Why Was British Growth So Slow During the Industrial Revolution?

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Although it has been labeled the "First Industrial Revolution," British growth and industrialization was slow between the 1760s and the 1820s. The explanation seems to lie with low capital formation shares in national income, low rates of accumulation, and thus little change in the capital-labor ratio. What accounts for the modest investment rates? Lack of thrift? Weak investment demand? This paper argues that the answer is to be found in the enormous debt issues used to finance the French Wars. The war debt crowded out civilian accumulation, inhibited growth, and contributed to the dismal performance in the workers' standard of living. Mobilization and war-distorted prices also played an important role. A general equilibrium model is used to factor out the quantitative impact of each of these three wartime forces on British economic performance up to the 1820s.

I. INTRODUCTION

WE understand the dimensions of the British industrial revolution far better now than a century ago when the debate over its causes and consequences began to heat up. Feinstein has presented pioneering estimates of accumulation rates from 1760 to 1860, and Wrigley and Schofield have offered a brilliant reconstruction of demographic events at the time. The early estimates of national income by Deane and Cole have been augmented by a steady revisionist stream, most recently by Crafts, Harley, Lindert, and me. Informed guesses on the rate of total factor productivity growth are now available; and even trends in the standard of living of workers have now been nailed down more securely.[1]

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[1] Charles Feinstein, "Capital Formation in Great Britain," in *The Cambridge Economic History of Europe: Volume VII: the Industrial Economies: Capital, Labour, and Enterprise*, ed. Peter Mathias and Michael Postan (Cambridge, 1978); E. A. Wrigley and R. S. Schofield, *The Population History of England, 1541–1871: A Reconstruction* (Cambridge, 1981); Phyllis Deane and W. A. Cole, *British Economic Growth, 1688–1959* (Cambridge, 1962); N. F. R. Crafts, "English

The new evidence confirms what has come to be called "trend acceleration." Somewhere around the 1820s Britain passed through a secular turning point. Growth in national income was much lower before than after: for example, Harley estimates the growth in per capita income at 0.33 percent per year 1770–1815 and 0.86 percent per year 1815–1841.[2] The doubling of the growth rate is apparent, too, in the indices of industrial production, which grow annually at 1.5 or 1.6 percent before 1815 and at 3.0 or 3.2 percent afterwards.[3] Feinstein's estimate of the rate of capital formation also drifts upwards during the period: in constant prices, the share of gross domestic investment in national income rises from about 9 percent in the 1760s to almost 14 percent in the 1850s; the rate of capital accumulation rises from 1 percent 1761–1800 to 1.7 percent per year 1801–1860; the capital per worker growth rate rises from 0.11 percent per year 1761–1830 to 0.88 percent per year 1830–1860.[4] The turning point is even more dramatic in the standard of living: the adult, male, working-class real wage failed to increase between 1755 and 1819, but from 1819 to 1851 rose at an annual rate of 1.85 percent.[5]

British growth before the 1820s, then, was modest at best. By the standards of the many industrial revolutions to follow, Britain's annual growth in per capita income of 0.33 percent before 1815 is hardly impressive. Even during the uneven 1970s the Third World managed per capita income growth rates around 3.2 percent per year, ten times the British rate before the 1820s.[6]

Economic Growth in the Eighteenth Century: A Re-examination of Deane and Cole's Estimates," *Economic History Review*, 2nd ser., 29 (May 1976), 226–35, "National Income Estimates and the British Standard of Living Debate: A Reappraisal of 1801–1831," *Explorations in Economic History*, 17 (April 1980), 176–88, and "British Economic Growth, 1700–1831: A Review of the Evidence," *Economic History Review*, 2nd ser., 36 (May 1983), 177–99; C. Knick Harley, "British Industrialization Before 1841: Evidence of Slower Growth During the Industrial Revolution," this JOURNAL, 42 (June 1982), 267–89; Peter H. Lindert and Jeffrey G. Williamson, "Revising England's Social Tables, 1688–1812," *Explorations in Economic History*, 19 (Oct. 1982), 385–408, and "Reinterpreting Britain's Social Tables, 1688–1913," *Explorations in Economic History*, 20 (Jan. 1983), 94–109. On the rate of total factor productivity growth, see Feinstein, "Capital Formation," p. 86; Crafts, "British Economic Growth," p. 196; and Crafts and McCloskey in *The Economic History of Britain Since 1700, Volume 1: 1700–1860*, ed. Roderick Floud and Donald McCloskey (Cambridge, 1981), chaps. 1 and 6. A recent quantitative assessment of the standard of living can be found in Lindert and Williamson, "English Workers' Living Standards During the Industrial Revolution: A New Look," *Economic History Review*, 2nd ser., 36 (Feb. 1983), 1–25.

[2] Harley, "British Industrialization Before 1841," p. 286.

[3] Ibid., p. 276, Divisia Index.

[4] Feinstein, "Capital Formation," Table 3 (col. 10), and pp. 84 and 86. Crafts, "British Economic Growth," also offers new estimates for aggregate output growth, industrial output growth, and the investment rate. While his revisions may turn out to be superior, Crafts' choice of benchmark dates–1760, 1780, 1801, and 1831–are inconvenient for the analysis in this paper, where wars are at issue and the 1815 or 1821 benchmark is critical.

[5] Lindert and Williamson, "English Workers' Living Standards," Table 5, p. 13.

[6] International Bank for Reconstruction and Development, *World Tables*, 2nd ed. (Baltimore, 1980), p. 372.

British growth before the 1820s looks odd when set beside the conventional dating of the industrial revolution. There is no evidence of improvement in the standard of living among the working classes until the 1820s. Indeed, stability in the real wage during the early industrial revolution has encouraged models of labor surplus, still popular today in the Third World.[7] Growth of income as a whole was also poor down to the 1820s. And even the rate of industrialization was quite slow during the alleged industrial revolution. Industrial output grew at 1.5 or 1.6 percent per year up to the 1820s, a rate which exceeded the national income growth rate of 1.3 percent only modestly. Furthermore, Britain was a low saver. A gross domestic saving rate of 9 or 10 percent is low compared with the contemporary Third World average of 20.1 percent in 1977 or Meiji Japan (14.8 percent, 1910–1916) or late nineteenth-century America (28 percent, 1890–1905).[8] The rate of capital accumulation was so modest that hardly any capital-deepening took place. The absence of capital-deepening has suggested that the new technologies sweeping England were capital-saving.[9] The suggestion is remarkable when set beside the voluminous work on labor-saving in nineteenth-century America and in the contemporary Third World. The First Industrial Revolution looks very odd indeed.

Why was British growth so slow in the six decades before the 1820s? One answer might be that the conventional dating of the industrial revolution is simply wrong. Another answer, however, is more plausible: that Britain tried to do two things at once—industrialize *and* fight expensive wars, and she simply did not have the resources to do both.

During the 60 years following 1760, Britain was at war for 36; in the three decades following the late 1780s Britain went from a peacetime economy to a level of wartime commitment that had no parallel until World War I. The war mobilized a good share of the civilian labor force, suggesting that labor scarcity might have been created in the civilian economy. The war debt grew to enormous size, suggesting that civilian capital accumulation might have been suppressed by crowding-out. Tax revenues surged to one-fifth of national income, implying that real private incomes after tax were eroded. Meanwhile, war, blockades, and embargoes diminished international trade, inflating the relative prices of agricultural and raw material importables in the home market while

[7] The classic labor surplus statement, of course, can be found in W. Arthur Lewis, "Economic Development with Unlimited Supplies of Labour," *Manchester School of Economic and Social Studies*, 22 (May 1954), 139–92.

[8] International Bank for Reconstruction and Development, *World Tables*, p. 421; Allen C. Kelley and Jeffrey G. Williamson, *Lessons from Japanese Development: An Analytical History* (Chicago, 1974), p. 233; and Williamson, "Inequality, Accumulation and Technological Imbalance: A Growth-Equity Conflict in American History?" *Economic Development and Cultural Change*, 27 (Jan. 1979), 233.

[9] For example, see G. N. von Tunzelmann in *The Economic History of Britain*, chap. 8.

lowering the price of manufactured exportables deflected from world markets.

There has been no shortage of speculation on how the wars affected growth. The conventional wisdom on the standard of living, for example, is that the wars "almost certainly worsened the economic status of labor."[10] The same may perhaps be said of industrialization, capital formation, and export expansion. But we will not know until we make an explicit commitment to models capable of sorting out the influence of war.

