ECONOMIC GROWTH IN NINETEETH CENTURY BRITAIN: COMPARISONS WITH EUROPE IN THE CONTEXT OF GERSCHENKRON'S HYPOTHESES

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1. Introduction

Cliometric research has led to a considerable revision of an earlier conventional wisdom concerning the pace and nature of economic growth during British industrialization. Britain is still very much an early industrializer and a country whose employment structure became non-agricultural to an unusual extent, but can now be seen as a case of relatively slow overall growth involving a gradual acceleration rather than a take-off in the late eighteenth and early nineteenth centuries (Crafts, 1985a). These revisions to the quantitative record of British economic development make this an opportune moment to reflect on contrasts between British industrialization and that of later developers with reference to some of the themes brought forward by Gerschenkron's 'Economic Backwardness' approach to nineteenth century European economic history.

In sections 2 and 3 below we review recent developments in the historiography of nineteenth century British economic growth. Inevitably this survey relies quite heavily on already published work by Crafts. In sections 4 to 8 we build on the improved time series relating to industrial growth in Britain and Europe to reconsider the timing and extent of trend growth changes to develop an appropriate comparative perspective on Gerschenkron's notions concerning "great spurts" of industrialization. These sections constitute new research based on quantitative techniques not used hitherto in this context.

2. Overview of British Growth and Structural Change, 1700-1913

At the time when Gerschenkron's economic backwardness thesis achieved prominence Deane and Cole (1962) represented the best available estimates concerning British economic growth in the long run. Subsequent research has improved considerably on those estimates, although, given the problems of imperfect data, there will always be some room for disagreement and doubt. Thus, the Matthews et al (1982) figures for growth in the late nineteenth century shown in Table 1 are based on an average of the somewhat discrepant estimates produced by the output, income and expenditure methods, while the

TABLE 1

Growth Rates of Real GDP, Real Industrial Output and Total Factor Productivity in Britain: Old and New Views (% per annum)

	GDP		Industrial Output	
	New	Old	New	Old
1700-60	0.7	0.7	0.7	1.0
1760-80	0.7	0.6	1.5	0.5
1780-1801	1.3	2.1	2.1	3.4
1801-31	2.0	3.1	3.0	4.4
1830-60	2.5	2.0	3.4	1.7
1856-73	2.2	3.0	2.8	2.8
1873-99	2.1	2.8	2.2	1.8
1899-1913	1.4	1.4	1.6	1.9

	TFP in Whole Economy		TFP by Sector: New View	
	New	Old	Industry	Agriculture
1700-60	0.3	na	na	na
1760-80 } 1780-1801 }	0.2	0.2	0.2	0.2
1801-31	0.7	1.3	0.3	0.9
1830-60	1.0	0.8	0.8	1.0
1856-73	0.8	1.6	1.0	0.9
1873-99	0.7	1.4	0.7	0.5
1899-1913	0.0	0.0	0.0	0.4

Sources: "New" is based on Crafts (1985a) and Matthews et al (1982); "old" is based on Deane and Cole (1962) and for factor input growth to derive TFP growth uses Feinstein (1978) and Matthews et al (1982). Feinstein's capital stock estimates in levels are superseded by his (1988a) estimates discussed in Section 3 below but growth rates and hence TFP growth are unaffected after rounding.

Crafts (1985a) figures for earlier growth are necessarily crude for parts of the services sector. Nevertheless, these 'best guess' estimates of growth appear to be more soundly based than was the "old view". They embody more detailed archival work by many different authors and, in particular, avoid errors made in earlier attempts to obtain constant price series by deflating current price series for output.

As far as rates of growth are concerned, the major differences from Deane and Cole's view offered by the Crafts and Matthews et al studies are, firstly, that acceleration in the trend rate of growth during the British industrial revolution was more modest and gradual than was widely believed in the heady days of the 'take-off' literature and, second, that the late Victorian climacteric seems to have been pushed back to Edwardian times. It should be noted that it is possible to test both these claims more rigorously than did their proponents originally and we report results of these tests in section 8, where it is shown that the first appears to be valid but the second not so.

It has also been possible to quantify more firmly what has always been known in outline, namely that in a number of ways the British pattern of economic development differed strikingly from the experience of other European countries. Table 2 reports the results of a Chenery-Syrquin type investigation carried out by Crafts (1984, 1985a). Several aspects of Table 2 are of interest in the context of Gerschenkron's hypotheses. Britain is confirmed as a country whose labour force was particularly rapidly redeployed out of agriculture and into industry, which was relatively urbanized but in which home investment remained low and savings flowed abroad to an unusually high extent.

Table 2: Britain's Development Transition Compared with the European Norm

Year	1700	1760	1800	1840	1870	1890	1910
Income Level(1970 dollars)	333	399	427	567	904	1,130	1,302
Crude Birth Rate	33.1	33.9	37.7	35.9	35.2	30.2	25.1
European Norm	38.0	36.5	36.0	33.7	30.0	28.2	27.0
Crude Death Rate	26.5	28.7	27.1	22.2	22.9	19.5	13.5
European Norm	28.0	26.4	25.9	23.4	19.4	17.5	16.3
Urbanization	na	na	33.9	48.3	65.2	74.5	78.9
European Norm			23.2	31.4	44.8	51.3	55.4
Percentage of Labour Force in Primary Sector	57.1	49.6	39.9	25.0	20.0	16.3	15.1
European Norm	69.8	64.3	62.3	53.7	39.7	32.9	28.6
Percentage of Male Labour Force in Agriculture	61.2	52.8	40.8	28.6	20.4	14.7	11.5
European Norm	72.0	66.2	64.0	54.9	40.0	32.8	28.3
Percentage of Male Labour Force in Industry	18.5	23.8	29.5	47.3	49.2	51.1	54.3
European Norm	12.6	16.9	18.6	25.3	36.5	41.9	45.2
Percentage of Income in Primary Sector	37.4	37.5	36.1	24.9	18.8	13.4	10.3
European Norm	51.4	46.6	44.8	37.2	24.8	18.9	15.1
Percentage of Income in Industry	20.0	20.0	19.8	31.5	33.5	33.6	31.8
European Norm	19.3	21.3	22.0	25.2	30.3	32.8	34.4
Consumption as % of National Expenditure	92.8	74.4	76.8	80.4	80.5	81.6	73.8
European Norm	82.7	81.5	81.1	79.2	76.2	74.8	73.8
Investment as % of National Expenditure	4.0	6.0	7.9	10.5	8.5	7.3	7.0
European Norm	11.1	12.2	12.6	14.4	17.2	18.6	19.5
Government Spending as % of National Expenditure	4.8	12.7	15.3	7.9	4.8	5.9	8.2
European Norm	7.8	7.5	7.4	7.0	6.3	5.9	5.7
Foreign Capital Inflow as % of National Expenditure	na	na	0.6	-1.2	-6.2	-5.2	-11.0
European Norm			0.5	0.1	-0.4	-0.7	-0.9
School Enrollment Ratio	na	na	na	na	0.168	0.385	0.542
European Norm					0.514	0.582	0.626

Source: Crafts (1985a, pp. 62-3) based on regression analysis reported in Crafts (1984); the European Norm was obtained using a variant of the approach adopted by Chenery and Syrquin (1975). The table has not been revised to take account of the slight changes to I/Y arising from Feinstein's (1988a) estimates.

3. The New View of British Growth and Gerschenkron's Hypotheses

With the broad outline of the previous section in mind it is now possible to examine Britain's development in the light of Gerschenkron's hypotheses in rather more detail. As will become apparent, there are in fact divergent paths which can be followed within the "new view" which have rather different implications especially in this context for the first half of the nineteenth century.

a) Agriculture and British Industrialization to 1860

Gerschenkron's approach to economic backwardness suggests that Britain, as the least backward industrializer, should have experienced a relatively large contribution to its growth and development from productivity increases in agriculture. Crafts (1985a) regarded this expectation as broadly fulfilled and stressed relatively high output per worker in British as compared with continental agriculture, a rapid rate of increase in total factor productivity in British agriculture (see Table 1), and the decline to very low levels in agriculture's share in the labour force by 1840 even prior to the abolition of the Corn Laws. This view has been challenged by Williamson (1985, 1987) and there have been some important recent publications by other writers. It seems appropriate to review the state of play.

