

REVISIONS AND REVOLUTIONS:

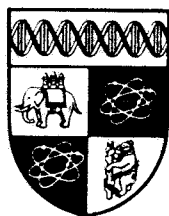
Technology and Productivity Change in
Manufacture in Eighteenth Century England

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be considered preliminary

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I. Interpretations of the Industrial Revolution

We used to look back to the Industrial Revolution as the great turning point in our history, as the origin and indeed cause of modern society. Eric Hobsbawm described it in his great classic, Industry and Empire, published in 1968, as 'the most fundamental transformation in the history of the world recorded in written documents. For a brief period it coincided with the history of a single country, Great Britain.'¹

His words convey images of new technology and industry, the steam engine and the cotton mill. This Industrial Revolution was a Prometheus. It was not unlike the perceptions of those in the 1830s and 1840s who saw themselves as living through an Age of Machinery. They were those such as Thomas Carlyle, who spoke of 'the huge demon of Mechanisation...changing his shape like a very Proteus...and infallibly at every change of shape, oversetting whole multitudes of workmen.'²

Recently, however, historians have turned to a much more gradualist Industrial Revolution, seeing it as a phenomenon stretching back to the early days of the eighteenth century and continuing at least until the mid nineteenth century. This

¹ Eric Hobsbawm, Industry and Empire, Harmondsworth, Penguin, 1978, p. 13.

² Thomas Carlyle, cited in Raymond Williams, The Long Revolution, Harmondsworth, Penguin, 1965, p. 88

perspective has dominated the historiography in varying degrees since the early 1970s.³ The latest quantitative work on the period takes this view much further; its effect has been to dethrone the Industrial Revolution altogether. Within the last five years a whole series of new indices has replaced the much used estimates provided by Deane and Cole in their British Economic Growth, (Cambridge University Press, 1962). Wrigley and Schofield's estimates on population increase have pushed the beginning population change back to the very early eighteenth century, and have charted an upward movement of population over the whole period. Harley, McCloskey, Crafts and Williamson have produced new indices on growth rates and productivity. O'Brien has marshalled price indices of agricultural and manufactured commodities, and Lindert as constructed new indices on the social and occupational distribution of the labour force.⁴

³ See David Cannadine, 'The Past and Present in the Industrial Revolution', Past and Present, No. 103

⁴ See N.F.R. Crafts, British Economic Growth during the Industrial Revolution, Oxford, Clarendon Press, 1985; C. K. Harley, 'British Industrialisation before 1841: Evidence of slower growth during the Industrial Revolution', Journal of Economic History, 42 2 (1982) pp. 167-189; P. H. Lindert and J. G. Williamson, 'English Workers' Living Standards during the Industrial Revolution: A New Look', Economic History Review, 36, pp. 1-25; and his 'Why was British Growth so Slow during the Industrial Revolution?', Journal of Economic History, 44, 1968, pp. 689-712; D. N. McCloskey, 'The Industrial Revolution: a Survey,' in R.C. Floud and D. N. McCloskey ed., The Economic History of Britain since 1700, vol. 1, Cambridge, Cambridge University Press, pp. 103-127; E. A. Wrigley, 'The Growth of Population in Eighteenth Century England: a Conundrum Resolved,' Past and Present, xcviii, 1983; P. K. O'Brien, 'Agriculture and the Home Market for English Industry, 1660-1820, English

My paper addresses the findings of the new picture of the Industrial Revolution which relies primarily on aggregative indices of economic growth.⁵ It assesses the findings and analysis of this new economic orthodoxy in comparison to those espoused earlier under the aegis of the estimates of Deane and Cole. It examines early criticisms of the new view. It then discusses two problems of interpretation which cast doubt, I think, on the conclusions of the quantitative historians: first their dependence on dualistic models of economic development, and second their limited perspective on sources of productivity change in the industrial sector. My paper looks in depth at technological change and labour force participation, arguing that productivity gains have been hidden by excessively narrow definitions of technology and the labour force. Industry experienced gains in productivity due to product and process innovations neglected by a narrow focus on capital output ratios. Industry also gained from the use of a child and female labour force which is entirely missed in current labour supply data used by the quantitative historians.

Historical Review, 1985, 100, pp. 773-800; J. Mokyr, ed., The Economics of the Industrial Revolution, Totawa, NJ., Rowman & Allanheld, 1985.

⁵ Another critique of the aggregative approach to the Industrial Revolution, written separately but contemporaneously with this one, and raising some similar issues in the introductory section can be found in Pat Hudson, 'The Regional Perspective,' Introduction to Hudson, ed. Regions and the Industrial Revolution, forthcoming Cambridge University Press, Cambridge, 1988/9. I am grateful to Pat Hudson for allowing me to see her paper, and for our discussions which have been very helpful in the revisions of my paper.

II. Revisions of Deane and Cole

The conclusions drawn from recent estimates must be set against the perspectives which prevailed when Deane and Cole's estimates were accepted. Deane and Cole's British Economic Growth presented an integrated picture of the eighteenth century origins of the Industrial Revolution; they marshalled data on trade, both foreign and domestic, on industrial output and capital formation, and on agriculture and population growth to demonstrate parallel and interrelated growth in all these sectors. They also sought an explanation for the growth they described in the special dynamic produced by this conjunctural growth. They were particularly concerned to present an industrial transformation which went far back in the eighteenth century, at least as far back as the 1740s. Deane and Cole did not in fact present their work as particularly novel; they saw it rather as a revival of an older historiographical tradition. What they did see in their results was a refutation of the then popular views of 'Nef, Ashton and Rostow that the decisive turning point in the economy had to be brought forward from the 1760s to the 1780s.' They pushed the acceleration in growth even further back to the 1740s, and argued for an even earlier phase of growth in the very early eighteenth century, but one which faltered by the 1720s, only to be properly resumed in the 1740s. Their assessment of industrial output indicated 'that the acceleration of output in the last quarter century may have been

less of a break with past trends than the earlier upsurge.⁸ Nor were they unaware of the wider perspective of the impact of the cotton industry. For this reason, they looked at the textile industry as a whole and emphasised the predominant role of the woollen industry until the second decade of the nineteenth century - in 1805 the net value of output of cotton was only three and a half per cent of the output of the U.K. as a whole; value added to national income by all textiles was estimated at 11 percent of that of the U.K.