II. WAR DEBT: CROWDING OUT CIVILIAN CAPITAL ACCUMULATION

Was Saving a Constraint on British Growth?

The "modest" rate of accumulation during most of the First Industrial Revolution could have been a result of limited saving (constrained perhaps by war) or merely a result of modest growth in investment demand.[11] The two views are portrayed in Figure 1, where the rate of return or interest rate appears on the vertical axis and the investment share in national income on the horizontal axis. Assume for the moment that prices were stable, so that the nominal and real interest rate are the same. If one believes, as most neo-Keynesians did in the 1950s and early 1960s, that investment demand is the critical variable, then the Elastic Saving Function will be attractive. Investment demand shifts and saving responds passively. If one believes, as most neoclassicists in the 1980s do, that saving is an active constraint, then the upward sloping saving functions will be more attractive. In such cases both investment demand and saving supply play a role. The modest rise in the investment ratio from 1760 to 1815 is driven in the diagram by the shift to Actual Saving in 1815 and by the shift to Investment in 1815. If the rise in the war debt competed with civilian accumulation, then Actual Saving in 1815 would be somewhere to the left of Hypothetical (No Wars) Saving in 1815, a counterfactual peacetime case in which the war debt is kept constant. Clearly the war debt helps explain the modest rate of accumulation up to 1815 if the saving function was inelastic. The war debt explains none of the modest rate of accumulation if, instead, the saving function was perfectly elastic. Judging from François Crouzet's *Capital Formation in the Industrial Revolution,* the active-investment-passive-saving belief dominated as late as 1972.

[10] T. S. Ashton, "The Standard of Life of the Workers in England, 1790–1830," this JOURNAL, 9 (Supplement 1949), 22–23.

[11] Deane and Cole (*British Economic Growth*, p. 276) call it a "modest" increase and in Peter Mathias's words ("Preface" in François Crouzet, *Capital Formation in the Industrial Revolution* [London, 1972], p. viii), the "modesty of rates of capital accumulation" is one profound difference between eighteenth-century England and contemporary Third World economies.

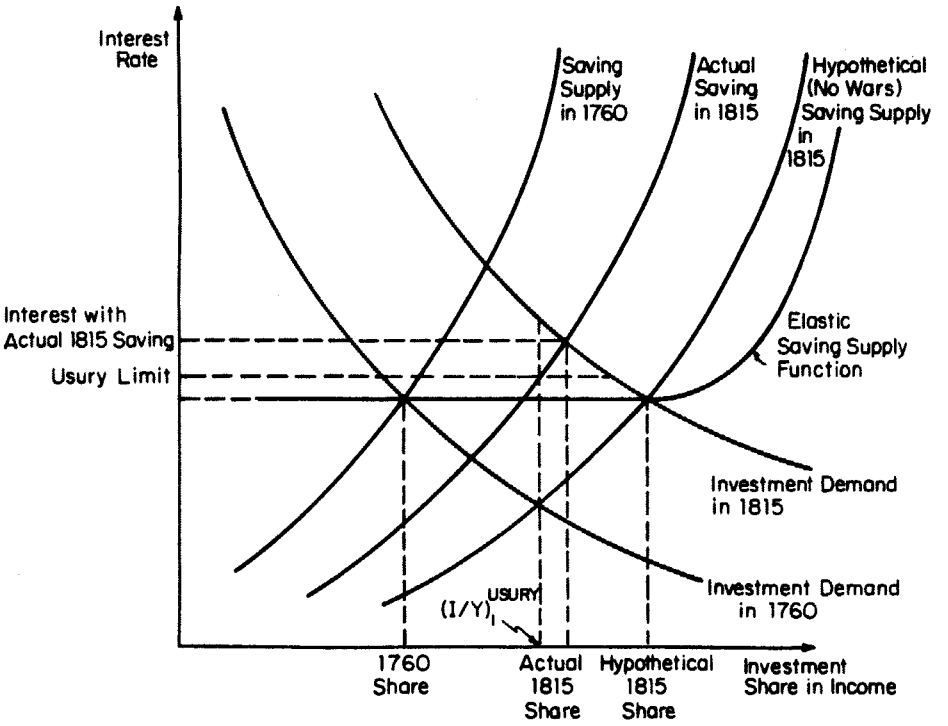

FIGURE 1
HOW THE WARS AFFECTED SAVING

Source: See text.

Contemporaries had some strong beliefs about forgone civilian accumulation and the cost of the wars, but most modern historians do not give them much weight. Deane and Cole's chapter on "Longterm Trends in Capital Formation" has no mention of the War, though they are puzzled by the modest rates of accumulation.[12] The same is true of von Tunzelmann's recent paper on the standard of living debate.[13] In his otherwise penetrating assessment of whether an enlightened policy could have done better for Britain's poor during the industrial revolution he makes no mention of the resource commitment to military conflict. Mokyr and Savin add crowding-out to their list of potential explanations of British economic performance between 1793 and 1815, but ignore crowding-out when they offer an assessment of what they call "stagflation."[14] Even Charles Feinstein's oft-cited "Capital Accumula-

[12] Deane and Cole, *British Economic Growth*, chap. 8, pp. 259–77.

[13] Von Tunzelmann, "The Standard of Living, Investment, and Economic Growth in England and Wales, 1760–1850," in *Technical Change, Employment, and Investment*, ed. Lars Jörberg and Nathan Rosenberg (Lund, 1982), 209–24.

[14] Joel Mokyr and N. E. Savin, "Stagflation in Historical Perspective: The Napoleonic Wars Revisited," *Research in Economic History*, ed. Paul Uselding, vol. 1 (Greenwich, 1976), 198–259.

tion and Economic Growth" ignores the issue, save for a suggestive reference to a "wartime dip" in the investment to GNP ratio.[15] And while Mathias and O'Brien tell us that "the ability of the British state to wage war effectively seems even more dependent upon the ability of governments to raise loans through the accumulation of a permanent National Debt than it was upon increasing revenues from taxation," their useful paper is devoted entirely to documenting the thesis that "the main economic impact of taxation in Britain fell upon consumption and demand, rather than upon savings and investment."[16]

The Mill-Ashton Hypothesis

Contemporary observers saw things quite differently. New war debt crowded out private debt and the usury laws were seen to deflect saving to government borrowing, much as funds in Third World financial markets are diverted to state-backed projects and government borrowing.[17] Writing on the state of the private capital market after the government borrowed £12 million in 1781, David Macpherson and George Chalmers saw the crowding out clearly:[18]

> Such high interest with government security evidently makes it extremely difficult, if not quite impossible, for individuals to borrow any money, upon legal interest, either for the extension of commerce and manufacture, or the improvement of agriculture.
>
> Every one must remember how impossible it was for individuals to borrow money on any security for any premium towards the end of 1784.

Writing after the French Wars had ended, but in the face of the immense debt, John Stuart Mill saw deflection and crowding-out as an important cause of relatively modest British progress:[19]

> Did the government, by its loan operations, augment the rate of interest? . . . When they do raise the rate of interest, as they did in a most extraordinary degree during the French War, this is positive proof that the government is a competitor for capital. . . .

What was true of England was apparently true for Scotland as well:

> A small amount of government securities first appeared in the accounts of the Bank of Scotland in 1766, but they did not become a permanent feature until the American Revolution. Such investments, including Bank of England . . . stock, shot up dramatically after 1792, quickly overshadowing ordinary lending. . . . [T]his policy, which was

[15] Feinstein, "Capital Formation," p. 90.

[16] Peter Mathias and Patrick O'Brien, "Taxation in Britain and France, 1715–1810," *Journal of European Economic History*, 5 (Winter 1976), 616 and 623.

[17] Ronald I. McKinnon, *Money and Capital in Economic Development* (Washington, D.C., 1972).

[18] David Macpherson, *Annals of Commerce* (London, 1805), vol. 3, p. 686; George Chalmers, *An Estimate of the Comparative Strength of Great Britain* (London, 1794), p. 186.