Difficulties arise, of course, from the lack of direct data on agricultural output prior to the late 1860s. Inferences must be drawn from price information, trade data and labour force estimates backed up by the work of contemporary investigators such as Marshall or Young. The evidence is to an extent contradictory; in particular, estimates of total factor productivity growth for c. 1780 or 1800 to 1850 derived from price data appear to yield lower estimates than those Crafts obtained from Deane and Cole's work on agricultural incomes and labour force inputs (Mokyr, 1987). Neither set of data is particularly well-suited to producing robust estimates of productivity growth.

Williamson (1985) offers a view of British productivity growth for the period 1821–61 quite different from that of Table 1; he uses estimates of total factor productivity growth of 1.05% in manufacturing and 0.3% in agriculture and this imbalance is indeed central to his vision of, and explanation for, rising differentials between skilled and unskilled workers related to the induced expansion of manufacturing and contraction of agriculture. This account of productivity advance with manufacturing dominant is distinctly less in accordance with Gerschenkronian expectations than is Crafts's. Subsequent research suggests that Crafts's view is nearer to the truth than Williamson's. Three points in particular should be noted.

(i) Williamson's 'estimates' for sectoral productivity growth rates were in fact assumptions (Crafts, 1987a, pp. 250–4). The a priori reasoning involved seems predicated on the need to explain a Kuznets Curve of rising inequality which Williamson claims to have found for Britain in the period 1815–c.1870. As Feinstein points out, however, the evidence for the pay ratio of skilled to unskilled workers, which is the key endogenous variable in Williamson's model is that, contrary to Williamson's own calculations, over the period 1821–61 there appears to be little change (1988b, Table 2). It appears likely that Williamson's own model would require reasonably rapid agricultural productivity growth if Feinstein's demolition of Williamson's pay-ratio calculations itself is robust.(1)

(ii) Wrigley's work in estimating labour force shares suggests relatively rapid increases in output per worker in British agriculture over the long run. He shows that trends in population and urbanization make it likely that output per worker in British agriculture rose by between 60 and 100 per cent over the period 1600–1800 compared with less than 20 per cent in France (1985, p. 720). Wrigley has also completed a full reworking of the early census estimates of the male agricultural labour force which shows a growth rate of only 0.26% for 1811–51, an estimate he regards as very reliable, with 39% of the male labour force in agriculture in 1811 and 25% in 1851. As Wrigley (1986, p. 334) notes, on the assumption that demand for agricultural output grew only as fast as population (a conservative estimate), given what is known about imports, output per worker grew about 1% per year. Feinstein's estimates of capital stock growth per worker (1978, pp. 42, 68) show only 0.35% in agriculture and, with unimproved land per worker not rising, this makes a value for total factor productivity growth as low as 0.3%

incredible and tends broadly instead to support Crafts's 1985 estimates.

(iii) As a result of the research of Allen (1988), it now appears possible to clarify the sources of rising labour productivity based on micro-economic information. The fundamental changes in pre-1850 agricultural production functions are usually thought of in terms of improved crop rotations which reduced fallow land, introduced legumes and root-crops and permitted greater livestock herds sustained by the new fodder crops. A particularly influential article by Timmer (1969) used contemporary evidence to consider the effects on a 500 acre farm of a switch to these new farming methods and concluded "the increase in output per worker was nearly nil. The English agricultural revolution increased land, not labour, productivity". (1969, p. 392). This article is unfortunately seriously misleading. Work on probate inventories helps to confirm that yields per acre rose much more than Timmer supposed - for wheat from 10 bushels in medieval times to 27 or so in 1850; it is also true that Timmer's example revolves around turnips, a particularly labour-intensive but by no means universally adopted crop. Most importantly, about half the gain in output per worker in the South Midlands between 1600 and 1800 (an area which reflects Wrigley's view of overall advance) came from the rising size of farms. Whereas in the early 17th century only 12 per cent of farms exceeded 100 acres, by the early 19th century 57 per cent did. On both arable and pasture farms labour costs per acre for a 400 acre farm were about 40 per cent of the figure for a 25 acre farm. The ability to obtain greater output per worker in agriculture in Britain compared to elsewhere during the Industrial Revolution was crucially dependent on having much larger farms. In 1851 only 21.7 per cent of agricultural land was farmed in units less than 100 acres, whereas in Ireland 67 per cent was in this category. Average farm size in France was about 30 acres against over 100 acres in Britain (Crafts, 1989). On the basis of Allen's results for the South Midlands, the smaller size of farms relative to Britain would imply in both France and Ireland a difference of around 30 per cent in land and capital to labour ratios (Allen, 1988, p. 128-9). Comparisons of output per worker in mid-19th century agriculture suggest that Britain's lead of 40 per cent or so over her near neighbours comes mainly from differences in land and capital per worker rather than total factor productivity (Crafts, 1989).

Thus the large long-run increases in output per worker suggested by Wrigley's estimates appear fairly straightforward to account for on the basis of rising yields and bigger farms. Despite the high labour requirements of some new crops, the claim that the English agricultural revolution did not raise labour productivity should not be taken seriously. Substantial growth of overall output allowed absolute numbers employed in agriculture to rise slowly over time but there was a very substantial release of labour in the sense that many more urban/industrial workers could be fed by each agricultural worker (Crafts, 1980). In assessing Britain's agricultural revolution it is essential to look at the effects of changing agrarian structure as well as those of new crop rotations.

It is easy to construct arithmetic examples which suggest that the key implication of Britain's unique agricultural history was a much greater industrialization of employment based on higher agricultural labour productivity than elsewhere (Crafts, 1989). Such examples are, of course, unsatisfactory and it is necessary also to explain why Britain's agricultural superiority did not lead to her becoming the granary rather than the workshop of the world. Indeed, it has been suggested that such would be the implication of Crafts's total factor productivity growth estimates as in Table 1 and that accordingly Britain's experience in international trade shows them to be unreliable (Williamson, 1987, p. 275).

Only by considering developments in agriculture together with industrial advance in an international context can we obtain an adequate account of the redeployment of labour out of British agriculture. There is an obvious requirement to approach this question in a general equilibrium framework, but Williamson's model is clearly inadequate and the data requirements to find an appropriate specification are too severe to be met at present (Crafts 1987a, pp. 248-56, 260-4; 1987b, pp. 182-4; Feinstein, 1988b). Nevertheless the broad outlines of the process can be plausibly guessed at.

First, it is important to bear in mind that much of British 'industry' in the first half of the nineteenth century was traditional, small-scale and catering for local markets without entering into international trade – this sector was responsible for perhaps 60 per cent of industrial employment and probably experienced virtually no productivity growth at all during 1780–1860 (Wrigley, 1986, p. 298; Crafts, 1987a, p. 255). Second, by contrast productivity growth in exportable manufacturing was rapid. The most notable sector was cotton textiles, which accounted for over 40 per cent of British exports in the first half of the nineteenth century. Total factor productivity in British cotton spinning rose by 64 per cent and in weaving by 56 per cent between 1835–56 (Von Tunzelmann, 1978, p. 225), while between 1830 and 1860 labour costs fell by a half and two-thirds respectively (Merttens, 1894, p. 128). Even in France, Britain's closest rival, despite wage rates more than a third lower, supply prices for cotton yarn and woven goods were about 25% higher than Britain in the 1850s (Rist, 1956). Third, cotton textiles were very cheap to transport at a time when most goods were not; as a result they were a large part of world trade and completely dominated by one relatively efficient producer. At mid-century, exports were about 60 per cent of British cotton output and as late as 1882/4 Britain still held 82 per cent of the world market for cotton cloth (Sandberg, 1974). Patterns of trade, as Ricardo noted(2), are based on relative efficiency and, given the position in cottons, agricultural goods became importables much more quickly than elsewhere in Europe. Specialization in international trade contracted agriculture's share in output in Britain which, when combined with the effects of rising yields, farm size and investment on output per worker in the sector, promoted a low share of employment in agriculture.