Deane and Cole furthermore tied their economic indicators to an attempt to analyse the dynamics of growth. Their analysis was based on the favourable conjuncture of expanding home markets, population growth and agricultural development; and not on foreign trade, high capital investment or industrial innovation. Their analysis of more long term growth was subsequently reinforced by E.L. Jones, Stanley Chapman and others who also offered substantial microeconomic analysis of agricultural progress and capital formation. A long slow process of indigenous agricultural change, and rather low rates of capital formation, with the emphasis on circulating not fixed capital, have thus become an accepted part of the canon of the Industrial Revolution. This was further reinforced by studies of productivity change which took the centre of the Industrial

⁸ See Phyllis Deane and W.A. Cole, British Economic Growth, Cambridge, Cambridge University Press, 1962, p. 40 and passim chapter two

revolution away from the advance and pervasive impact of steam power, factory organisation and machinery, putting in their place the role of intermediate technical change, the the increasing intensity and discipline of labour.⁷

The novelty of the substance of the new interpretations offered by the quantitative historians is cast into perspective by these long standing and indeed traditional assessments. David Cannadine has recently demonstrated the widespread existence, at least from the early 1970's of a 'limits to growth' school.⁸ This school, in turn, was not new, but indeed reached back to the 1930s in the work of Clapham, Redford and Lipson, who wrote of a slow and localised Industrial Revolution. The optimistic vision of a 'high growth, capital intensive Industrial Revolution sparked by short term takeoff appears, in fact to have been confined to the relatively brief interlude of the 1950s and 1960s when many economic historians were heavily influenced by contemporary theories of economic growth.

While the quantitative historians do not, therefore, represent the complete break with traditional interpretations that they imagine, they have certainly gone beyond these. For

⁷ See for example, C.K. Hyde, Technological Change and British Iron Industry 1700-1870, Princeton, J.J. 1977; von Tunzelmann, G. N., Steam Power and British Industrialisation to 1860, Oxford Clarendon Press, 1978; and V.A.C. Gattrell, 'Labour, Power and the Size of Firms in Lancashire Cotton in the second quarter of the nineteenth century, Economic History Review, 2nd series 30, p;. 95-139.

⁸ See David Cannadine, 'The Present and the Past in the Industrial Revolution,' Past and Present, No. 103

Williams, Mokyr and especially Crafts have gone beyond slow growth to question the very existence of industrialisation before the mid nineteenth century. Their new quantitative estimates have now replaced Deane and Cole's indices. The Deane and Cole analysis of the process of economic growth has also been replaced by recent developments in economic analysis. The findings of the revisionists have quickly formed the basis for a new orthodoxy on the economy of eighteenth and early nineteenth century England.

This new orthodoxy is best presented by summarising the findings of N.F.R. Crafts, who has brought a number of the new indices together, and added his own new estimates of per capita and aggregate growth. Crafts presents a much more pessimistic picture of the eighteenth century than we have ever previously had. He has criticised other revisionists, including McCloskey and Williamson for exaggerating productivity. He estimates productivity growth in manufacturing at only 0.2 per cent in 1760-80, 0.3 per cent 1800 to 1830, 0.8 per cent 1830-60, and argues that productivity growth in manufacturing was probably very slow until 1830. One small and atypical sector - cotton - probably accounted for half of all productivity change in manufacturing. In Crafts' words, 'not only was the triumph of ingenuity slow to come to fruition, but it does not seem appropriate to regard innovation as pervasive.' Productivity advance, he argues, was much more important in agriculture at

least until 1760.⁹ Floud has effectively summarised the implications of Crafts' indices:

'Britain underwent the pain of structural change but without the reward of rapid income growth...technical change came slowly and patchily, with the spectacular changes in textiles disguising the backwardness of many other sectors. Thus, although an extraordinary proportion of workers entered industry, Britain did not get as much from them as it should have done, principally because of a neglect of education and a concentration on producing low wage factory fodder rather than high wage technicians.'

The upshot was that 'Britain has simply muddled through 200 years of economic growth.'¹⁰

Crafts' indices suggest that before 1760 national production probably increased at the same rate as indicated by Deane and Cole, but after 1780 the estimates diverge sharply. Crafts found a substantially lower growth in output per head in the later part of the century, while Deane and Cole had envisaged a marked acceleration at that time. Even more dramatically, Crafts' figures showed a substantial decline in the rate of growth in product per head in the period 1760 to 1801 compared to that of 1700 to 1760.¹¹

Crafts' estimates of slow growth during the classic Industrial Revolution have been confirmed by other quantitative

⁹ N.F.R. Crafts, British Economic Growth during the Industrial Revolution, p.

¹⁰ Roderick Floud, 'Slow to Grow' Review of N.F.R. Crafts, Times Literary Supplement, July 19, 19085, p. 794

¹¹ This is also summarised in R. V. Jackson, 'Government expenditure and British economic growth in the eighteenth century: some problems of measurement,' Discussion Paper, A.N.U., 1988, p. 3

economic historians. Mokyr refers to an 'consensus among the proponents of the "new view" that in the first half century or so of the Industrial Revolution its economy wide effects were limited and economic growth was rather slow.'¹² Williamson speaks even more confidently:

'The quantitative dimensions of the classic British Industrial Revolution are understood far better now than a century ago...Informed guesses on the rate of total factor productivity growth are now available, and as we have seen...even trends in workers' living standards have been nailed down securely.'...