[19] John Stuart Mill, *Principles of Political Economy*, 5th ed. (New York, 1909), vol. 2, p. 481.

apparently also followed by the other Edinburgh banks, drew criticism on the grounds that it deprived Scottish industry of capital . . .[20]

Mill had a view of crowding-out in which new war debt issues displaced private capital accumulation, one-for-one: "the government, by draining away a great part of the annual accumulations . . . subtracted just so much [capital] while the war lasted."[21] And Mill thought crowding-out was large enough to warrant the belief that the counterfactual peacetime rate of capital accumulation would have been "enormous":

the accumulation going on in the hands of individuals was sufficient to counteract the effect of that wasteful [military] expenditure, and to prevent capital from being diminished. The same accumulation would have sufficed, but for the government expenditure, to produce an enormous increase.[22]

A century later Ashton affirmed the crowding-out hypothesis, using it to explain the operation of capital markets in the eighteenth century.[23] The best statement of his thesis can be found in Chapter 4 ("Building and Construction") of his *Economic Fluctuations in England*:

much of the revenue needed for the prosecution of war had to be obtained from loans. The proportion was low at first, but mounted as the cost of maintaining the forces increased. . . . Some of the money subscribed must have come out of idle balances, but . . . a good deal of it was deflected from other channels, and in particular from investment in building and construction. The production of capital goods was relatively low in most years of war.[24]

Building and construction were the victims of crowding-out, and according to Feinstein they were 60 percent of total gross domestic fixed capital formation in the 1760s and 68 percent in 1801–1810.[25] Ashton has more to say about the operation of British capital markets during wartime, especially about usury and credit rationing. The banking system did not expand total credit when they purchased war debt, but it did ration what credit remained:

when the Bank of England increased its advances to the state it usually curtailed its loans and discounts to other clients. . . . Nor does the cautious policy of the Bank seem to have been offset by an expansion of credit elsewhere. There was no marked increase

[20] Rondo Cameron, "Scotland, 1750–1845," in *Banking in the Early Stages of Industrialization*, ed. Cameron (New York, 1967), pp. 81–82.

[21] Mill, *Principles*, vol. 2, pp. 481 and 483.

[22] Mill, "Observations on the Effects Produced by the Expenditure of Government During the Restriction of Cash Payments," *The Westminster Review*, 2 (July 1824), Art. II, p. 40.

[23] Ashton, *An Economic History of England: The 18th Century* (London, 1955), and *Economic Fluctuations in England, 1700–1800* (Oxford, 1959).

[24] Ashton, *Economic Fluctuations*, p. 65.

[25] Feinstein, "Capital Formation," Table 7, p. 41.

in the number of private banks, and there is evidence that the London banks, at least, reduced their loans to private customers when they lent to the state.[26]

The civilian loan market was constrained by usury:

in the eighteenth century the range of possible rates on mortgages and bonds was limited. No instance has been found of a rate below 3 per cent.; and the Usury Laws prohibited borrowers from offering, or lenders from receiving, more than 6 per cent. until 1714 and more than 5 per cent. during the rest of the century. The existence of this upper limit is of the utmost importance to an understanding of the fluctuations of the period. Once the critical point had been reached further borrowing might become impossible.[27]

The usury laws are not essential to crowding-out, but they help Ashton explain the business cycle. Further, they make clear that the interest rate is not the sole index of scarcity in the civilian capital market:

It was not, then, simply through a rise in the cost of borrowing, but through interruptions to the flow of funds, that depression came to [building and construction]. . . . When the rate of 5 per cent. had been reached builders and contractors might be getting all the loans they wanted or, on the other hand, many of them might be in acute need of more. If we want to know the degree of scarcity we must look for other sources of information.[28]

The Size of the War Debt

The first step in testing the Mill-Ashton hypothesis is to compute the size of the war debt. The calculation requires two pieces of evidence: national income and net additions to the war debt. The additions to the debt were available even to Mill, but national income estimates only became available with the appearance in 1962 of Deane and Cole's book. Table 3 summarizes the information using two different concepts of the real impact of the war debt. One estimate follows most economists in using the Department of Commerce National Income Accounts view, deflating the increase in nominal debt outstanding. Siegal, Dewald, Eisner, and others have recently argued that we should use instead Real Accrual Accounting, computing the real debt at the beginning and the end of the period, before the increase is calculated.[29] The accrual concept includes the impact of inflation on the stock of old debt, whereas the national accounts concept does not. Since these were

[26] Ashton, *Economic Fluctuations*, pp. 65–66.

[27] Ibid., p. 86.

[28] Ibid., pp. 86–87.

[29] Jeremy J. Siegal, "Inflation-Induced Distortions in Government and Private Saving Statistics," *Review of Economics and Statistics*, 61 (Feb. 1979), 83–90; William G. Dewald, "Federal Deficits and Real Interest Rates: Theory and Evidence," *Federal Reserve Bank of Atlanta Economic Review*, 68 (Jan. 1983), 20–29; Robert Eisner and Paul J. Pieper, "A New View of the Federal Debt and Budget Deficits," *American Economic Review*, 74 (March 1984), 11–29.

TABLE 1
CIVILIAN INVESTMENT IN REPRODUCIBLE CAPITAL AND NATIONAL INCOME PER YEAR, 1761–1860: BASED ON FEINSTEIN, DEANE AND COLE

	Y: National Income in Great Britain, £m		*Investment and "Saving" in Great Britain, Current Prices, £m*			*Investment and "Saving" in Great Britain, 1851/61, Prices, £m*			*Implicit Price Deflators*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Decade	*Current Prices*	*Constant 1851/61 Prices*	*Gross Domestic Fixed Capital Formation*	*Gross Domestic Capital Formation*	*Gross Domestic Saving in Reproducible Capital*	*Gross Domestic Fixed Capital Formation*	*Gross Domestic Capital Formation*	*Gross Domestic Saving in Reproducible Capital*	*Investment*	*National Income*
1761–1770	74.6	89.6	3.7	4.7	5.2	6.6	7.6	8.1	.55	.83
1771–1780	88.8	96.0	4.0	6.0	6.5	7.1	9.1	10.1	.57	.92
1781–1790	107.1	110.2	6.8	8.8	10.3	11.1	13.1	14.6	.61	.97
1791–1800	174.3	139.7	11.4	14.9	16.4	14.3	17.3	18.8	.80	1.25
1801–1810	266.6	172.1	20.4	21.9	18.9	16.6	17.6	15.6	1.23	1.55
1811–1820	296.1	212.2	26.5	29.5	37.0	20.5	22.5	27.5	1.29	1.40
1821–1830	315.5	291.6	31.3	35.8	44.3	28.3	32.3	39.8	1.11	1.08
1831–1840	396.2	396.9	40.5	44.0	48.5	38.6	42.1	46.6	1.05	1.00
1841–1850	487.8	495.7	50.5	55.0	61.5	49.4	54.4	60.9	1.02	.98
1851–1860	595.7	595.7	58.0	61.5	81.5	58.0	61.5	81.5	1.00	1.00

Sources: Cols. (1) and (2): Mid-decade averages, based on Deane and Cole, *British Economic Growth*, Tables 19 and 37, where Table 19 is converted into current prices by applying Gilboy's price index reported in Mathias and O'Brien, "Taxation in Britain and France," p. 605, and linking on 1801; Table 37 is converted into constant prices by applying Deane and Cole's (Table 72, p. 282) implicit national product price deflator, which is, in fact, the Rousseaux index.

Cols. (3) and (6): Gross domestic fixed capital formation, decade averages, in Feinstein "Capital Formation," Tables 6 and 7, pp. 40–41.

Cols. (4) and (7): Gross domestic capital formation, cols. (3) and (6) plus stockbuilding, in ibid., Table 16, p. 69.

Cols. (5) and (8): Gross domestic savings in reproducible capital, cols. (4) and (7) plus net investment abroad, in ibid., Table 16, p. 69.

Col. (9) = col. (3) ÷ col. (6).

Col. (10) = col. (1) ÷ col. (2).