In sum, our reading of the role of agricultural productivity growth in British industrialization would be as follows. Productivity levels in British agriculture were unusually high both before and during the Industrial Revolution. This was made possible in substantial part by the attainment of a capitalist, large-farm agrarian structure, which institutional arrangement could not be emulated in many other countries. Productivity growth in agriculture was relatively rapid during British industrialization and, in the context of the lead Britain achieved in cotton textiles, was conducive to the unusually rapid shift of labour into industry. This was very much an "early-comer's" unique achievement (Pollard, 1981, pp. 176–182). This interpretation seems very much in keeping with the spirit of Gerschenkron's vision but at the same time would insist on giving patterns of comparative advantage a more explicit and prominent role than has been common in discussions of Gerschenkron's hypotheses. (3)

b) <u>Consumption, Investment and Real Wages during the Industrial Revolution</u>

Gerschenkron's analysis of backwardness argues that latecomers to European industrialization could expect to experience most pressure on consumption standards during their growth spurt as perforce they emphasized capital accumulation. Yet the case where debate over standards of living has been the most bitter is Britain, where a strong pessimist tradition critical of the impact of the Industrial Revolution on the economic welfare of the working classes still exists.

On the whole, recent quantitative research has tended to favour a rather more optimistic view of living standards, particularly for the period after the French Wars when growth in the economy is now perceived first to have exceeded 2 per cent. At the same time, the over-enthusiastic pronouncement from Lindert and Williamson (1983, p. 11) that "real wages...nearly doubled between 1820 and 1850. This is a far larger increase than even past 'optimists' had announced" can now be seen as a considerable exaggeration.

Revisions to earlier views of trends in real wages have come mainly from the construction of new cost of living indices. These are improvements on what was previously available as they include rent and have weights with some claim to represent workers' expenditure patterns. Earlier indices were, in fact, distinctly unsuitable for calculating workers' real wages. For example, although Phelps-Brown and Hopkins' index continues to be widely used, its weights are completely inappropriate, for it takes no account of rent, its cereals do not include bread or flour, and drink is very largely represented by beer (Phelps-Brown and Hopkins, 1981, pp. 28-44). No-one should use this index without first considering adjustments to remedy these deficiencies, which are certainly feasible for 1750-1850. Nevertheless, it must be recognised that we are still some way from obtaining a fully satisfactory cost of living index for this period; budget studies are of poor quality as regards information on purchases other than food or on differences in weights appropriate for different income levels, family sizes, regional tastes, etc., and price data is scarce for all services, rents and manufactured goods other than clothing.

Lindert and Williamson's (1985) index is the best available at present. This constitutes a major revision of their (1983) index, following a debate with Crafts (1985b), and remedies a highly unsatisfactory treatment of clothing prices in their earlier work. For the years 1750–80 Lindert–Williamson's index can be extended back by including available information on rent and reweighting the Phelps–Brown and Hopkins index (Crafts, 1988).

Table 3 shows that the outcome of the interchange between Crafts and Lindert and Williamson is to provide a 'consensus' new view of real wage growth for all blue collar workers for 1780–1850, namely that it was virtually equal to overall personal consumption growth and quite modest prior to 1820. The revisions made by Lindert and Williamson in their 1985 paper are shown to be much larger than they admitted at the time. The divergence between estimates of real wage growth and per capita consumption and national output growth, apparent in the 'old views' part of the table, disappears by virtue of increases to the former and reductions in the latter of similar absolute magnitude for 1780–1850. Slow growth in consumption and real wages thus appears very much as an outcome of slow growth in the economy as a whole rather than of a really major change in income distribution, as seemed possible to writers like Perkin (1969, p. 138).

It should be noted, however, that this macro view conceals substantial regional variation in real wage behaviour. Recent publications by Schwarz (1985) and Botham and Hunt (1987) have highlighted this point without being in any way inconsistent with the 'consensus' view despite their authors' rather emotive claims to the contrary, as is shown in Crafts (1988, Table 7). Indeed, given the unevenness of industrial output growth between sectors and the limited impact of technological progress, quite large regional divergences in real wage growth are to be expected (Crafts 1985a, pp. 105–7). This means that there is certainly still life in a carefully stated pessimistic case emphasizing that, as far as unskilled workers are concerned, only those in the north can be regarded

Table 3. Growth of Real Wages and Real Personal Consumption per Head: Old and New Views (% per annum).

New Views

	Lindert-Williamson Real Wages, 1983	Crafts Real Wages, 1985	"Best Guess" Real Wages	Real Personal Consumption/Head	Real National Output/Head
1760-1800	-0.15	na	-0.17	0.25	0.18
1780-1820	0.28	0.71	0.56	0.47	0.42
1820-1850	1.92	0.94	1.27	1.24	1.19
1780-1850	1.00	0.80	0.88	0.80	0.75

Old Views

	Phelps-Brown and Hopkins Real Wages	Feinstein, Real Personal Consumption/Head	Deane and Cole Real National Output/Head
1760-1800	-0.57	0.23	0.52
1780-1820	-0.03	1.08	0.98
1820-1850	0.92	1.52	1.48
1780-1850	0.38	1.27	1.19

Sources: Lindert and Williamson (1983, Table 5), Crafts (1985b, Table 4), 'Best Guess' is based on Lindert and Williamson (1985) extended to 1760 as described in the text, Crafts (1985a, Table 5.2), Crafts (1985a, Table 2.11) are the New Views; the Old Views come from Phelps-Brown and Hopkins (1956), Feinstein (1981, p. 136) and Deane and Cole (1962, p. 78, 166).

as certain gainers before the 1830s (Crafts, 1987a, p. 265).

Despite the opening up of a north-south divide, the evidence is against a great surge in inequality during the period 1815-71, as argued by Williamson (1985). When the plainly unreliable evidence on civil servants is dropped from Williamson's calculations of the pay ratio of the wages of skilled to unskilled workers, Feinstein (1988b, Table 2) concludes that it rose from 1.74 in 1815 to a peak of 1.92 in 1851, which then declined slightly to 1.86 in 1911, whereas Williamson's estimates (1985, pp. 31, 48) were 2.56 in 1815, rising to 3.64 in 1851 and 3.44 in 1871, and falling to 2.64 in 1911. Similarly, Feinstein shows that the tax assessments available do not support Williamson's inequality surge when they are processed correctly; for example, dealing properly with the estimation of values of houses below £20 gives a best guess Gini coefficient based on Inhabited House Duty of 0.607 in 1830, rising to 0.667 in 1871, and falling to 0.553 in 1911 (Feinstein, 1988b, Table 5), rather than Williamson's estimates of 0.451, 0.627 and 0.328 respectively for the same years. Williamson's own estimates, based on the Social Tables of Colquhoun and Baxter for current incomes, show only a very modest rise in the Gini coefficient from 0.519 in 1801/3 to 0.551 in 1867. (1985, p. 68).(4)

Thus the overall picture which emerges from this discussion is that the explanation for slow growth in real wages and workers consumption reflects slow economic growth rather than a shift in income distribution. In the long run there was little change in the share of national expenditure going to consumption (Crafts 1985a, p. 95) and, as will be discussed more fully below, there was no surge in capital accumulation based on high taxation or profit retention in the style Gerschenkron associated with latecomers. It must, however, be noted that there is one piece of evidence which does not fit very easily into this account, namely Mokyr's (1988) investigation of the consumption of sugar, tea and tobacco in the period 1780-1850. His econometric estimates lead to an inference that, having allowed for price effects, slow growth in consumption of these imported goods implies little or no increase in workers real incomes. Rightly he warns against over confident acceptance of the 'consensus' view. We would be reluctant to give Mokyr's findings a heavy weight against the formidable array of other evidence at present.

Revisions to overall growth estimates for output in Crafts (1985a) can be combined with Feinstein's most recent revisions to his investment estimates (1988a, p. 462) to obtain estimates of the ratio of investment to gross national product in current prices. The results are shown in Table 4. The rate of increase is distinctly slower than the Rostow-Lewis hypothesis would predict or than Feinstein himself had believed (1978), and a little less than in Crafts (1985a, p. 73), which used Feinstein's earlier investment figures. The picture, as indicated in Table 2, is of British home investment levels throughout the eighteenth and nineteenth centuries tending to be decidedly low relative to the European norm. It was only after the French Wars that capital stock growth moved appreciably ahead of population growth, although at its maximum, population growth was just less than 1.5 per cent. Thus relatively slow increases in output per head reflected capital stock growth and total factor productivity growth of 1.5 per cent and 0.7 per cent per year respectively in 1801-31 and 2.0 per cent and 1.0 per cent per year respectively in 1830-60 (Crafts, 1985a, p. 81).

