentiate between genuine partnerships and illegal usury.⁹⁸ From 1713, throughout the period of this study the legal maximum rate was 5%.⁹⁹ The partnership agreement of 1777 between Boulton and Watt specified that interest should be charged at 'the rate of £5 in every hundred per year' on the joint stock of the partnership.¹⁰⁰ The same rate, of 5% on opening capital was used in the example cited by Roll for 1806.¹⁰¹ These appropriations of profit are not the same as the absorption of interest charges for costing purposes referred to in figure 2 above. Partners could quite easily appropriate profit using interest charges without any requirement to

⁹⁷ Bryer, 'A Marxist accounting history of the British industrial revolution', p.47.

⁹⁸ *Grace and Smith (1775); Bloxham and Fourdrinier against Pell and Brooke, (1775)*. For discussions of these cases, see Campbell, S. (1933), 'The Economic and Social effect of the Usury Laws in the Eighteenth Century', *Transactions of the Royal Historical Society* (Fourth Series) (1933), 16: 197-210.

⁹⁹ Campbell, 'The Economic and Social effect of the Usury Laws', p.197.

¹⁰⁰ Boulton and Watt Collection, MS/3147/2/8-9.

¹⁰¹ From the table in Roll, *An Early Experiment*, p.259, one year's interest (£793) divided by balance at the beginning of the year (£15,793 19s 2d), equals 5%.

maximise profits or earn a higher figure than 5% as a target rate. Charging interest on capital is not therefore evidence of a capitalist mentality pursuing residual income or the rate-of-return on capital employed. Rather it is evidence of the continued restrictive impact of pre-modern financial practices on the developing productive base.

Conclusions

As the discussion above has suggested, risks arising from the physical labour process through to valorisation create important challenges from the capitalist's point of view. These are the use of external subcontracting versus internal subcontracting, the use of internal subcontracting versus direct hierarchy, and the use of piece rates versus time (or day) rates. All these decisions are trade-offs between the risks and costs of supervision in the labour process and the corresponding distribution of gains in the valorisation process. As the review of the evidence has illustrated, pre-industrial practices and custom, combined with the technical solutions to measurement issues combined at B&W to provide the main elements of an innovative and sophisticated system of accounting and labour control.

Bryer's Marxist interpretation of accounting at Boulton and Watt is that it is necessary to show that the firm was capitalist by providing evidence that they charged depreciation and that they really subsumed labour. Like Marx, Bryer shows that in the case of B&W the motivation for the adoption of factory production was more effective exploitation. To achieve this, as argued above, B&W had to solve the supervisory problem. There is evidence that their labour management practices succeeded in this respect, but that it came at the expense of transferring risk in the labour process from the employees to the owners of the enterprise and that generous salaries and piece rates were offered to ensure the work was satisfactorily overseen.