'Most of us now agree that British growth was slow up to about 1820, and much faster thereafter...we also agree that the rate of accumulation was slow throughout the first Industrial Revolution.'¹³

The new orthodoxy is itself, however already the subject of debate. Jackson has recently pointed out problems in the measurement of government expenditure, and he has argued that the effect of this on the measured rate of growth of total and per capital output is substantial. The effect of different measures of government expenditure is to lower Crafts' estimates of national productivity growth before 1760, and to raise it for the period 1760 to 1800. Jackson argues that Crafts' finding that per capita growth was lower in 1760 to 1801 than in 1700 to 1760 is due partly to the treatment of government expenditure,

¹² Joel Mokyr, 'Has the Industrial Revolution been Crowded out? Some Reflections on Crafts and Williamson,' Explorations in Economic History, 24., 1987, 293

¹³ Jeffrey Williamson, Did British Capitalism Breed Inequality, London, Allen & Unwin, 1985, p. and Williamson, 'Debating the British Industrial Revolution,' Explorations in Economic History, 24, 1987, p. 269

and partly to a computational error affecting 1780-1801.

Though Williamson and Mokyr agree with Crafts' scenario of slow growth, they differ over its explanations and its timing. Crafts explained slow growth by low rates of total factor productivity growth, which in turn caused low rates of accumulation. Slow growth was caused by supply side considerations. Private capital formation was not crowded out by war debt, but rather as a pioneer industrialiser, Britain found it hard to achieve high rates of productivity growth on a wide front. Only a gradual acceleration in growth was available. Williamson, in contrast, emphasised the constraints of saving on accumulation, arguing that the increase in government debt during the eighteenth century onwards from 1776-1815 reduced investment, and slowed down capital formation, thus reducing output and the growth of consumption. Williamson furthermore identified 1820 as a key turning point for both growth and increases in the standard of living; before this time the expansion of war debt was largely responsible for Britain's low rate of accumulation.¹⁴

Mokyr believes that though Williamson has probably overstated the effects of crowding out on accumulation, nevertheless he was right to argue that the wars exercised a major effect. They certainly caused supply shocks, seen through higher transportation and transaction costs. He argues that in spite of exaggerations, Williamson was probably closer to the

¹⁴ Williamson, 'Debating the British Industrial Revolution,' pp. 286-294.

truth than Crafts, who hardly mentions the effect of war.¹⁵ Mokyry is also critical of the excessive significance attached by Crafts to estimates of agricultural total factor productivity, and his downgrading of opportunities for improvements in industrial productivity.¹⁶

These differences among the revisionists lie both in aggregate indices and in their interpretation. Some of the revisionists have pointed out the contingency of their data, the restrictive assumptions, the limitations of their models, the large margins of error, and the alternative techniques of measurement which throw up different conclusions. Aggregate estimates carry particularly high margins of error. As Feinstein has pointed out, estimates of national capital and flows of capital, 'in a few cases...especially before 1800...rely on fragments of evidence glued together with rough guesses and more or less arbitrary assumptions.'¹⁷ Lindert concedes high margins of error in his estimates of occupational distribution. He reckons that for his finer occupational grouping (fewer than 40,000) the true numbers could be one third to three times his estimates (at the 95 per cent level of subjective confidence). Estimates for shoemakers, carpenters etc. were 'little more than

¹⁵ Mokyry, 'Has the Industrial Revolution been crowded out?', p. 302

¹⁶ Mokyry, *ibid.*, pp. 308, 312-315

¹⁷ Charles Feinstein, 'Capital Accumulation and the Industrial Revolution, Floud and McCloskey, The Economic History of Britain since 1700, p. 129

guesses.' And for categories with over 100,000 persons (agriculture, commerce, manufacturing etc.), the true value could be three-fifths to five-thirds the estimate.¹⁸

Mokyr concludes,

'it seems we have run into strongly diminishing returns in analysing the same body of data over and over again...the highest return strategy now is to uncover new data.'¹⁹

Problems with the new orthodoxy lie not just in continuous analysis of the same body of data, but in explaining sources of slow productivity change. Crafts' slow growth economic profile turns to a considerable extent on a reduction of the contribution of the industrial sector. Instead he sees agriculture as an engine of growth. 'Its performance permitted the migration of labour to the industrial sector, it kept food prices under control, and it accounted for most of the (slow) growth before 1830.'²⁰ I will therefore now turn to a consideration of the industrial sector and productivity change in it.

Crafts' findings of low productivity in the industrial sector are backed up by an assumption that technology and work organisation were primitive in all but his 'glamour sectors' of cotton and iron. It is interesting that keen though he is to dissociate the term Industrial Revolution from rapid

¹⁸ Lindert, Journal of Economic History, 1980, p. 701

¹⁹ Mokyr, 'Has the Industrial Revolution been Crowded Out,' p. 318

²⁰ Mokyr, 'Industrial Revolution crowded out', p. 305

transformation to factories and machinery, his model of technical change is exclusively contained within this framework. The recent theory of proto-industrialisation, fraught though it is with problems, both theoretical and applied, has at least highlighted the role of change associated with handicraft production, particularly rural putting out. It identified an innovation in organisation whose success lay in extracting a greater surplus out of an extensive and flexible labour force. Other broadly based research in economic history, and the sociological research focussed recently on 'flexible specialisation' has pointed out the gains of market and product development and technological innovation in the small scale sector.²¹ Explanations of productivity change need thus to be sought beyond the aggregate data for contributions of capital, labour and total factor productivity. They must be analysed at source in the world of work and its social and cultural contexts. The limited assessment given the industrial sector in the new orthodoxy rely on a series of models themselves requiring reassessment.