<u>Table 4. Revised Estimates for I/Y in Current Prices (%)</u>

1761/70	6.8	1801/10	8.4	1841/50	10.8
1771/80	8.1	1811/20	10.1	1841/50	9.7
1781/90	8.0	1821/30	10.7		
1791/1800	8.5	1831/40	9.7		

<u>Source</u>: see text.

Williamson (1985, p. 178) has argued that had it not been for the French Wars, Britain would have had investment as a share of national expenditure about 6 percentage points higher, leading, on a neoclassical analysis of the sources of growth, to growth of real GNP about 0.8 percentage points faster from a capital stock growth up by 2.4 percentage points. In other words, but for the crowding out effects of government borrowing to finance military expenditure, Britain would have had a much more decisive growth spurt and an investment boom and would altogether have looked much less like a Gerschenkronian early-comer - in this view much of the contrast between Britain and later developers would be no more than a fluke of political history. Williamson's position seems to be an extreme one, however, and unlikely to be accepted by many, based as it is on the heroic assumption that war debt crowded out private capital formation on a one-for-one basis - in current prices, investment in real capital used savings of £707.7m over 1791-1820 while the increase in government debt was £594.3m, which in Williamson's counterfactual would also have represented saving to have been invested in physical capital (Crafts 1987a, Table 2). In particular, the absence of any rise in real interest rates during the wartime period (Heim and Mirowski, 1987) and the availability of foreign funds

(Neal, 1985) both suggest the existence of an elastic supply of savings; moreover, the savings rates of 1791–1800 and 1811–20 were not observed again during the nineteenth century and the British economy did not achieve Williamson's counterfactual investment rate until after World War II. Investment rates in 1791–1820 were only about 1.5 percentage points lower than 1821–50, which includes the railroad boom. Williamson's argument therefore seems overstated, but it is important to recognize that war may have had a distorting effect on comparisons of the growth spurt with those of other countries.

The traditional picture in the literature which stresses the importance of ploughed back profits in financing investment and points out the absence of investment banking institutions in Britain is also consistent with Gerschenkron's vision of earlycomers compared with latecomers. This view is in need of some modification but still seems basically correct. Research has emphasized in recent years that, despite the small size of English banks and their proneness to fail, nevertheless the banking system did in various ways expedite the provision of what were in effect long term loans to industry (Mathias, 1973). Indeed, the most detailed recent research stresses the essential part played by long term bank finance in the transition to factory production in the West Riding woollens industry (Hudson, 1986). Nevertheless, legal restrictions kept English banks to a small scale prior to the mid-nineteenth century. Moreover, when the really large investment demands associated with railways come along, Britain was a relatively mature economy and invested £15 million a year for a decade without recourse to the institutional innovations related to railway building in Germany (Tilly, 1986, p. 118). So despite the obvious weaknesses of the financial system, partially reflected in high rates of bankruptcy (Duffy, 1985), in an era of family capitalism Britain at the middle of the nineteenth century, based on her early start, still had a capital to labour ratio in the economy as a whole some 12 per cent higher than that of the United States.(5)

Thus, as far as consumption and investment are concerned, in the main, recent research has suggested that the British Industrial Revolution can still be seen as broadly in line with Gerschenkron's expectations of an early comer economy. Growth was not rapid enough to permit workers' consumption standards to rise much prior to the second quarter of the nineteenth century but there was only a modest increase in the investment ratio. Comparisons with other countries are complicated somewhat more than was once recognized by the counterfactual question of what would have happened in the absence of the Napoleonic Wars.

c) Late Victorian Economic Failure?

The apparent slowing down in British economic growth somewhere in the later part of the nineteenth century has given rise to vigorous controversy. We defer discussion of problems of measurement to section 8 and concentrate at this point on the debate concerning the extent of, and reasons for, any failure in growth performance and the links between this literature and Gerschenkron's hypotheses.

The widespread notion that Victorian Britain 'failed' was one of the earliest targets for attack by New Economic Historians, with the main thrust of the argument forcefully stated in McCloskey (1970) and McCloskey and Sandberg (1971). Earlier writers had accused entrepreneurs of failures in innovation, research and development, and marketing, had blamed capital markets for inefficient allocation of funds, notably an undue bias towards foreign investment, and had attributed to falling export growth a failure of the 'engine' of British growth, leading to actual growth falling behind potential. In one of the most popular versions of this view, Richardson (1969) developed the argument that Britain was "overcommitted" to the old staples as a result of her early start in industrialization and the 'lopsided' economic structure that was its legacy. By contrast, new economic historians examined choices of technique from a profit-maximizing criterion and found that British failures to adopt new technology in use abroad were typically rationally based on British cost conditions (Sandberg, 1981), investigated home and foreign investment and found little evidence of bias in the London capital market (Edelstein, 1982) and concluded that the idiosyncratic structure of the British economy reflected comparative advantage under free trade (Harley and McCloskey, 1981) such that McCloskey's seminal paper argued that this was a case of "an economy not stagnating but growing as rapidly as permitted by the growth of its resources and the effective exploitation of the available technology" (1970, p. 459).

Since the mid-1970s the pendulum has swung back towards a rather more critical view of the late nineteenth century British economy even among the cliometrics fraternity.(6) Business historians have in any case continued to draw unfavourable comparisons between British firms and their continental or American counterparts, particularly in respect of slowness to move to large-scale corporate capitalism, hostility to new methods and inability to develop strategies capable of handling industrial relations in a manner compatible with twentieth century industrial leadership (Chandler, 1980; Coleman and Macleod, 1986; Lewchuk, 1987). From the quantitative economic history literature the following points have emerged:

(i) Comparisons of productivity levels and rates of growth at the macroeconomic level do not seem fully to justify McCloskey's optimism. Thus, Feinstein's estimates show that while in 1870 GDP/hour worked in the United States was only 90 per cent of the British level, by 1890 it was 5 per cent and by 1913, 25 per cent, higher (Feinstein, 1988c, p. 4). Over the period 1873-1913, American total factor productivity growth appears to have been about three times the British rate (Feinstein, 1988c, p. 10) and Britain appears to have failed to participate in the American leap forward to total factor productivity growth rates of 1.5 per cent or so, characteristic of the early twentieth century but well ahead of anything Britain achieved until the post-1945 era.

(ii) Microeconomic studies of productivity levels and entrepreneurial decisions have also become a little less favourable to the Panglossian view. In particular, in the much studied iron and steel industry Allen (1979, 1981) and Berck (1978) have produced evidence that innovation lagged and productivity fell below German and American levels (perhaps by 15 per cent c. 1910).

(iii) There are reasons to be sceptical of the effectiveness of British education, training and research in an age when these factors mattered much more than earlier in the achievement of rapid productivity growth. Pavitt and Soete (1982) show that Britain's share of patents granted in the United States as a percentage of all foreign patents fell from 36.2% in 1890 to 23.3% in 1913 while Germany's share rose from 21.5% to 34.0% over the same period. Crafts and Thomas (1986) showed that British comparative advantage was based on exports intensive in the use of unskilled labour while Williamson, noting growth in skills per worker over 1871–1911 at only 70 per cent of the American rate, concluded that "it may well be said that the 'failure' of British industry in the late nineteenth century can be laid at the doorstep of inadequate investment in human capital...compared to her main competitors in world markets" (1981, p. 28).

McCloskey, in seeking to exonerate the late nineteenth century British economy, stressed the power of market forces in eliminating inefficient management and suboptimal performance – a theme which is developed particularly well in his study of the steel industry (1973). Certainly, earlier advocates of British failure had not adequately dealt with this line of argument, especially in proclaiming entrepreneurial failure. On reflection, however, McCloskey's position is itself vulnerable to counter–attack as has been implied in some of the subsequent literature. First, and most obvious, some of the alleged failings, particularly in education and training, are in activities where one would expect market failure and where the state was slow to develop appropriate remedies (Sanderson, 1988). Second, the economy lacked the capital market institutions appropriate to effective monitoring and to the existence of a takeover threat to guarantee rapid exit of bad management (Hannah, 1974). Indeed, in some cases such as chemicals, the capital market may have been instrumental in creating large barriers to entry (Kennedy, 1987). Third, the laxity of disclosure requirements may have led to serious weaknesses in the market for new industrial issues, arising from problems of asymmetric information impeding the development of new industries such as electricity (Kennedy, 1987, ch. 5).