TABLE 2
THE TAX BURDEN IN GREAT BRITAIN, 1761–1860

Decade	*(1) Share of Direct Taxes in Total Tax Revenues: ϕ_t*	*(2) Share of Net Tax Revenue in National Income*	*(3) Share of Direct Taxes in National Income*
1761–1770	.208	.128	.027
1771–1780	.188	.129	.024
1781–1790	.184	.140	.026
1791–1800	.168	.139	.023
1801–1810	.235	.180	.042
1811–1820	.258	.202	.052
1821–1830	.136	.165	.022
1831–1840	.088	.122	.011
1841–1850	.150	.102	.015
1851–1860	.199	.097	.019

Sources: Col. (1) calculated from Brian R. Mitchell and Phyllis Deane, *Abstract of British Historical Statistics* (Cambridge, 1962), pp. 387–88 and 392–93, where taxes on income and wealth include land and assessed taxes, property and income taxes. Central government only.
Col. (2) takes current price national income from Table 1, col. (1). Net tax revenues for 1760–1800 are from Mathias and O'Brien "Taxation in Britain and France," Table 2, p. 605, five-year averages, central government only, and for Great Britain. For 1801–1861, the United Kingdom gross tax revenues in Mitchell and Deane, *Abstract*, pp. 392–93, are adjusted downwards to get estimated net tax revenues for Great Britain, and refer to five-year averages.
Col. (3) = col. (1) × col. (2).

decades of inflation the two concepts may well yield quite different results.

Whether one favors the national income or the accrual concept, the size of the war debt issue was enormous, although the two concepts imply somewhat different timing in the real impact of war debt. While the national income concept in Table 3 (column 9) suggests a peak share in national income of 11.5 percent across the 1790s, the accrual concept (column 8) reduces this figure to 3.6 percent, removing the impact of rapid inflation on the outstanding stock of old war debt. Symmetrically, the price deflation across the 1810s raises the accrual share above the national income share, 14.9 versus 7.4 percent. The estimates are comparable over the long run: for the 1760–1820 epoch, the accrual and national income estimates averaged 5.8 and 6.8 percent of national income. Since it is used so commonly in the literature I shall use the national income concept in what follows.

Net additions to the war debt were 3.6 percent of national income as early as the 1760s (Table 3, NIA, column 9) about the same as the 3.7 percent America achieved during 1980–1982, when crowding-out and capital scarcity began to attract attention. The share had risen to 6.5 percent by the 1780s, a near doubling. It reached a peak of 11.5 percent

TABLE 3

PUBLIC DEBT ISSUE, GROSS DOMESTIC SAVING IN REPRODUCIBLE CAPITAL, AND GROSS PRIVATE SAVING: LEVELS AND SHARES IN NATIONAL INCOME, 1761–1860

	(1)	(2)	(3)		(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						Increase Per Year in Government Debt			Shares in National Income			Gross Private Saving Rate	
Year	Government Debt Outstanding (£m) D	National Income Price Deflator (1851/61 = 1.0) P_Y	Real Debt Outstanding D/P_Y	Decade	P_Y	Nominal (£m) ΔD	Real: RAA $\Delta(D/P_Y)$	Real: NIA $\Delta D/P_Y$	RAA $\Delta(D/P_Y)$	NIA $\Delta D/P_Y$	S/P_I	RAA $[S/P_I + \Delta(D/P_Y)]$	NIA $[S/P_I + \Delta D/P_Y]$
1761	103.2	.77	134.7										
1771	130.2	.90	144.9	1761–1771	.83	2.7	1.0	3.3	1.1%	3.6%	9.1%	10.2%	12.7%
1781	173.7	.95	183.2	1771–1781	.92	4.4	3.8	4.7	4.0	4.9	10.5	14.5	15.4
1791	243.6	1.00	244.9	1781–1791	.97	7.0	6.2	7.2	5.6	6.5	13.3	18.9	19.8
1801	443.1	1.50	295.6	1791–1801	1.25	20.0	5.1	16.0	3.6	11.5	13.5	17.1	24.9
1811	618.9	1.60	387.3	1801–1811	1.55	17.6	9.2	11.4	5.3	6.6	9.0	14.4	15.6
1821	838.0	1.19	703.6	1811–1821	1.40	21.9	31.6	15.7	14.9	7.4	13.0	27.9	20.4
1831	790.6	.97	813.4	1821–1831	1.08	−4.7	11.0	−4.4	3.8	−1.5	13.6	17.4	12.1
1841	790.9	1.02	773.1	1831–1841	1.00	0.0	−4.0	0.0	−1.0	0.0	11.7	10.7	11.7
1851	789.1	.95	835.0	1841–1851	.98	−0.2	6.2	−0.2	1.3	−0.0	12.3	13.5	12.3
1861	805.8	1.05	764.5	1851–1861	1.00	1.7	−7.1	1.7	−1.2	0.3	13.7	12.5	14.0

Sources: Col. (1): funded and unfunded government debt of the United Kingdom, where annual observations are five-year averages, centered, from Mitchell and Deane, *Abstract*, pp. 402–3.

Cols. (2) and (4) are described in the "Sources" to Table 1.

Cols. (6) and (7) offer two alternative estimates of the *real* increase in the war debt: RAA refers to "real accrual accounting" = $\Delta(D/P_Y)$; *NIA* refers to Department of Commerce "national income accounting" = $\Delta D/P_Y$.

Cols. (8) and (9): cols. (6) and (7) divided by Table 1, col. (2).

Col. (10) from Table 1, col. (8) divided by col. (2).

Col. (11) = col. (8) + col. (10).

Col. 12) = col. (9) + col. (10).

in the 1790s. The last figure approximates that for America during the Civil War (15.5 percent).[30] America generated a similar burden of war debt over five years or so of the Civil War decade, as did Japan over the decade 1894–1905 (during war with China and Russia).[31] But neither of these newly industrializing countries maintained the burden over six decades. Net additions to the British war debt continued at high levels throughout the first two decades of the nineteenth century, holding at 6.6 percent of national income in the 1800s and 7.4 percent in the 1810s.

The average burden of these net additions to the war debt was 6.8 percent between 1761 and 1820, and 8.5 percent between 1791 and 1820. To get an estimate of the *gross private saving rate*, civilian reproducible capital formation and new public war debt should be added. When they are, Britain's private saving rates during the First Industrial Revolution no longer seem so modest. Indeed, while domestic investment in reproducible capital averaged only around 11.4 percent of national income from 1761 to 1820 (Table 3, column 10), the gross private saving rate averaged 18.1 percent (Table 3, column 12).

It appears that Britain was not a "modest" saver during the First Industrial Revolution after all. What makes Britain unusual is that much of the potential saving went into the financing of war.

Crowding-Out and the Ricardian Non-Equivalence Theorem

Does the typical household view government debt issue as an increase in its own net wealth? It has been assumed that it does in some full employment models: an increase in government debt is assumed to imply an increase in perceived household wealth, inducing a rise in desired consumption, an increase in interest rates, and a decline in the share going to capital accumulation. While one-for-one crowding-out survived Franco Modigliani's tests on American data, and while David and Scadding thought that the "invariance [of the gross private saving rate in twentieth-century America] to changes in the size of the government deficit suggests that private debt and public debt are close substitutes in private portfolios," the debate over crowding-out has hardly been closed.[32]

A critical assumption of these models is full employment. If Britain is

[30] Williamson, "Watersheds and Turning Points: Conjectures on the Long Term Impact of Civil War Financing," this JOURNAL, 34 (Sept. 1974), Table 3, p. 643.

[31] Williamson and Leo J. DeBever, "Savings, Accumulation and Modern Economic Growth: The Contemporary Relevance of Japanese History," *The Journal of Japanese Studies*, 4 (Fall 1977), 125–67.

[32] Franco Modigliani launched this literature with his "Long-Run Implications of Alternative Fiscal Policies and the Burden of the National Debt," *Economic Journal*, 71 (Dec. 1961), 730–55, and his tests appear in "The Life Cycle Hypothesis of Savings, the Demand for Wealth and the Supply of Capital," *Social Research*, 33 (Summer 1966), 160–217. Paul A. David and John L. Scadding, "Private Savings: Ultrarationality, Aggregation, and 'Denison's Law'," *Journal of Political Economy*, 82, Pt. 1 (March/April 1974), 239.

better described by under-full employment, then the war debt issue may have crowded *in* private investment.[33] But the full employment assumption is the best description of Britain during the industrial revolution, certainly when attending to a period as long as three to six decades.