III. Dualism and the Industrial Revolution

The basic model deployed by most of the revisionists is a dual economy model, that is to say, a division of the economy into traditional and modern parts. Crafts has created several

²¹ See Maxine Berg, The Age of Manufactures, Fontana, London, 1985, chapters 8-12; and C. Sabel and J. Zeitlin, 'Historical Alternatives to Mass Production.' Past and Present, No. 108, 1985, pp. 133-176

variations on this divide. He argues that his productivity estimates are for industry rather than just manufacturing. They include mining, building and handicrafts. He elaborates on his earlier distinction between 'glamour manufacturing sectors and traditional industry,' or between 'traditional' and 'revolutionised' sectors²² to draw a distinction between 'production of goods for large dispersed national or international markets, and the production of goods and services for a local market.'²³ Once it was clarified how much manufacturing, mining and building was in handicrafts and non-tradeables, he thought it was certainly plausible for productivity growth in agriculture to be faster than in industry. He found the implied rate of technical progress in the unmodernised sectors to be approximately zero, and contrary to McCloskey's view, 'technical progress was not pervasive at a rapid rate through the industrial revolution.'²⁴

Crafts has argued that instead there was unbalanced productivity growth within industry: that is, that Britain had relatively fast productivity growth in traded goods both exportables and importables, as compared with non-internationally traded goods. There were big productivity differences between the progressive

²² See Crafts, British Economic Growth, p. 17

²³ Crafts, 'British Economic Growth 1700-1850: Some Difficulties of Interpretation,' Paper to the Workshop on Quantitative Economy History, University of Groningen, September 1985, pp. 3-4

²⁴ Crafts, 'British Economic Growth: difficulties of Interpretation,' p. 255

parts of the economy, including agriculture, transport and a subset of industry, and the rest.²⁵

Mokyr too proposes a dual approach, distinguishing the traditional from the modern parts of the economy. But his definitions of the modern and the traditional clearly differ from those of Crafts. He includes in his modern section all factories, transport, mining, quarrying, metallurgy, paper and potteries. His traditional sector includes agriculture, domestic industry, food processing, small scale metalworking shops, construction and building. He argues that slow growth of output per person hour in the traditional part diluted aggregate growth until the modern sector became large enough to dominate the movement of the economy.²⁶

The dualistic division of the economy, however defined, is accepted by Crafts and Mokyr in a way closely tied to Wrigley's pessimistic view of the early industrial economy. As Williamson puts it, Crafts' estimates confirmed the classical economists' pessimism that between 1761 and 1831, the rate of capital deepening was trivial and failed to offset the impact of increasing land scarcity.

Wrigley accepts this classical pessimism, taking an entirely Malthusian perspective on the economy before the mid nineteenth century, and he interprets the classical economists to underwrite

²⁵ Crafts, *ibid.*, p. 255-6

²⁶ Mokyr, 'Is the Industrial Revolution being Crowded Out?', p. 315

his views. He thinks the classicals were right to argue as they did; indeed 'their reluctance to envisage the possibility of large gains in individual productivity find support in ...Crafts' estimates...' Their systems were dominated by 'negative feedback loops,' and most of the economic change taking place until the 1830s and 1840s are in his view best understood within their systems.²⁷ After this time, a new system emerged, due largely due to the deployment of inanimate sources of energy and inorganic sources of raw materials.

'The natural technology of the day, though demonstrably capable of substantial development, especially under the spur of increased specialisation of function, was not compatible with the substantial and progressive increase in real incomes which constitutes and defines an Industrial Revolution...the raw materials which formed the input into the production processes were almost all organic in nature, and thus restricted in quantity by the productivity of the soil.'²⁸

Power sources and raw materials were thus subject like agriculture to declining marginal returns to the land.

He confirmed these views in census data which showed that as late as 1831, in spite of comparatively high urban populations, most were working in occupations supplying goods for local markets. Those working in factories or proto workshops made up only 10 per cent of the adult male labour force. While agricultural productivity increased substantially in the seventeenth and eighteenth centuries, releasing labour into other

²⁷ E.A. Wrigley, 'The Classical Economists and the Industrial Revolution,' in People, Cities and Wealth, Oxford, Blackwell, 1987, p. 36, and 22-34

²⁸ Wrigley, *ibid.*, p. 9

occupations, output per head in most of these did not improve a great deal. As late as 1831 to 1841, at least two thirds of the total increase in adult male non-agricultural employment was in occupations like building labourers, butchers, alehouse keepers, shoe makers, tailors, blacksmiths and bakers.²⁹

The new orthodoxy thus divides the economy into the traditional and modern, and accepts the overriding primitive state of most manufacture, defined as it is as part of the traditional part. Crafts and Mokyr have recently conceded that there may have been some limited technical progress in handicrafts. Wrigley accepts that framework knitting, coastal shipping, some forms of metal goods manufacture, brewing glassmaking and paper making 'may have constituted exceptions to the general rule.'³⁰ But all agree that these were no more than minor exceptions, and could never have provided the scale of cost reductions which were brought about in what they assign to the modern part.

IV. Dual Economics

The analysis of industrial productivity deployed by all the revisionists relies on dual economy models. We must ask just how appropriate these models were to eighteenth century England, and to what extent we can accept their underlying assumption of technological stagnation in much of the industrial sector in the

²⁹ Wrigley, *ibid.*, pp. 11,15

³⁰ Crafts, 'British Economic Growth: some Difficulties,' p. 255; Mokyr, 'Industrial Revolution Crowded Out,' p. 313; Wrigley, People, Cities and Wealth, p. 15

eighteenth and early nineteenth centuries.