In other words, it is no longer easy to believe that conditions of entry and exit into most industries were so easy as in effect to prevent managerial failure. Moreover, these lines of argument both make early start hypotheses such as Richardson's potentially more plausible and also relate to Gerschenkron's ideas on backwardness. The reasoning would run that Britain's early start obviated the need to develop new forms of banking, for example, to construct a railroad network, or to legislate for appropriate reforms of financial markets. By contrast, the pressures of backwardness, it might be argued, led in Germany especially to the creation of investment banking in a form conducive to lessening inefficiencies resulting from problems of information flows, to reducing managerial incompetence and to promoting vertical integration and corporate capitalism. Something very much like this position can be found in both Kennedy (1987) and Tilly (1986).

It will be obvious that the Kennedy/Tilly view is at most an agenda for research, but nevertheless it should not be discarded a priori. Some support can be found in Cottrell (1980, ch. 7), who finds a tendency for British banks to withdraw from long-term industrial financing as amalgamations led to nationwide and conservative lending policies being established, and in Tilly's own calculations that the German bank portfolio was much closer to the efficient portfolio frontier than was a collective portfolio based on new capital issues in London, and that the contribution of the portfolio diversification achieved by the advent of superior financial intermediation in raising the supply of funds to higher risk, higher yield sectors could have been to raise the growth rate for the whole economy by 50 per cent. (1986, pp. 130–139). On the other hand, calculations of counterfactual growth rates are fraught with difficulty and Kennedy's own attempt to justify a 2.9 per cent growth rate for Britain in 1870–1913, rather than the actual 1.8 per cent had capital markets been less inefficient (or more like Germany!), has been widely dismissed as arbitrary and unconvincing (Harley, 1988; Thomas, 1988).

In sum, there are grounds for suspecting that late Victorian and Edwardian Britain did fail. The extent of the failure is not entirely clear but its proximate sources seem to lie in poor productivity performance not prevented by the market institutions of the day. It is possible that Britain was more vulnerable to these problems by virtue of receiving the institutional legacy of a Gerschenkronian early–comer. Such a hypothesis may well appeal to followers of Mancur Olson (1982), but remains at the moment a very speculative proposition.

4. Growth and Fluctuations in British Industrial Output in Comparison with other European Countries

The notion of 'great spurts' in industrial growth is central to Gerschenkron's approach to European industrialization. As is well-known, he argued that "the more delayed the industrial development of a country, the more explosive was the great spurt of its industrialization, if and when it came" (1962, p. 44). This claim has been tested, albeit rather crudely, using rank correlations by Barsby (1969) and Trebilcock (1981), who both find support for it, although characteristically Trebilcock is no more than lukewarm.

More precisely, Gerschenkron provides the following description:

> "after a lengthy period of fairly low rates of growth came a moment of more or less sudden increase in the rates, which then remained at the accelerated level for a considerable period. That was the period of the great spurt...the phenomenon in its entirety was altogether different from the cycle... The crucial observation, then concerns a specific 'kink' in the curve of industrial output (drawn on a semi-logarithmic scale)... The more backward the country, the sharper was the angle of the kink." (1968, pp. 33-34).

Gerschenkron did not, however, offer any precise operational criteria for distinguishing the "specific discontinuity of the kink", although he did advise that historians should work with "appropriately selected periods" and not be put off by "the fact that any curve can be 'smoothed' by the use of an appropriate technique in such a way as to eliminate any sign of discontinuity" (1968, p. 34). Unfortunately, as O'Brien notes in his recent survey article, European economic historians have found that "the statistical problems of delineating phases of trend acceleration are formidable" (1986, p. 306) and "discussions of 'decisive' upswings...degenerate into semantics" (1986, p. 309).

Recent historiography reflects O'Brien's point only too well. In the British case, most recent writing has rather coyly tended to talk of a gradual acceleration in trend without giving any precise timing and has sheltered behind phrases such as "rapid growth of the industrial sector...became dominant after 1815" (Mokyr, 1985, p. 4) when considering the question of a great spurt. Neither Crafts (1985a) nor Harley (1982) are able to throw much light on the issue as they both worked from benchmark years chosen for data availability. Thus, while few would any longer readily accept Hobsbawm's singling out of the 1780s as the point where "all the relevant statistical indices took that sudden, sharp, almost vertical turn upwards which marks the take-off" (1962, p. 28), there is no detailed chronology with which to replace this description, merely growth rates calculated between "convenient end-points".

Similar tendencies appear in the historiography of other European countries as it has retreated from the Rostovian era. Thus for both France and Austria it has been strongly argued, by Marczewski (1963) and Komlos (1983), that there was no true take-off and no unambiguous discontinuity. For each country there is also a quite extensive literature pointing to unevenness in rates of growth over time and trying to read more or less significance into particular upturns. For Italy, Gerschenkron (1962, p. 76) isolated 1896-1908 as the years of the 'great spurt' but other writers have been less confident, for example, Cafagna (1973, p. 321) and Trebilcock, whose picture is of "a series of jerks towards industrialization, each linked fairly closely to its predecessor, none of outstanding force, frequently interspersed with periods of hesitation" (1981, p. 305). Tilly is similarly sceptical in the German case of the advisability of singling out a period of trend acceleration: "it is both possible and theoretically plausible that German economic growth in the nineteenth century took the form of long swings and, furthermore, that the take-off of the 1840-73 period was little more than the sum of one complete long swing (from 1843 to 1861) plus the expansion phase of another (from 1861 to 1879), coupled to some historically unique railway investment booms" (1981, pp. 52-3).

There are important implications which arise from this review of the literature. In particular, it is clear that hitherto problems of measurement have bedevilled the identification and thus the international comparison of 'great spurts'. Thus the Barsby and Trebilcock rank correlations of backwardness and industrial output growth are undermined both by lack of agreement on the periods of growth to be compared in the test and also by uncertainty in distinguishing trend growth and actual growth. Many writers are justifiably worried that misleading inferences may be drawn from ad hoc approaches to the analysis of time series of industrial output. Moreover, not only is it desirable that changes in the estimated rate of trend growth are the result of appropriate time series decomposition procedures but also it would seem sensible to use techniques which do not rely on prior specification of points at which the trend shifted.

In the British case these remarks apply not only to the investigation of increases in growth in the Industrial Revolution period but also to the subsequent slowing down in the era when the alleged problems of the early start putatively made an impact. There has, of course, between a prolonged debate over the extent and timing of the climacteric in British growth which is well surveyed in Saul (1985). Saul, whose pamphlet is probably the most widely-read item in the literature on late nineteenth century growth, in his second edition favoured placing the climacteric in the period after 1899 whereas in his first edition he preferred to date it in the 1870s. The issue is of considerable interest given the prominence which comparisons of growth trends have assumed in the British failure debate (Floud, 1981).

5. Data

For the purposes of our analysis of trends in growth of industrial output in different European countries we have attempted to select the best available series. It must be recognized, however, that the quality of data is somewhat variable and that the coverage of activities is inevitably not equally complete in every case. For Russia and Italy we relied on the series in Goldsmith (1961) and Fua (1966) respectively, although in the latter case Fenoaltea's forthcoming work will surely supercede what is currently available. For Austria-Hungary we used the indices constructed by Komlos (1983) and for Germany we based our work on Lewis's (1978) revision of Hoffmann's index. For France, discussion of acceleration and deceleration has involved indices with and without traditional handicrafts and accordingly we analysed both the series in Toutain (1987) and in Levy-Leboyer (1978).