But even granting full employment, there were always strong opponents to one-for-one crowding-out. James Tobin thought such arguments implied "fiscal illusion": "How is it possible that society merely by the device of incurring a debt to itself can deceive itself into believing that it is wealthier? Do not the additional taxes which are necessary to carry the interest charges reduce the value of other components of wealth?"[34] Barro's 1974 paper ("Are Government Bonds Net Wealth?") showed that taxes can offset debt issue, but had to make two assumptions likely to be grossly inconsistent with the environment of the British industrial revolution.[35] For one thing, future tax liabilities were probably *not* fully capitalized. Bondholders probably did suffer fiscal illusion. As O'Driscoll pointed out, Ricardo thought fiscal illusion was the best characterization of bondholders' behavior in late eighteenth- and early nineteenth-century Britain:

> In [theory], there is no real difference [between taxes and debt issue] . . .; but [in fact] the people who pay the taxes never so estimate them, and therefore do not manage their private affairs accordingly. We are too apt to think that war is burdensome only in proportion to what we are at the moment called to pay for it in taxes, without reflecting on the probable duration of such taxes.[36]

Ricardo wrote his analysis of the impact of the war debt in September of 1820, when crowding-out and sinking funds were being publicly debated, with the background of two decades of British accumulation under war finance.

For another thing, Barro was "willing to make the severely restrictive assumption that the source for the ultimate purchase of the government bonds is identical to the source from which the alternative taxes would be drawn."[37] Historians have always assumed the opposite, namely, that those receiving the interest on bonds were not the tax payers. Ignoring certain subtleties of tax incidence, Table 2 suggests that the historians have been right. The British central government tax system was highly regressive at this time. Direct taxes on income and wealth

[33] Benjamin M. Friedman, "Crowding Out or Crowding In? Economic Consequences of Financing Government Deficits," *Brookings Papers on Economic Activity*, 3 (1978), 593–641.

[34] James Tobin, *Essays in Economics: Vol. 1: Macroeconomics* (Amsterdam, 1971), p. 91.

[35] Robert J. Barro, "Are Government Bonds Net Wealth?" *Journal of Political Economy*, 82 (Nov./Dec. 1974), 1095–117; James M. Buchanan, "Barro on the Ricardian Equivalence Theorem," *Journal of Political Economy*, 84 (April 1976), 337–42.

[36] David Ricardo, *The Works and Correspondence of David Ricardo*, ed. P. Straffa (Cambridge, 1962), vol. 4, pp. 186–87; see also G. P. O'Driscoll, "The Ricardian Nonequivalence Theorem," *Journal of Political Economy*, 85 (Feb. 1977), 207–10.

[37] Buchanan, "Barro on the Ricardian Equivalence Theorem," p. 339.

produced a very small share of total taxes (Table 2, column 1, ϕ_t). Furthermore, the temporary direct taxes that *had* been imposed in the late 1790s and afterwards were quickly dismantled after the war, leaving tariffs and excise taxes on necessities the main source of revenue to make payments on the debt. Fiscal illusion was not illusory.

In short, the assumption of one-for-one crowding-out may be a rather good description of behavior during the British industrial revolution. It may be good enough, at least, to warrant its use to assess what the rate of accumulation might have been had the wars never been fought and had the debt never been issued.

Civilian Accumulation in the Absence of War: Counterfactual Conjectures

The next step is to explore the implications of the crowding-out when it is posed in its strongest, one-for-one form. The most difficult part of the exercise involves the redistributive effect of the war debt. The redistributive effect is a simple enough notion, with a long tradition in British historiography.[38] Since the war debt was held by high-income savers, and since taxes fell primarily on low-income nonsavers, a redistribution from nonsavers to savers is implied. The redistribution effect would not have had a favorable impact on the living standards of workers, but nonetheless would have served to augment the gross private saving rate. In other words, the redistribution effect might have offset the crowding-out effect, raising investment.

The question is how large the offset might have been. The answer depends in part on the size of the debt charges. They were large, exceeding the new debt issue itself in all but one decade, the 1790s. The answer also depends on the source of the tax revenue. Pitt had imposed an income tax on the rich, which lasted from 1799 to 1816. Of course, there were land and assessed taxes too, all of which imply thorny problems of tax incidence, ignored here. And the answer also depends on the marginal saving rates of the taxed poor against the debt-holding rich.

The set of assumptions underlying Table 4 can be stated briefly. Assume that ("direct") taxes on income and wealth fell on the top half of the income distribution. The assumptions are likely to make the estimate of the redistribution effect too large, which is the right direction of bias. While some of the direct taxes on wealth must have been shifted back on the poor, one would think that the shifting was trivial; more importantly, some of the regressive indirect taxes fell on the rich; on net the latter bias probably dominated the former.

[38] E. P. Thompson, *The Making of the English Working Class* (New York, 1963), p. 304; Sidney Pollard and D. W. Crossley, *The Wealth of Britain, 1085–1966* (London, 1968), p. 207; R. M. Hartwell and Stanley Engerman, "Models of Immiseration: The Theoretical Basis of Pessimism," in *The Standard of Living in the Industrial Revolution*, ed. A. J. Taylor (London, 1975), pp. 208–9.

TABLE 4
CONJECTURES ON THE IMPACT OF WAR DEBT ISSUE ON CIVILIAN SECTOR ACCUMULATION AND GROWTH, 1761–1860

Period	*(1)* *Counterfactual Rise in I/Y*	*(2)* *Capital's Productivity Y/K*	*(3)* *Counterfactual Rise in the Rate of Accumulation, dK**	*(4)* *Counterfactual Rise in the Aggregate Growth Rate, dY**
1761–1820	+4.84%	0.36	+1.74%	+0.61%
1791–1820	+6.38	0.38	+2.42	+0.85
1821–1860	−2.22	0.53	−1.18	−0.41

Sources and Notes: Col. (1) is a constant price estimate derived from $d[I/Y]_{CF} = [\Delta D - (\delta)(1 - \phi)(iD)] \div Y$. The NIA estimates of the real deficit, ΔD, are taken from Table 3, col. (7). The estimate of ϕ is taken from Table 2, col. (1), and the estimate for δ can be found in the text (.362). Average annual charges on the funded and unfunded government debt, iD, are taken from Mitchell and Deane, *Abstract*, pp. 390–91 and 396–97, Great Britain 1761–1800, and United Kingdom 1801–1860, deflated by P_Y in Table 1, col. (10). The constant price national income figure, Y, is taken from Table 1, col. (2).
Col. (2) assumes that a *net* capital-output ratio of 2.5 applies to the eighteenth and early nineteenth centuries as a whole (1760–1830); from Phyllis Deane, "Capital Formation in Britain Before the Railway Age," *Economic Development and Cultural Change*, 9 (April 1961), 356, an estimate which Floud and McCloskey (*The Economic History of Britain*, p. 8, fn. 2) also accept, and which Kuznets cites with favor (*Population, Capital, and Growth* [New York, 1973], pp. 143 and 149). Feinstein reports *gross* capital-output ratios which are much higher, but his estimated *trends* in capital productivity (Feinstein, "Capital Formation," Table 26, p. 87) are used here.
Col. (3) = col. (1) times col. (2).
Col. (4) = col. (3) times 0.35, the latter an estimate of capital's outputelasticity from Floud and McCloskey (*The Economic History of Britain*, p. 8). See text.

If the average saving rate out of incomes in the lower half of the distribution was zero, and defining the average saving rate out of the top half to be s_H, then the economy-wide gross private saving rate can of course be written as $s = (s_H Y_H)/Y$, where by definition $Y_H/Y = .5$. The value for s in Table 3 (column 12) averaged 18.1 percent (1760–1820) implying that s_H was 362.[39] The differential between *average* saving rates may, of course, exceed the differential between *marginal* saving rates. If so, the assumption exaggerates the positive net saving associated with the redistribution effect and the impact of the war debt on civilian accumulation rates is, once again, understated.

The investment share can now be calculated in the absence of the

[39] If this estimate seems large, recall that it covers business reinvestment rates in a precorporate era. The estimate is very close to that favored for America by Simon Kuznets, *Shares of Upper Income Groups in Income and Savings*, National Bureau of Economic Research, Occasional Paper No. 35 (New York, 1950).

wars, reported in Table 4. Including the redistribution offset, the counterfactual rise in I/Y is calculated as:

$$d[I/Y]_{CF} = [\Delta D - (\delta)(1 - \phi_t)(iD)]/Y,$$

where ϕ_t is the share of income and wealth taxes in total tax revenue, ΔD is the deflated deficit, iD is the deflated interest charge on the debt outstanding, Y is total real income, and δ is the differential between saving rates. Using Harrod's identity (the rate of capital accumulation, K^*, equals the investment share divided by the capital/income ratio), it is a simple matter to compute the counterfactual change in the accumulation rate, dependent on the change in the investment share just calculated:[40]

$$d[K^*]_{CF} = (Y/K) \cdot d[I/Y]_{CF}$$

where Y/K is the income/capital ratio.