The reliance of the revisionists on dual economy models is reminiscent of the early phases of development economics which used labour surplus explanations. These explanations were couched in terms of a rural/urban dichotomy, labour intensive/capital intensive divisions, a formal/informal distinction and other variations on the traditional/modern divide. The development economics which dominated planning for two decades after World War II looked to a policy of accelerated and large scale industrialisation. The economy was divided into dual sectors of traditional and modern parts, and it was argued that with the process of modernisation, the traditional parts of the economy would be absorbed into the modern. The traditional/modern divide was overthrown in the seventies in favour of an informal/formal sector division, and a reassessment of the role of small scale activities. Instead of a pool of stagnant disguised unemployment, informal activity was credited with essential urban services. 'From being the Cinderella of underdevelopment; the informal sector could become a major source of future growth.'³¹ New attention to the informal sector only underlined the divide: Formal and informals sectors were seen as 'two juxtaposed systems of production, one derived from

³¹ Caroline Moser, 'Informal Sector or Petty Commodity Production: Dualism or Dependence in Urban Development?', World Development, 1978, Vol. 16, p. 1052; Also see John Toyne, Dilemmas in Development. Reflections on the Counter revolution in Development Theory and Policy, Oxford, Blackwell, 1987

capitalist forms of production, the other from the peasant system' ... as two types of economy, 'a firm centred economy' and a 'bazaar type economy,' ... as 'two sectors, a high profit/high wage international oligopolistic sector, and a low profit/low wage competitive capitalist sector.'³²

From the mid seventies this optimistic perspective on the informal sector was subjected to new scrutiny which stressed the constraints on its expansion, and the need for assessing potential dynamic in terms of the structural position of each sector. Subsequently, the validity of the whole dualist model was challenged. There was recognition of extensive internal differentiation in the urban economy, and an alternative framework developed based on a continuum of economic activities rather than a two sector divide. Workers were seen as employed in a number of different categories, as self - employed, casual and wage and nonwage family labour. Recognition also went to the diverse dependent linkages between the activities of the 'traditional', 'handicraft', 'local market' or informal sector and that of the 'modern', 'factory', 'international' or formal sector. There were linkages through subcontracting, outworkers, the use of retail agents between the sectors and many more connections. Research discovered the connections between homeworking and subcontracting carried out in our own inner cities and the peripheral urban areas of Southeast Asia and Latin America on the one hand, and large international

³² Moser, *ibid.*, p. 1052

firms employing high-tech large-scale factories. The current Italian firm Benetton combines the use of domestic subcontractors as a part of the informal sector, and high tech production process in the formal sector to balance its control of production, the market and distribution. Dualistic models were eventually found to be incapable of handling the complexities of these relationships.³³

But where the dualism which was once fundamental to development economics has been overthrown, it is now raised to new heights in economic history. The divide between agriculture and industry has been challenged by the revisionists who, contrary to older theories, now identify agriculture with substantial productivity gains while associating much industrial employment with nil productivity growth. With their recognition of the literature on proto-industrialisation, they have now also divided the rural and the industrial sector into factory and handicraft or putting out. But in spite of such concessions, they still see the major divide as that between high productivity factory and mechanised industry along with a high productivity agriculture on the one hand, and a widespread industrial and service backwater on the other. In spite of concessions to some technical innovation in the handicraft sector, the divide between the modern and the traditional remains firmly entrenched. It accords with the industrial dualism that Piore describes, as one that associates craft production and the

³³ Moser, p 1056

small firm as complementary to mass production, but necessarily subordinate and derivative of it.³⁴

The divide between the modern and traditional sectors, sectors dealing in tradeables or non-tradeables, handicraft and factory industry is a convenient one for economists, but one that distorts the characteristics of manufacturing in the eighteenth century, and hides major sources of productivity gain in manufacture. Rigid associations of productivity gain and technical progress with concepts of large scale production, factories, powered machinery and capital deepening pervade the revisionist position. In practice it was and is very difficult to make clear cut divisions between the traditional and the modern, the tradeable and the non-tradeable, as there were rarely separate organisational forms, technologies, locations or even firms to be ascribed to either. Eighteenth and nineteenth-century cotton manufacturers typically combined steam powered spinning in centralised factories with large scale employment of domestic handloom weavers using traditional techniques. The small metalworking shops of Birmingham, Sheffield and Lancashire were classified by the revisionists with the traditional sector, handicrafts and non-tradeables though they typically developed their high technology in the luxury goods trade of the home market, though also trying to break into and extend foreign markets. Artisans in the sector frequently combined occupations

³⁴ Charles Sabel and Jonathon Zeitlin, 'Historical Alternatives to Mass Production,' Past and Present, 108, 1985, p. 138

or changed these over their life cycle in such a way that they too could be classified in both the traditional and the modern sector. Firms primarily concerned with metalworking, (classified by the revisionists as traditional), also diversified into metal processing ventures, (classified as modern), as a way of generating steady raw material supplies. The aggregate divisions between sectors which form the foundation of conclusions by the revisionists on the industrial sector are certainly questionable. Even more questionable is their understanding of the handicraft sector.

V. Handicraft and Productivity

The revisionists associate the progressive with the machine and the factory: Wrigley requires inorganic sources of raw materials and power; Williamson requires capital deepening; Crafts requires tradeables; Mokyr requires modern mechanised industry which generated the 'dazzling cost reductions of the Industrial Revolution'.³⁵ Wrigley's emphasis on inorganic materials and power would hold little sway in a comparative context: American and Swedish industrialisation relied to a predominant extent on wood using technologies and water power. Crafts, Mokyr and Williamson base their ideas of technological change on artifacts rather than processes. A broader concept of technological change would include not only machinery, but tools, skills and dexterity, and the knacks and the work practices of

³⁵ Wrigley, People, Cities, Wealth, p. 3-4; Williamson, 'Debating', p. 273; Crafts, 'British Economic Growth: Difficulties', p.254; Mokyr, pp. 314-5

manufacture. And a broader definition of innovation must include product innovation, market creativity and organisational change. The non-factory, non-tradeable and supposedly stagnant section of the economy experienced extensive technical change not recognised by the revisionists. Early textile innovations - carding and scribbling machinery, the Dutch loom, the knitting frame, the flying shuttle and the jenny, silk throwing machinery and finishing techniques especially in bleaching and calico printing - were all developed within rural manufacture and artisan industry, and few of these were initially developed for the high profile cotton industry. The metal working trades were proverbial for skill intensive hand processes and hand tools. The stamp, press, drawbench and lathe were developed to innumerable specifications and uses, and new malleable alloys, gilding processes, plating and japanning were at least as important. And other industries experienced some form of transformation in materials or division of labour, if not in the artifacts of technological change.