For Britain we require a series for industrial output free of the faults from which Hoffmann's (1955) index suffers. We have therefore constructed a revised series which takes account of the corrections proposed by Harley (1982) and Lewis (1978). Lewis's revisions, which were accepted by Feinstein (1972), are used from 1855–1913 and Hoffmann's original index for 1700–60 and 1801–54. For 1761–1800 Harley (1982, p. 277) pointed out that Hoffmann's index is fatally flawed by virtue of giving much too high a weight to the atypically fast growth sectors of cotton and iron. The problem arose because Hoffmann was only able to obtain estimates for 56 per cent of industrial output, which he then used to represent the whole. In effect, this virtually doubled the weighting for cotton and iron, although calculations for benchmark years, where a fuller set of data can be constructed, suggest that Hoffmann's unobservable sectors grew at a rate similar to that of his observable sectors minus cotton and iron (Crafts, 1985a; Harley, 1982). We have prepared a corrected series for 1761–1800 which removes the above problem. Cotton and iron are given weights throughout the period 1761–1800 of 6.7% and 6.5% respectively, these being their proportions of industrial output in 1783. For the remaining observable sectors, having weights summing to 43.2%, their weightings were inflated by a factor of (100–13.2)/43.2 and the revised series was then spliced to Hoffmann's at 1800. A revised index was then worked back to 1761 where it was again spliced to the Hoffmann original. As some sectors disappeared from observation during the period, appropriate adjustments were made: for example, output of ships is not observable for years prior to 1789 and is assigned a weight by Hoffmann of 4.0%; sectors other than cotton and iron were thus adjusted in 1788 (and earlier years) by an inflation factor of (100–13.2)/39.2 and so on. Full details of weights and the complete index are reported in Crafts et al (1989b). The index exhibits long run growth up to 1780 and also short run growth in the last two decades of the eighteenth century at virtually the same rates as those Crafts (1985a, p. 32) found for the wider set of data which could be constructed for benchmark years.

6. Modelling Trends and Cycles in Economic Time Series

In examining the behaviour of economic growth in nineteenth century Britain and Europe, we make use of some recently developed techniques in the econometric analysis of macroeconomic time series. In particular, macroeconomists are often concerned with 'decomposing' an observed time series to isolate, for example, its trend (or secular) and cyclical components. The fact that the trend component is thought to be of importance necessarily implies that the series under examination is nonstationary, so that it has a tendency to depart even farther from any given value as time goes on. This leads to a number of statistical problems, brought about by the nonconstancy of the series mean, variance and autocovariances. In applied work, a simple way of capturing trend is to attribute such movement to a functional dependence on time. Accordingly, nonstationary time series are often "detrended" by regressing the series on a function of time, the resulting residuals then being treated as a stationary time series with well defined variance and autocovariances. The implicit model underlying these procedures is

$$y_t = f(t) + u_t, \qquad (1)$$

where $\{y_t\}$ is the observed nonstationary time series and $\{u_t\}$ is the stationary series of residuals around the trend function f(t), often taken to be the linear trend, $\alpha+\beta t$. These residuals can then be interpreted as the cyclical component to be explained by business cycle theory. Recent examples of this approach include Perloff and Wachter (1979), Hall (1980), and Blanchard (1981), while Nelson and Plösser (1982) provide a more extensive list of references.

As these last authors point out, secular movement need not be modeled by a deterministic trend. One alternative is that popularised by Box and Jenkins (1976), namely that y_t represents the accumulation of changes that are themselves a stationary time series, so that

$$y_t = y_{t-1} + \beta + \epsilon_t, \tag{2}$$

where $\{e_t\}$ is a stationary, but not necessarily serially uncorrelated, series with mean zero and constant variance $\sigma_\epsilon{}^2$, and where β is the (fixed) mean of the differences. Accumulating changes in y from any initial value, $y_0=\alpha$ say, yields

$$y_t = \alpha + \beta t + \sum_{i=1}^{t} \epsilon_i, \tag{3}$$

which looks superficially like the linear trend version of (1), but has a fundamental difference. The disturbance is not stationary; rather, the variance and covariances depend on time. For example, if the $\{\epsilon_t\}$ are serially random, then the disturbance variance is $t\sigma_\epsilon{}^2$. Nelson and Plosser (1982) refer to models of the class (1) as trend stationary (TS) processes and those of the class (3) as difference stationary (DS) processes.

The distinction between these two types of process has important implications for both business cycle analysis and theories of economic growth. If output is of the TS class, then all variation in the series is attributable to changes in the cyclical component, whereas if output is a DS process its trend component must be a nonstationary stochastic process rather than a deterministic function of time, so that an innovation to output has an enduring effect on the future path of the series. Hence treating output as a TS process rather than as a DS is likely to lead to an overstatement of the magnitude and duration of the cyclical component and to an understatement of the importance and persistence of the trend component. Furthermore, as West (1987) points out, if output is DS then, since all innovations are permanent, the concept of a stationary natural rate will have little meaning, for an output shock will, on average, never be offset by a return to some trend growth rate.[7] In addition, if monetary shocks are typically thought to be transitory, such shocks must therefore be unlikely to be important sources of output fluctuations, which are thus dominated by variations in real factors.

The testing of whether a time series belongs to the DS class against the alternative that it belongs to the TS class is essentially one of testing whether $\{y_t\}$ contains a unit root. Thus, following Dickey and Fuller (1979), in its simplest set up this requires estimating the model

$$y_t = \beta + \rho y_{t-1} + \gamma t + \epsilon_t \tag{4}$$

by least squares and testing whether the estimate of ρ is significantly less than unity, for under the null hypothesis that $\{y_t\}$ belongs to the DS class, $\rho=1$, whereas under the alternative of a TS class of model, $\rho<1$. The usual 't-ratio' for $(\hat{\rho}-1)$ is, however, not distributed as Student's t and, in the above case, the tables given in Fuller (1976, p. 373) must be used. When computing such tests, it is important to account for any serial correlation in ϵ_t, and two families of test statistics have been developed. Said and Dickey (1984) consider parametric variants, where the basic equation (4) is augmented by an autoregression in the lagged changes of y_t,

$$y_t = \rho + \rho y_{t-1} + \gamma t + \sum_{i=1}^{\ell} \delta_i (y_{t-i} - y_{t-i-1}) + \epsilon_t, \tag{5}$$

in which, after judicious choice of the lag length ℓ, ϵ_t is assumed to be serially independent. Again, the appropriate t-test on y_{t-1} can be used, and a second test statistic, the 'F-test' of the joint null hypothesis $[\gamma=0,\ \rho=1]$, denoted Φ and obtained in the conventional way from the regression of (5), may also be employed. For this joint test, the asymptotic distribution tabulated in Dickey and Fuller (1981) must be used.

The second family of tests has been proposed by Phillips and Perron (1988), in which the above test statistics are nonparametrically adjusted to account for both serial dependence and heteroskedasticity in $\{\epsilon_t\}$. Details of these adjustments are presented in Phillips and Perron (1988) and Perron and Phillips (1987), and require an estimate of the variance of $\{\epsilon_t\}$ based on sample autocovariances truncated at lag ℓ. These nonparametric statistics have the same asymptotic distributions as the parametric statistics presented above, and Phillips and Perron (1988) show that their use entails no loss of power over the parametric tests in spite of the fact that they allow for a more general class of error processes. The battery of test statistics applied to the logarithms of the European industrial production series are shown in Table 5. The statistics t_ρ and Φ are the Said and Dickey (1984) 't-ratio' and 'F' tests obtained from estimation of (5), while $Z(t_\rho)$ and $Z(\Phi)$ are their nonparametric counterparts calculated by adjusting the statistics obtained from the estimation of (4). Also shown is Phillips and Perron's (1988) "normalised bias" statistic $Z(\rho)$. In both cases the lag length ℓ was set at 4, this choice being in accordance with the selection criteria used by Schwert (1987).

Before discussing these statistics, Schwert's (1987) important simulation findings must be taken into account. He found that if the series under investigation contain important moving average components, then the usual critical values (at the 5% level, –3.41 for t_ρ and $Z(t_\rho)$, 6.26 for Φ and $Z(\Phi)$, and –21.8 for $Z(\rho)$) are too small in absolute value, so that the unit root hypothesis would tend to be rejected too often. Schwert thus recommends that, prior to testing for unit roots, the correct specification of the ARIMA process generating each series should be ascertained. On the assumption that each series contains a unit root, so that first differencing is required, the ARIMA specifications shown in Table 6 were arrived at. We see that many of the series do indeed have important moving average components. Since Schwert's simulations suggest that the parametric tests are less affected by the presence of such components, it may be wise to concentrate on these statistics in determining the presence of unit roots. From these, only Austria rejects the unit root null hypothesis and this conclusion is supported by the nonparametric tests, since both $Z(\rho)$ and $Z(\Phi)$ are highly affected by moving average behaviour.