If the crowding-out assumptions are anywhere near correct, Table 4 suggests that war debt issue explains much of the peculiarities of the First Industrial Revolution. Between 1761 and 1820 the capital formation share would have been 4.84 percent higher in the absence of war, and the rate of accumulation would have been 1.74 percent per year higher. Assuming an output elasticity of 0.35, national income would have grown some 0.6 percent per year faster. The counterfactual calculations are even more striking for the decades in which the wars were most important, 1791–1820: the capital formation share would have been higher by 6.38 percent, the rate of accumulation would have been higher by 2.42 percent per year, and the rate of output growth would have been some 0.8 or 0.9 percent per year faster. In contrast, the post-1820 growth rates would have been lower in the absence of the wars. Thus, most of the trend acceleration from the pre-1820 war-distorted decades to the post-1820 *Pax Britannica* may well be explained by crowding-out rather than by some endogenous attribute of capitalist development.

While the counterfactual conjectures reported in Table 4 are useful, they are not enough. They ignore the potential impact of other war-induced economic influences—such as mobilization and labor scarcity, or food and resource scarcities induced by blockades and embargoes. And they only offer insight into the impact at the aggregate level. They tell us nothing about the standard of living of common labor or about industrialization.

[40] The counterfactual assumes that all of the rise would be allocated to domestic accumulation, implying one-for-one crowding-in. It should also be pointed out that I ignore the possibility that the rate of return to capital might have declined in response to the higher rates of accumulation. Unless capital rationing under usury continued to bind capital markets, rates of return would have fallen with more rapid accumulation.

III. MOBILIZATION AND WORLD MARKETS DURING THE NAPOLEONIC WARS

Major wars create a scarcity of unskilled labor, and the French Wars were no exception. Ashton's compilation from the *Parliamentary Papers* shows men in the armed forces rising from 98,000 in 1790 to 437,000 and 482,000 in 1795 and 1802.[41] Colquhoun estimated that men under arms number 501,000 in 1812.[42] By 1820, demobilization had reduced the figure back to a peacetime level of about 100,000. These estimates suggest that the share of the total labor force mobilized for the French Wars rose from about 2 to 10 percent, a mobilization rate that begins to approximate twentieth-century wars.[43]

Furthermore, mobilization had a predictable impact on the composition of the diminished civilian labor force: mobilization fell most heavily on the young, unskilled, rural male. The mobilization bias comes as no surprise—the same bias tended to breed scarcity of unskilled labor in the twentieth century. In America, for instance, both World Wars were ones of very steeply rising relative costs of unskilled labor, producing a leveling in earnings and a collapse in pay gaps between the skilled and unskilled.[44] Perhaps the collapse in pay gaps during the Napoleonic Wars can be explained in the same way.[45] These mobilization effects have in any case been documented for the 1790–1815 epoch.[46] They suggest that the growth of the civilian labor force was lowered from what it might have been, 1.25 percent per year, to what it was, 0.91 percent per year.

The relative price of agricultural goods rose sharply across the period, implying a deterioration in Britain's terms of trade, an erosion in aggregate real income, and a fall in the standard of living of the working classes. By reworking the Gayer-Rostow-Schwartz and Beveridge series, Glenn Hueckel estimated that, relative to manufactures, grain prices rose by 1.05 percent per year, 1790–1815, and I have estimated that the relative price of imported raw materials rose by even more, 2

[41] Ashton, *Economic Fluctuations*, Table 8, p. 187.

[42] Patrick Colquhoun, *A Treatise on the Wealth, Power, and Resources of the British Empire* (London, 1815), Table 1, p. 47.

[43] Mokyr and Savin ("Stagflation in Historical Perspective," p. 221) feel that these estimates of the mobilization effect are too high. They estimate that those mobilized went from 2 to 5 percent, rather than from 2 to 10 percent as reported in the text. My estimate covers the period 1790–1812, while the Mokyr and Savin figure covers the period 1800–1812. Furthermore, my estimate includes the navy and marines while the Mokyr and Savin estimate does not. I shall stick to my estimate in what follows, but if Mokyr and Savin are correct the impact of war on the standard of living, per capita income, and industrialization is understated in Section IV, the right direction of bias.

[44] Williamson and Lindert, *American Inequality: A Macroeconomic History* (New York, 1980), chap. 4.

[45] Williamson, "The Structure of Pay in Britain, 1710–1911," in *Research in Economic History*, ed. Paul Uselding, vol. 7 (Greenwich, 1982).

[46] Williamson, *Did British Capitalism Breed Inequality?* (London, forthcoming 1984), chap. 12, Table 12.1.

TABLE 5
CONJECTURES ON THE IMPACT OF WAR ON BRITAIN'S RELATIVE PRICE TRENDS

Price Variable in Per Year Rate of Change	*(1) Actual Wartime, 1790–1815*	*(2) The Impact of War: Based on Hueckel*	*(3)*
		1790–1815	*1760s–1810s*
Grains: P_A*	1.57%	0.99%	0.49%
Manufactures: P_M*	0.52	0	0
Imported Raw Materials: P_F*	2.00	0.99	0.49
P_A* − P_M*	1.05	0.99	0.49
P_F* − P_M*	1.48	0.99	0.49

Sources and Notes: Col. (1): P_M and P_A from Hueckel, "War and the British Economy," Table 3, p. 388, who reworked the Gayer-Rostow-Schwartz and Beveridge series; P_F is based on Gayer-Rostow-Schwartz "imported commodities" in Mitchell and Deane, *Abstract*, p. 470, sugar, tea, cotton, wool, and raw silk.
Cols. (2) and (3) are based on Hueckel's (p. 389) estimate that the wars raised P_A/P_M by 28 percent.

percent per year.[47] These relative price trends are somewhat less dramatic when the longer period from the 1760s to the 1810s is examined, but the drift towards greater scarcity of imported raw materials is still apparent. The question is how much of the drift was due to war.

Three supply-side forces have received attention. First, rapid technical progress in manufacturing tended to raise the relative price of all other goods, including grains. Second, harvest failures can account for some of the increased scarcity of food, but not for very many years.[48] Third, the French Wars affected trade.[49] Hueckel has estimated that the hostilities and blockades inflated 1812 wheat prices by some 25–40 percent due solely to higher freight and insurance costs. For the 1790–1815 period as a whole, Hueckel estimated that the wars raised the relative price of grains by 28 percent.[50] Table 5 summarizes his findings.

[47] Glenn Hueckel, "War and the British Economy, 1793–1815: A General Equilibrium Analysis," *Explorations in Economic History*, 10 (Summer 1973), p. 369; Williamson, *Did British Capitalism Breed Inequality?* Appendix D.

[48] J. D. Chambers and G. E. Mingay, *The Agricultural Revolution: 1750–1880* (London, 1966), p. 113; E. L. Jones, *Seasons and Prices: The Role of Weather in English Agricultural History* (London, 1964); Hueckel, "War and the British Economy," pp. 367–68.

[49] Mancur Olson, *The Economics of Wartime Shortage* (Durham, 1963); Mokyr and Savin, "Stagflation in Historical Perspective," pp. 223–31.

[50] Hueckel, "War and the British Economy," p. 389. In "The 1807–1809 Embargo Against Great Britain," this JOURNAL, 42 (June 1982), 305, Jeffrey Frankel recently estimated that the American embargo raised British raw cotton prices by as much as 72 percent in English markets, and that it served to lower the British terms of trade at home (cotton twist relative to Sea Island cotton) by some 42 percent. Frankel's calculations are much too high to be applied to the Napoleonic Era as a whole. Furthermore, they cannot serve as a very effective proxy for the terms of trade between imported grains and raw materials relative to all manufactures.