The impact of these new techniques on productivity has never been adequately investigated. There have been some estimates based on contemporary opinion that the water driven scythe hammer raised output per unit of labour to five times that of the hand forge; the treadle operated spinning wheel with a flyer increased productivity by one third over that of the hand spinner. The flying shuttle doubled labour productivity, the Dutch loom increased labour productivity four fold, and the knitting frame

ten fold. Looked at in their own context, these are great gains, but they have generally been discounted against later developments in cotton spinning techniques which soon made hundred fold leaps over the old spinning wheels.³⁶ There are no productivity estimates for the range of hand tools and early machine tools in the metal industries, but their significance to overall productivity growth is a recurrent theme of economic history.³⁷

A range of traditional industries certainly underwent reorganisation due to changes in materials and processes. New industrial uses for coal affected brewing, brick making, malting, sugar and soap boiling as well as metallurgy and metal working. Salt refining based on rock salt solutions yielded ten times as much salt as natural brine solutions. The division of labour and production time of luxury industries such as hat making and jewellery production were transformed by changes in materials such as the replacement of beaver fur by hare, or the introduction of silver plating and gilding.

In traditional textile industries changes in the product

³⁶ See P. Kriedte, H. Medick and J. Schlumbohm, Industrialisation before Industrialisation. Rural Industry in the Genesis of Capitalism, Cambridge University Press, Cambridge, 1981, p.pp. 112,113; W. Endrei, L'évolution des techniques du filage et du tissage dur Moyen Age a la revolution industrielle, Industrie et artisanat, vol. 4, Paris, 1968

³⁷ See Nathan Rosenberg, Inside the Black Box: Technology and Economics, Cambridge University Press, Cambridge 1982; Roderick Floud, The British Machine Tool Industry; and David Landes, The Unbound Prometheus, Cambridge, Cambridge University Press, 1969

such as the move from heavy serges to mixed stuffs, where wool was mixed with silk or cotton, considerably reduced the finishing time, for many of these needed no fulling, and they were dyed in the wool or printed rather than vat dyed. The success of the calico printing industry later in the eighteenth century hinged not on new machinery or materials, but on new cheaper labour prepared to carry out labour intensive processes on a new scale and under new organisation and discipline.

The productivity benefits of these changes in processes and products are notoriously difficult to measure. For product innovation falls outside the conventional measures of productivity change, doomed as it is to index number problems. And changes in skills, organisation and discipline may affect the quality of labour inputs without affecting the quantity of labour.³⁸ As contemporary literary evidence and current historical assessments make clear, for the eighteenth century at least, the expansion of consumption and the product innovation associated with that were the really essential elements of economic growth.³⁹

Josiah Tucker's observation of 1757, was no figment of the

³⁸ See N. Rosenberg, The Economics of Technological Change, Penguin, Harmondsworth, 1971, passim; M. Salter, Productivity and Technical Change, Cambridge University Press, Cambridge; W. Lazonick and T. Brush, 'The "Horndal Effect in Early U.S. Manufacturing," Explorations in Economic History, 22, January 1985

³⁹ See Neil McKendrick, John Brewer and J.H. Plumb, The Birth of a Consumer Society, Hutchinson, London, 1983

imagination. And its sentiments, I have argued elsewhere, were widely echoed in the economic commentary of the eighteenth century:

'Few countries are equal, perhaps none excel, the English in the number of contrivances of their Machines to abridge labour. Indeed the Dutch are superior to them in the use and application of Wind Mills for sawing Timber, expressing Oil, making Paper and the like. But with regard to Mines and Metals of all sorts, the English are uncommonly dexterous in their contrivance of the mechanic Powers..Yet all these, curious as they may seem, are little more than preparations or Introductions for further Operations. Therefore, when we still consider that at Birmingham, Wolverhampton, Sheffield and other manufacturing Places, almost every Master Manufacturer hath a new Invention of its own, and is daily improving on those of others; we may aver with some confidence that those parts of England in which these things are seen exhibit a specimen of practical mechanics scarce to be paralleled in any part of the world.'⁴⁰

The revisionists argue that most industrial labour was, however, to be found in those occupations which really did experience little change. But these occupations in the food and drink trades, shoe making, tailoring, blacksmithing, and trades catering to luxury consumption were also a part of the unique urban expansion of early modern and eighteenth century England.⁴¹ They supplied the essential services on which town life was dependent, and provided for the remarkable flowering of a consumer culture in the eighteenth century to which historians

⁴⁰ Cited in Charles Wilson, England's Apprenticeship 1603-1763, London, Longman, 1965, second edition 1984, p. 311