The TS model fitted to the Austrian series is

$$\begin{aligned} y_t &= \underset{(.044)}{1.833} + \underset{(.001)}{.028t} + u_t \\ u_t &= \underset{(.080)}{.698}\, u_{t-1} + a_t \quad , \quad \hat{\sigma} = .0560, \end{aligned} \tag{6}$$

(standard errors in parentheses)

so that the series evolves as a deterministic linear trend, having a constant growth rate of 2.8% per annum, upon which is a cyclical component that exhibits a first order autoregressive structure, i.e. any innovation away from trend decays back exponentially, the decay factor being approximately 0.7, so that the mean and median lengths of decay are 2.3 and 1.0 years respectively. In terms of residual standard error, this model is superior to the ARIMA specification (a random walk with drift of 2.7% per annum) shown in Table 6.

The remaining series are consistent with them evolving as difference stationary processes. Beveridge and Nelson (1981) show that, under rather weak assumptions, y_t can then be decomposed into trend and cyclical components,

$$y_t = \mu_t + \psi_t, \tag{7}$$

such that, if y_t has the Wold decomposition

$$\nabla y_t = \alpha_0 + a_t + \alpha_1 a_{t-1} + \dots \quad ,$$

where $\nabla y_t = y_t - y_{t-1}$, α_0 is the mean of ∇y_t, and $\{a_t\}$ is a white noise series with zero mean and constant variance $\sigma_a{}^2$, then the trend component is given by

$$\nabla \mu_t = \alpha_0 + \left[\sum_{j=0}^{\infty} \alpha_j\right] a_t \quad , \alpha_0 = 1,$$

and the cyclical component is

$$\psi_t = \left[\sum_{j=1}^{\infty} \alpha_j\right] a_t + \left[\sum_{j=2}^{\infty} \alpha_j\right] a_{t-1} + \dots$$

Since a_t is white noise, the trend component is therefore a random walk with rate of drift equal to μ and an innovation equal to $(\sum_0^\infty \alpha_j)a_t$. The cyclical component, on the other hand, is clearly a stationary process which may exhibit many patterns of serial correlation depending on the signs and pattern of the α's. It may be interpreted as representing the forecastable 'momentum' present at each time period but which is expected to be dissipated as the series tends to its 'permanent' level, given by the trend component.

Using the ARIMA specifications shown in Table 6, the Beveridge and Nelson decomposition implies that, since both Germany and Italy evolve as pure random walks, $\mu_t=y_t$ and $\psi_t=0$, and hence they contain no forecastable momentum and no meaningful cycle. Britain, France(2), and Russia are all integrated moving average processes and hence have cyclical components that are also (finite) moving averages, thus ruling out (pseudo-)cyclical behaviour. France(1) has a more complicated dynamic structure, being an ARIMA(2,1,1) process. The autoregressive polynomial has complex roots, and thus the cyclical component does exhibit pseudo-cyclical behaviour. Hungary too has an autoregressive structure having complex roots, so that pseudo-cyclical behaviour is again implied for the cyclical component.

Beveridge and Nelson (1981) provide estimators of the trend and cyclical components that are based simply on the present and past observations of the series, so that they are estimated by <u>one-sided filters</u>. This is very convenient for assessing current business cycle developments, but is less attractive in historical exercises, for the known 'future' observations are ignored. Perhaps more appropriately in this context, Watson (1986), for example, considers estimators based upon this extended information set, and which use <u>two-sided</u> filters.

TABLE 5

Unit Root Test Statistics

(a) Parametric Test Statistics

	$\hat{\rho}$	t_{ρ}	Φ
Austria	.440	-4.75	11.29
Britain	.980	-1.59	4.68
France (1)	.789	-3.10	4.89
France (2)	.812	-2.03	2.13
Germany	.790	-1.98	2.05
Hungary	.903	-1.85	3.06
Italy	.986	-0.18	1.28
Russia	.595	-2.45	3.34

(b) Nonparametric Test Statistics

	$\hat{\rho}$	$Z(\rho)$	$Z(t_{\rho})$	$Z(\Phi)$
Austria	.689	-61.74	-3.45	13.82
Britain	.971	-11.78	-1.23	2.52
France (1)	.801	-43.69	-2.79	9.56
France (2)	.725	-59.35	-3.28	12.89
Germany	.777	-32.14	-2.50	7.12
Hungary	.895	-19.01	-1.73	4.02
Italy	.953	-7.98	-1.27	1.49
Russia	.507	-50.46	-2.90	12.11

France(1) is the Toutain (1987) series, while France(2) is from Levy-Leboyer (1978). See Section 5 above.

TABLE 6

ARIMA Specifications

Austria	$y_t - y_{t-1}$	$= .027 + \epsilon_t\ , \qquad \hat{\sigma} = .0600$
Britain	$y_t - y_{t-1}$	$= .019 + \epsilon_t - .400\epsilon_{t-1}\ , \quad \hat{\sigma} = .0617$
France(1)	$y_t - y_{t-1}$	$= .064 - 1.023(y_{t-1} - y_{t-2}) - .357(y_{t-2} - y_{t-3})$
		$+ \epsilon_t + .754\epsilon_{t-1}\ , \quad \hat{\sigma} = .0356$
France(2)	$y_t - y_{t-1}$	$= .018 + \epsilon_t - .241\epsilon_{t-1} - .321\epsilon_{t-2}\ , \quad \hat{\sigma} = .0470$
Germany	$y_t - y_{t-1}$	$= .043 + \epsilon_t\ , \qquad \hat{\sigma} = .0354$
Hungary	$y_t - y_{t-1}$	$= .027 + .397(y_{t-2} - y_{t-3}) + \epsilon_t\ , \quad \hat{\sigma} = .0648$
Italy	$y_t - y_{t-1}$	$= .020 + \epsilon_t\ , \quad \hat{\sigma} = .0438$
Russia	$y_t - y_{t-1}$	$= .046 + \epsilon_t - .266\epsilon_{t-1}\ , \quad \hat{\sigma} = .0789.$

7. Structural Time Series Models

In the previous section we have presented evidence to suggest that one European industrial production series (Austria) is best described as a trend stationary process, while the others (Britain, Russia, Hungary, both French, Germany and Italy) appear to be difference stationary processes. Neither model is particularly attractive to the Gerschenkron view of the historical evolution of economies, for the former model implies that the trend in output is linearly deterministic, the latter that the trend moves as a random walk, with persistent innovations to a constant growth rate. Both models thus imply that trend growth is constant, but differ in how they allow (cyclical) innovations to affect the level of the series.

Economic historians have typically rejected the view that trend growth is constant through time, preferring models which allow for variable growth rates. Feinstein et al (1982), for example, allow trend growth to vary across chosen phases, calculating growth trends as the average rates required to connect the actual values of the series in the chosen terminal years of two successive phases. A related approach, not favoured by Feinstein et al but preferred by Greasley (1986), is to compute growth rates across chosen phases by semilogarithmic trend regression, i.e. by using the TS model (1), with $\{y_t\}$ measured in logarithms, in a piecewise fashion, thus allowing for abrupt jumps in trend growth across phases. The significance of these jumps can easily be examined by extending (1) with an appropriate set of intercept and slope dummies. If desired, continuity in trend growth can be imposed by using a cubic spline formulation, as carried out by Hausman and Watts (1980). While undoubtedly enabling nonconstant trend growth rates to be examined, these approaches may be criticised as being essentially ad hoc, forcing trend growth to shift abruptly at discrete intervals whose exact timing must be agreed upon.

An alternative approach to trend estimation, usually employed for trend removal so that the cyclical component can be isolated, is to use some form of moving average as, for example, Aldcroft and Fearon (1972). While such techniques have long been used for trend estimation (see, for example, Macauley (1931)) and are, indeed, the basis for the widely used X-11 seasonal adjustment programme, difficulties can arise if the chosen moving average, usually a simple 9- or 13-year filter, departs substantially from the optimal linear filter derived by signal extraction from the stochastic process actually generating the observed series, as the results for the X-11 filter obtained by Burridge and Wallis (1984) and the more general examples of Mills (1982) and Whiteman (1984) clearly reveal.