IV. ASSESSING THE IMPACT OF THE WARS ON BRITISH ECONOMIC PERFORMANCE

Modeling the Industrial Revolution

A general equilibrium model is necessary to factor out the wars from the industrial revolution properly, as an early effort by Glenn Hueckel has shown.[51]

A simple model capturing the main features of the British economy in the early nineteenth century has five domestic factors of production:[52]

farm land (*J*), excluding improvements other than initial clearing for cultivation or pasture;

capital (*K*), consisting of all civilian nonhuman asset services in the private and government sectors, other than farm lands, and excluding dwellings;

unskilled labor (*L*), or total civilian manhours compensated at the unskilled wage rate, including own labor time utilized in owner-occupied farms and in nonfarm proprietorships;

skills (*S*), or all attributes of civilian labor inputs generating earnings in excess of the unskilled wage; and

intermediate resource inputs (*B*), used directly in the manufacturing sector or indirectly in the urban sectors facilitating manufacturing production.

In addition, the model needs one imported intermediate input:

imported raw material inputs (*F*), processed by manufacturing and unavailable at home.

The first four are determined exogenously; that is, primary factor endowments are given. Intermediate inputs (*F* and *B*), however, are determined endogenously in response to demand and supply, domestic and foreign.

These factor inputs are used in the production of four sectoral outputs:

agriculture (*A*), or all national income originating in agriculture, forestry, and fisheries;

manufacturing (*M*), or all national income originating in manufacturing, building, and construction;

the tertiary sector (*C*), or all national income originating in finance, trade, gas, electricity and water, private services, local and national government (excluding military), transport and communications; and

[51] Hueckel, "War and the British Economy."

[52] Hueckel's "War and the British Economy" was the pioneering application of such methods to the problem, but his approach differs from what follows. For example, there are only two sectors in Hueckel's model—agriculture and manufacturing, no raw material inputs to manufacturing, and no nontradables. The most important difference is that Hueckel did not offer a quantitative assessment of the impact of capital formation.

intermediate resources (B), or all national income originating in mining and quarrying.

The civilian economy is open to trade in all *final* consumption and investment goods, save the tertiary sector, which produces nontradable home services. The home-produced *intermediate* good B cannot be traded internationally (for example, coal) while the foreign-produced intermediate good F cannot be produced at home (for example, cotton). The model conforms to the reality that Britain was a net importer of agricultural goods and a net exporter of manufactured goods. The small-country assumption has prices of all tradables determined exogenously by commercial policy and events outside of Britain, such as blockades, embargoes, and international transport costs. That is, demands for exportables and supplies of importables are taken to be highly price elastic.

The production relationships can be summarized as:

$$A = A(L, K, J),$$
$$M = M(L, K, S, B, F),$$
$$C = C(L, K, S, B),$$
$$B = B(L, K).$$

Capital and unskilled labor are assumed to move freely among all sectors; skilled labor is mobile between the industrial and tertiary sectors to which its use is restricted; land is specific to agricultural production; the imported intermediate resource is an input to manufacturing only; and the home-produced intermediate resource (coal) is used in manufacturing and the service sector.

The six inputs and four produced outputs have nine prices, since one of the produced outputs is also an input. By the small-country assumption, P_A, P_M, and P_F are taken as exogenous. The remaining six prices are determined endogenously:

d = rent earned on an acre of cleared farm land under crop or pasturage;
r = rent (or rate of return) earned on reproducible nonhuman capital (and the return on equity $i = r/P_K$, where P_K = price of capital);
w = the wage rate (or annual earnings) for unskilled labor;
q = the wage for skills;
P_C = the price of tertiary services; and
P_B = the price of home-produced resources.

The first four of these prices are factor rents, central to understanding inequality and the standard of living. The share of wages is the ratio of $[wL + qS]$ to national income. Pay ratios are measured by q/w, and the distribution of earnings is approximated by unskilled labor's share, $wL/[wL + qS]$. The distribution of income among recipients of property

income can also be explored by the behavior of rents (dJ) and profits (rK). The model is class-ridden, and capable, therefore, of telling explicit stories about the determinants of inequality in nineteenth-century Britain.

The prices in nominal values can be converted into real or relative prices. For example, the standard-of-living debate can be confronted by deflating the nominal wage of common labor by the cost-of-living index (P), the latter constructed by a weighted average of the various prices in the model, taking the weights on each to be the budget shares implied by the demand system elaborated below.

The model also predicts the following seven quantities:

A = home-produced agricultural goods;
M = home-produced manufactured goods;
C = tertiary services, home-produced and home-consumed;
B = home-produced resources;
A_M = imported agricultural goods;
M_X = exported manufactured goods;
F = foreign-produced intermediate goods, imported.

The mix of industrial output is determined endogenously in the model. Industrialization can be measured by the behavior of the value of manufactures, $P_M M$, as a share in national income. World market conditions and domestic supply can both play critical roles as engines of industrialization.

Final product demands are endogenous. The budget constraint serves to eliminate the demand equation for tertiary services, and the remaining two final demand equations take the form:

$$A + A_M = D_A(y/P)^{\eta_A}(P_A/P)^{\varepsilon_{AA}}(P_M/P)^{\varepsilon_{AM}}(P_C/P)^{\varepsilon_{AC}}(Pop)$$

$$M - M_X = D_M(y/P)^{\eta_M}(P_A/P)^{\varepsilon_{AM}}(P_M/P)^{\varepsilon_M}(P_C/P)^{\varepsilon_{MC}}(Pop)$$

The market clearing condition is imposed, making sectoral supplies equal to final aggregate demand. The D_js are exogenous shift terms, y is nominal gross national product per capita, P is the cost-of-living index, Pop is total population, η_j is the income elasticity of demand for j, and ε_j and ε_{jk} are own-price and cross-price elasticities of demand for j. Nominal income is defined as:

$$Y = P_A A + P_M M + P_C C + D$$

where resource output, $P_B B$, is excluded since it is an intermediate good, and D is the net trade deficit in nominal terms. A final equation insures that the trade account is in balance:

$$P_A A_M + P_F F = P_M M_X + D.$$

It is a simple matter to convert the model into annual rates of change, and it makes a lot of sense to do so. After all, the issues raised by debate

over the First Industrial Revolution hinge on trends and growth performances, not the level of variables. Of the many exogenous variables driving the model, only five attract attention in the counterfactual analysis that follows (asterisks refer to annual rates of change): the impact of wars, embargoes, and blockades on the price of the three tradables—P_A^*, P_M^*, and P_F^*; the impact of mobilization on civilian unskilled labor supplies—L^*; and the influence of crowding-out on civilian capital accumulation—K^*. The important endogenous variables are:

the real wage of the common laborer:	$w^* - P^*$
real national income:	$Y^* - P^*$
sectoral output in constant prices:	
agriculture	A^*
industry	M^*
"home" services	C^*
mining and quarrying	B^*
industrialization index:	$M^* - A^*$
export expansion:	M_X^*

All interpretations of history are fiction, of course, but some fictions are better representations of the past than others. This one has been estimated with data drawn from the early 1820s. The model was then asked to predict British trends between 1821 and 1861, a far better documented epoch than 1760 to 1820. It did extremely well.[53] Thus encouraged, we can proceed with confidence to the period before 1820.

How Would Britain's Performance Have Differed in the Absence of Wars?

One could image two counterfactuals, either of which would serve to factor out the wars from the industrial revolution. On the one hand, we could ask how the British economy would have performed in the absence of the wars. On the other, we could ask how Britain's performance would have *differed* in the absence of the wars. The second counterfactual is used here, for the sufficient reason that economic historians do not agree on what actually happened during the wars. Better to focus on the differences between wartime performance predicted by the model and a predicted peacetime counterfactual.

Table 6 reports the counterfactual. The last column supplies the total impact while the first three columns break the total into its three parts—crowding-out affecting capital formation, dK^*; mobilization affecting the growth of the unskilled labor force, dL^*; and trade disruptions affecting relative prices at home, dP_j^*. The counterfactual is reported separately for 1790–1815 (the worst of the war years) and for the 1760s–

[53] Williamson, *Did British Capitalism Breed Inequality?* chap. 9.