⁴¹ See Wrigley's essays on urban growth in People, Cities and Wealth, pp. 133-157

are now turning their attention.⁴²

It is, furthermore, the case that early industrial capital formation and enterprise typically combined activity in the food and drink or agricultural processing trades with more obviously industrial activities. The separation of 'traditional' from 'modern' activities is an artifact of the modern economist, not a realistic analysis of the complexities of the eighteenth century economy. This was true in the textile manufacture⁴³, and in the metal manufactures in Birmingham and Sheffield where innkeepers and victuallers were common mortgagees and joint owners of metalworking enterprises. Such manufacturers also maintained joint occupations in the metal and food and drink trades. In the South Lancashire tool trades, Peter Stubs was not untypical when he first appeared in 1788 as a tenant of the White Bear Inn in Warrington. Here he combined the activity of innkeeper, malster and brewer with that of filemaker.' And there were good technological reasons for this combination. One of the processes in filemaking involved covering the file with a paste to preserve it from damage: this paste consisted of malt dust and 'barm bottoms' or the dregs of

42 See Brewer, Plumb, McKendrick, *ibid*
 Timothy Breen, 'Beubles of Britain: The American and British Consumer Revolutions of the 18th Century, Past and Present, 119, 1988
 Workshop on Luxury Production, ESRC Workshops on Protoindustrial Communities, 1986

43 See K.H. Burley, 'An Essex Clothier of the Eighteenth Century,' Economic History Review, xi, 1958; and Stanley Chapman, 'Industrial Capital Before the Industrial Revolution 1730-1750; in Harte, N. and Ponting, K., Textile History and Economic History, Manchester 1973

beer barrels. The carbon from these ingredients was made to enter the teeth of the file so giving it greater durability and strength.⁴⁴

VI. Handicraft Industry and the Labour Force

Another striking feature of the new orthodoxy is its restricted definition of the labour force, and this in turn is closely related to the analysis of productivity change. The literature on proto-industrialisation highlighted the contributions to productivity increase achieved through the intensification and division of labour. It also drew attention to the age and gender differentiation of the labour force.⁴⁵ Substantial productivity increase was achieved in ways we rarely consider now by the special contributions of women's and children's labour.

Yet Wrigley assesses productivity growth only through the 10 per cent of adult male labour who in 1831 worked in industries serving distant markets. Williamson's documentation of inequality and Lindert and Williamson's survey of the standard of living consider only adult males. What place did female and child labour play in industrial employment? It is difficult to

⁴⁴ See T.S. Ashton, An Eighteenth-Century Industrialist, Peter Stubs of Warrington 1756-1806, Manchester University Press, Manchester, 1939, pp. 4-5

⁴⁵ See Hans Medick, in P. Thane and A. Sutcliffe, Essays in Social History, Vol. 2 Oxford 1985. Maxine Berg, The Age of Manufactures David Levine, Reproducing Families, Cambridge 1987

assign a quantitative estimate of this for this is the part of the labour force which was excluded from official statistics. Lindert's estimates for industrial occupations rely only on adult male burial records. But the implications of the inclusion of child and female labour are significant. They dramatically affect the analysis of inequality. Williamson argued that 'demographic forces from below' did not account for the widening of inequality in the industrial revolution. But population increase analysed in a household context put pressure on wages not only of the male breadwinner, but through this also affected the supply of female and child labour and their wages. As Saito has argued, 'it is likely that sex differentials in wages also widened when population rose faster. Wages for unskilled males were perhaps stagnant, but wages offered to females and children may have been actually falling.'⁴⁶ Thus women's and children's labour appeared in the eighteenth century to be a lucrative source of profit not to be bypassed by manufacturers ready to launch new labour intensive industries during the age of mechanisation.

Though quantitative evidence on the amount of child and female industrial labour is sparse, there is enough to indicate the inadequacy of conclusions based only on adult male labour forces. Wrigley and Schofield estimate that children aged five

⁴⁶ Osamu Saito, 'The Other Faces of the Industrial Revolution', Review Essay, Institute of Economic Research Hitotsubashi University, 1988; also see his 'Labour Supply behaviour of the poor in the English industrial revolution,' Journal of European Economic History, vol. x, 1981, pp. 633-652

to fourteen accounted for between eighteen and twenty-five per cent of the total population. This compares to a proportion of six per cent in 1951. The employment of such large numbers of children would clearly be a major problem for any economy.

Levine has argued that children could and did begin to pay their own way from an early age, thereby cushioning the impact of this high dependency ratio.⁴⁷

Textiles was the most important manufacturing industry, accounting for 45 per cent of the increase in national product in 1770 and 42 per cent in 1801. Wool made up 30.6 per cent in 1770 and 18.7 per cent in 1801. In the woollen industry, women's and children's labour accounted for 75 per cent of the workforce; children's labour exceeded that of women and of men. Women and children also predominated in the cotton industry; Children under the age of 13 made up 20 per cent of the cotton factory workforce in 1816; those under 18 51.2 per cent.⁴⁸ The silk, lace making

⁴⁷ See David Levine, 'Industrialisation and the Proletarian Family in England,' Past and Present, No. 107. The argument is also elaborated in Levine, Reproducing Families, Cambridge, Cambridge University Press, 1987

⁴⁸ See Adrian Randall, 'The West Country Woollen Industry during the Industrial Revolution,' unblulished PhD Thesis, University of Birmingham, 1979, Vol. II, p. 249; Clark Nardinelli, 'Child Labour and the Factory Acts, Journal of Economic History, xl, 4, 739-755. The gender and age differentiation of the eighteenth century industry is discussed in more depth in Berg, 'Women's Work, Mechanisation and the early Phases of Industrialisation in England,' in Patrick Joyce, ed., The Historical Meanings of Work, Cambridge, CUP 1987, pp. 69-76; and Berg, 'Child Labour and the Industrial Revolution,' Workshop Paper to the University of Essex, 1986. Also see Claudia Goldin and K. Sokoloff, 'Women, Children and Industrialisation in the Early Republic: Evidence from the Manufacturing Censuses,' Journal of Economic History xlii Dec. 1982, No. 4, pp. 421-774; and

and knitting industries were also predominantly female. There were even high proportions of women and children in metal manufactures such as the Birmingham trades. Goldin and Sokoloff's more complete American data show that women and children together grew from 10 per cent of the manufacturing labour force of the north east early in the nineteenth century to forty per cent in 1832.⁴⁹ Though, as Wrigley points out, only 10 per cent of adult male labour was to be found in the modernised progressive sectors, this does not tell us a great deal. For the preferred labour force for precisely these sectors was overwhelmingly young and female. Was this labour force a drag on productivity gain in those few industries the revisionists credit with any real growth? Or did this labour force have other attributes making it attractive to manufacture, apart from its acceptance of lower wage levels? In the terms put by economists, were there supply side considerations apart from the labour demand effect of wage levels?

The significance of women and children to the manufacturing labour supply must affect estimates of occupational distribution between traditional and modern sectors. It must also lead us to enquire into the skills and attributes of this labour force. It

Claudia Goldin, 'The Economic Status of Women in the early Republic: some Quantitative Evidence,' Journal of Interdisciplinary History, 16:3, 1986

⁴⁹ See Goldin and Sokoloff, *ibid*

is not sufficient to see this as a stagnant pool of unskilled labour. For manufacturers were attracted by this labour force not just for low wages, but for labour supply characteristics which contributed to productivity gains. There is a recent analogy to this in research on the employment of women, especially young single school leavers in the new manufacturing industries of the Third World. Women are selected rather than men for their docility and their 'nimble fingers;' the result for industrialists is low labour costs and high labour productivity.⁵⁰ In many eighteenth century industries women and children were specifically sought out for their dexterity and amenability to discipline. They were, in addition, regarded as particularly suitable to a division of labour associated with eighteenth century technologies, one based on adult labour with child assistants. Indeed there are several instances of early textile machinery being designed and built to suit the child worker. The spinning jenny was a celebrated case; the original country jenny had a horizontal wheel and required a posture most comfortable for children of 9 to 12.⁵¹ For a time in the very

⁵⁰ See Ruth Pearson and Diane Elson, 'The Subordination of Women and the Internationalisation of Factory Production,' in K. Young, C. Wolkowitz and R. McCullagh, Of Marriage and the Market, CSE Books, London, 1981, pp. 144-167; and Ruth Pearson, 'Female Workers in the First and Third Worlds: the Greening of Women's Labour,' in R. E. Pahl, On Work, Blackwells, Oxford, 1988 pp. 449-469

⁵¹ These issues are explored in greater depth in my 'Child Labour and the Industrial Revolution,' Workshop on Child Labour and Apprenticeship, University of Essex, 1986; and in my 'Women's Work and the Early Phases of Mechanisation in England,' in Patrick Joyce, The Historical Meanings of Work,

early phases of mechanisation and factory organisation in the woollen and silk industries as well as cotton it was generally believed that child labour was integral to textile machine design.⁵²

This association between child labour and machinery may in England have been confined to a fairly brief period of factory development. In America, it appears to have been a much more straightforward development dating from 1812, and associated with new large scale technologies or divisions of labour to dispense with skilled adult male labour.⁵³ In England, it seems that the early predominance of women and children in textile factories was a development out of changes in technology and the division of labour taking place earlier in the eighteenth century under domestic and workshop production. An adult-child assistant workgroup was assumed; the assistant saved time and helped to increase throughput. The system was in some cases dramatically expanded to workshops organised under hierarchical division of labour. Processes were, furthermore, broken down into a series of dexterous operations which were performed particularly well by teenage girls who contributed learned manual dexterity and high labour intensity. The manufacturers who developed these new production processes and techniques which in many eighteenth

Cambridge, Cambridge University Press, 1988

⁵² See S.C. on Children's Employment, Vol. II, Parliamentary Papers, 1816-1817, pp. 279, 343; and S. C. on Children in Factories, Parliamentary Papers, 1831, p. 254

⁵³ Goldin and Sokoloff, p. 747

century industries were particularly successful in perceiving and capturing the benefits of this labour force.

Access to cheap supplies of labour, especially that of women and children was nothing new - it was integral to the spread of manufacture in the early modern period. But it was labour that was also endowed with special attributes particularly suited to eighteenth century technologies and work organisation. Young workers, as assistants when small and later as independent youth workers and a large workforce of women workers provided a great boost to labour productivity. But their contributions have been bypassed in assessments of productivity which rely wholly on capital-labour ratios. The estimate for labour must be disaggregated into gender and age differences, skill and labour intensity. This is particularly crucial for the years usually assigned to the Industrial Revolution. It is likely there was a special place for this women's and children's labour in the phases of industrialisation concentrated in the eighteenth and very early nineteenth century. Some aspects of this phenomenon have only recently found a parallel in the decentralisation of production processes in both Third World and core country manufacturing.

VII Conclusion

This paper has examined aspects of the recent quantitative assessments of the Industrial Revolution. It expresses considerable doubts over the treatment of the industrial sector

in these assessments. It has found major problems in the use made by the revisionists of dualistic models of the economy. It demonstrates the inappropriateness to the eighteenth century economy of narrow and restrictive definitions of technological innovation. And finally it examines the implications of entirely misconceiving the eighteenth century labour force through relying on data for adult males only.

The kinds of technological and organisational innovation I have discussed in my paper - those associated with product and materials innovation as well as the division and intensification of labour are hidden behind capital output ratios. They were also notably the most widespread and significant types of innovation to most manufacturing in the classic years of the Industrial Revolution, that is between 1760 and 1820. The types of definition and measures adopted by the revisionists do not capture the effects of the kind of innovation historically specific to the period. Neither do definitions of the labour force capture the age and gender mix which also seems to have been historically specific to these years. The emphasis of Crafts and others on continuity have masked the historical disjunctures which were probably distinctive for only a fairly brief period before more conventional and more easily quantified signposts of industrialisation appeared.

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