TABLE 6
BY HOW MUCH WOULD BRITAIN'S GROWTH HAVE CHANGED UNDER COUNTERFACTUAL PEACETIME CONDITIONS?
(annual growth rates)

Endogenous Variable (growth per year)	*No War Debt Crowding-Out Effects, dK**	*No Mobilization Effects, dL**	*No War-Distorted Price Effects, dP_j**	*All Effects Combined*
1. *The 1790–1815 Period*				
Real Wage: $d[w^* - P^*]$	.94%	−0.27%	0.59%	1.27%
Real Income: $d[Y^* - P^*]$	.93	0.13	0.46	1.51
Sector Outputs: dA^*	.40	0.34	−2.76	−2.05
dM^*	1.14	0.02	2.93	4.09
dC^*	1.13	0.09	0.70	1.93
dB^*	1.14	0.02	2.82	3.98
Industrialization Index: $dM^* - dA^*$	.74	−0.32	5.69	6.14
Export of Manufactures: dM_x^*	1.59	−0.56	11.92	12.95
2. *The 1760s–1810s Period*				
Real Wage: $d[w^* - P^*]$	.68	−0.13	0.30	.84
Real Income: $d[Y^* - P^*]$	.67	0.06	0.23	.96
Sector Outputs: dA^*	.29	0.15	−1.38	−.94
dM^*	.82	0.01	1.47	2.30
dC^*	.81	0.05	0.35	1.21
dB^*	.82	0.01	1.41	2.24
Industrialization Index: $dM^* - dA^*$	.53	−0.14	2.85	3.24
Export of Manufactures: dM_x^*	1.14	−0.28	5.96	6.82

Notes: The counterfactual civilian capital stock assumptions are taken from Table 4, col. (3). The counterfactual price assumptions are taken from Table 5, and the counterfactual civilian unskilled labor force assumptions are taken from the text in Section III; for the 1790–1815 period, $dL^* = 0.34$, $dP_A^* = -0.98$, $dP_F^* = -0.98$, and $dP_M^* = 0$; for the 1760s–1810s period, $dL^* = 0.17$, $dP_A^* = -0.49$, $dP_F^* = -0.49$, and $dP_M^* = 0$.

1810s. Each panel reports the impact on the growth rates of eight endogenous variables: aggregate real income, output in four sectors, manufactured exports (in constant prices), an industrialization index (the difference between the growth of industry and of agriculture), and the real wage of common labor.

The effects on capital accumulation were the most important source of slow growth (0.67/0.96 = 60 percent of the combined effects of war from the 1760s to the 1810s). Yet the war-induced decline in the terms of trade (the dP_j^* effects) plus mobilization (the dL^* effects) were both sufficiently important that the effects of war in total exceeded the accumulation effects themselves. It appears that Britain's aggregate real income growth per year would have been higher by 1.51 percent from 1790 to 1815, and 0.96 percent per year higher from the 1760s to the 1810s, had peace prevailed.

If these calculations are even close to the mark they have important implications for the debate over British growth during the First Industrial Revolution. Harley has estimated that aggregate income growth per year accelerated from 1.3 to 2.3 percent between 1770–1815 and 1815–1841.[54] Table 6 suggests that almost all of the acceleration was caused by peace. In other words, the measured trend acceleration had little to do with the underlying forces of capitalist development.

Furthermore, the relatively slow rate of industrialization prior to 1820 appears to have been war-induced. Had peacetime conditions prevailed, manufacturing output would have grown 2.3 percent per year faster; that is, Harley's Divisia Index would have grown 3 or 4 percent per year, rather than the modest 1.5 or 1.6 percent actually achieved between 1770 and 1815.[55] Once again, if these calculations are even close to the mark, they imply that the doubling in the growth of industrial output that Harley measured can be explained entirely by the switch from war to peace.

In contrast, agriculture would have undergone far slower growth, perhaps some 0.94 percent per year slower, had not the wartime food scarcity encouraged domestic production. Since British agriculture grew annually no faster than 0.8 percent between 1770 and 1815, the counterfactual suggests that agricultural output might in fact have declined without war. And, of course, the great surge in Britain's exports would have been faster and sooner with peace, faster by some 6.8 percent per year.

One of the strangest features of the period is of course the failure of the standard of living of the working classes to rise much until the 1820s. Social reformers have argued for more than a century that British capitalism simply failed to let income improvements trickle down while others have stressed that supplies of labor were elastic. Table 6 suggests

[54] Harley, "British Industrialization Before 1841," p. 286.
[55] Ibid., Table 5, p. 276.

instead that most of the dismal standard of living performance before the 1820s can be attributed to the wars and their financing. Peace would have raised the growth in workers' living standards by 0.84 percent per year, or by 65 percent for the six decades as a whole. Once again, if this counterfactual result is even close to the mark, then it suggests that the evidence generated by the debate on the standard of living is of doubtful relevance for testing whether the gains from capitalism trickled down.

Crowding-out appears to have been the dominant force affecting the standard of living (0.68/0.84 = 81 percent of the total over the six decades as a whole). Slow accumulation and thus slow rates of job creation (especially in cities) account for most of the poor performance in living standards up to the 1820s, though war-induced price distortions played a major supporting role (0.30/0.84 = 36 percent of the total). As has been shown, crowding-out and forgone accumulation also account for most of the slow aggregate growth, but it does *not* account for a large share of slow industrialization. Prices and world markets played a far greater role.

V. SOME CONCLUDING REMARKS

Most of the increase in national income per worker during the First Industrial Revolution was caused by productivity advance, and little by accumulation and capital deepening. This has long been textbook wisdom. Now there is some evidence to support it. Feinstein, for example, estimates that total factor productivity growth accounted for almost nine-tenths of output per worker growth from 1761 to 1860.[56] McCloskey finds much the same, encouraging the conclusion that "ingenuity rather than abstention governed the industrial revolution."[57] Yet these findings seem inconsistent with most of what we know about other economies passing through the early stages of the industrial revolution. In the contemporary Third World, total factor productivity improvements explain only about 10 percent of growth.[58] Abramovitz and David have shown that total factor productivity improvements explain very little of antebellum American per capita output growth (about 27 percent). Ohkawa and Rosovsky suggest the same for Japan between 1908 and 1938 where total factor productivity improvements explain only a third of labor productivity growth.[59] Britain's industrial

[56] Feinstein, "Capital Formation," Table 26, p. 86.

[57] McCloskey, *The Economic History of Britain*, p. 108.

[58] Angus Maddison, *Economic Progress and Policy in Developing Countries* (London, 1970), Table 11.11, p. 53.

[59] Moses Abramovitz and Paul A. David, "Reinterpreting Economic Growth: Parables and Realities," *American Economic Review*, 63 (May 1973), Table 1, p. 430; Kazushi Ohkawa and Henry Rosovsky, *Japanese Economic Growth: Trend Acceleration in the Twentieth Century* (Stanford, 1973).

revolution seems odd: whereas other nations passing through early industrialization record high contributions for conventional capital accumulation and low contributions for total factor productivity growth, Britain prior to 1820 suggests the opposite. Why? The answer seems to be very simple: the rate of accumulation was suppressed by war well below what it would have been in peace.

The rate of accumulation in Britain up to the 1820s was so tiny that the capital-labor ratio hardly rose at all. The absence of capital-deepening is so striking that it has encouraged all manner of exotic speculation about the capital-saving attributes of the new technologies. Perhaps less exotic speculation is warranted: capital-deepening was modest because saving in reproducible capital out of national income was modest. Indeed, the surprising fact is the low saving rate. Deane and Cole called the level and increase in the conventional saving rate "modest," and Mathias thought the "modesty of rates of accumulation" was one profound difference between eighteenth-century England and the contemporary Third World.[60] The explanation for the apparent lack of thrift in eighteenth-century Britain is simply that savers were accumulating war debt. The gross private saving rate—which includes increased holdings of war debt—was as high as 18.1 percent between 1761 and 1821, not so distant from the contemporary Third World estimates after all.

There are two morals to the story. First, wars *can* be factored out of the First Industrial Revolution, and the exercise appears to have a profound impact on our interpretations of early British growth. Second, the time seems ripe for economic historians to examine critically their single-asset view of thrift, saving, and accumulation. It makes more sense to think in terms of multi-asset, portfolio choices. The motive for saving can be served by accumulating government debt, foreign debt, irreproducible assets, capital gains on these (including rising land values), as well as real capital. While it is certainly true that investment demand will influence the extent to which savers favor capital formation, it is also true that any exogenous change in the *supply* of the other forms of accumulation will tend to crowd out capital formation. These two forces—investment demand and crowding-out—are likely to be far more important than thrift in accounting for the historical variety in growth.

[60] Deane and Cole, *British Economic Growth*, p. 276; Mathias in Crouzet, *Capital Formation*, p. viii.