The approach to trend estimation that we favour here is to consider a structural time series model. This has the advantage of enabling a wide range of trend and cyclical behaviour to be analysed while still remaining within a formal modelling framework that admits a clear interpretation of the evolution of the underlying, but unobserved, components. The model employed here is similar to that proposed by Harvey (1985) and, in fact, includes all of the models discussed above as special cases. Rather than the trend-cycle decomposition of equation (7), an irregular component is explicitly included for model identification, so that we have

$$y_t = \mu_t + \psi_t + \epsilon_t \tag{7}$$

where, as before, y_t is the observed value (typically the logarithm) of output, μ_t is the trend, ψ_t is the cycle, and where ϵ_t is an irregular component. We assume that ψ_t is a stationary linear process, that ϵ_t is white noise with variance σ^2_ϵ, and that all components are uncorrelated with each other.

A stochastic linear trend can be modelled as

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t \tag{8a}$$

$$\beta_t = \beta_{t-1} + \xi_t, \tag{8b}$$

where η_t and ξ_t are uncorrelated white noise disturbance terms with variances σ_η^2 and σ_ξ^2 respectively. If $\sigma_\eta^2=\sigma_\xi^2=0$, then μ_t reduces to a deterministic linear trend and the model is then of the TS form (1). When $\sigma_\xi^2=0$, (7) is stationary in first differences and provided $\sigma_\eta^2>0$, it is of the DS form (2) with $\beta_t=\beta$.

The cycle ψ_t, since it is assumed to be a linear stationary process, should be capable of displaying pseudo-cyclical behaviour. Harvey (1985) uses a sinusoidal process that explicitly exhibits such behaviour, but we prefer here to employ the second order autoregressive (AR(2)) process (see also Clark (1987));

$$\psi_t = \rho_1\psi_{t-1} + \rho_2\psi_{t-2} + \omega_t, \tag{9}$$

where ω_t is a white noise disturbance with variance σ_ω^2. This choice is made on two grounds. The first is that it is relatively easy to handle and to estimate; the second is that the presence of a business cycle in all the series under investigation has by no means been demonstrated convincingly. The condition under which ψ_t will display pseudo-cyclical behaviour is well known to be $\rho_1^2+4\rho_2<0$, in which case the fundamental period (in years) of the cycle is given by $\lambda=[2\pi/(\cos^{-1}(|\rho_1|/2|\rho_2|^{\frac{1}{2}})]$ (Box and Jenkins (1976, chapter 3)).

Estimation of the model is best carried out through a state-space representation using the Kalman filter. The model can be written in state-space form by defining the state vector to be

$$\alpha_t = (\mu_t,\beta_t,\psi_t,\psi_{t-1})'.$$

The measurement and transition equations can then be written as

$$y_t = A\alpha_t + \epsilon_t$$

and

$$\alpha_t = M\alpha_{t-1} + u_t,$$

where

$$A = (1,0,1,0)$$

and

$$M = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \rho_1 & \rho_2 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

respectively, with

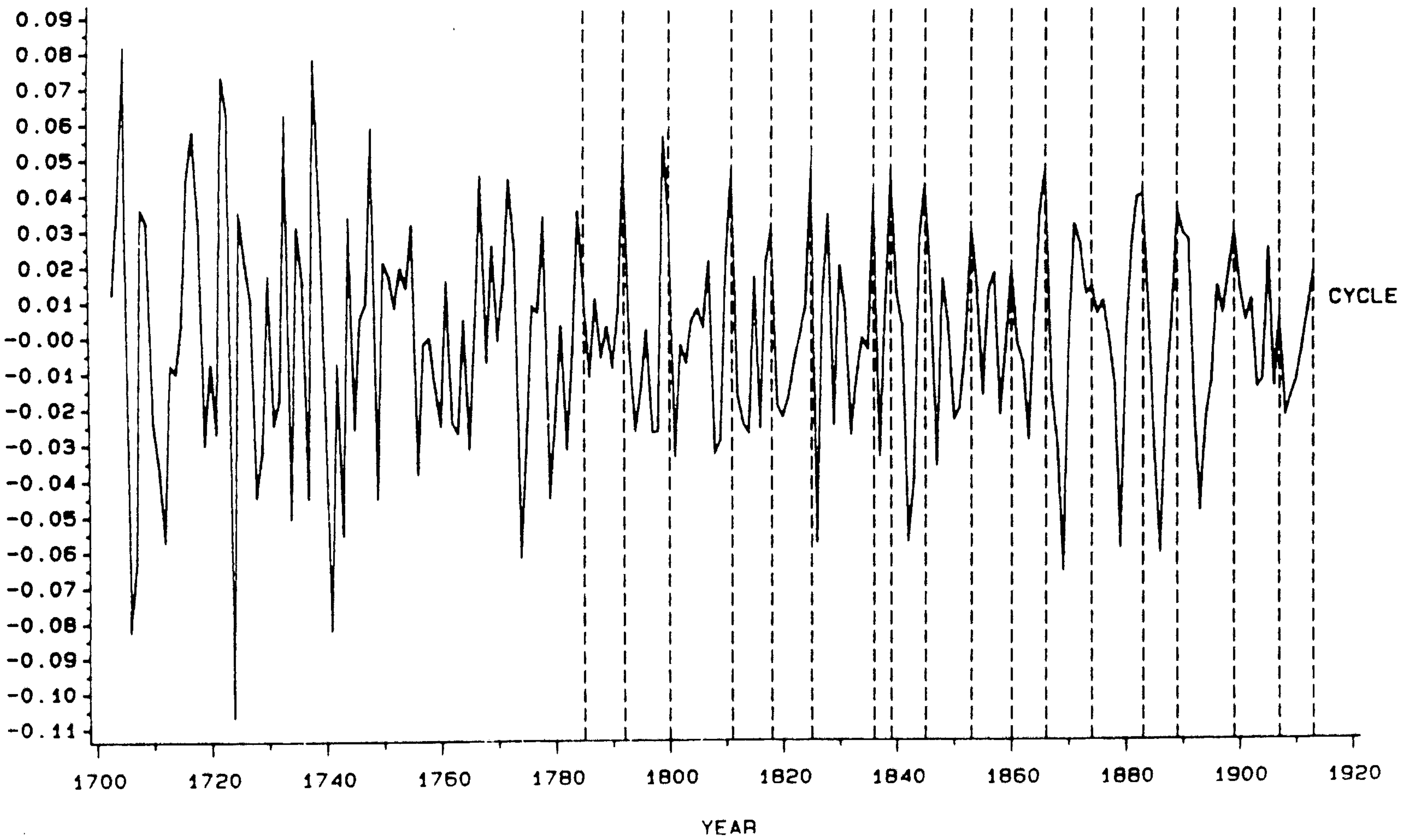
$$u_t = (\eta_t, \xi_t, \omega_t, 0)'.$$

The disturbances η_t, ξ_t and ω_t are assumed to be normally distributed with zero means and the assumption that the components are uncorrelated implies that the disturbances will have a diagonal covariance matrix.

Maximum likelihood estimates of the unknown parameters σ^2_ϵ, σ^2_η, σ^2_ξ, σ^2_ω, ρ_1 and ρ_2 can be obtained numerically via the application of the Kalman filter algorithm. Conditional upon these, optimal estimates of the components of the state vector α_t are then obtained by smoothing (running the Kalman filter forwards and backwards through time). Further discussion of this smoothing procedure and details of maximum likelihood estimation are given in Crafts et al (1989a).

The parameter estimates obtained for each series are shown in Table 7. Two sets of estimates are presented for Britain, one for the complete set of data from 1700 to 1913, and one for the comparable subperiod 1815 to 1913. The models differ primarily in their cyclical components. For the complete period, the cyclical parameters are small, and indeed statistically insignificant, implying a cyclical period of 5 years, whereas for the later period the parameters are significant and imply a period of 7½ years. This reflects the lack of any well defined business cycle in the eighteenth century, the period of 7½ years for the nineteenth century being consistent with earlier work. The cyclical component for the complete period is plotted in Figure 1. This shows quite clearly the lack of any

FIG. 1



Britain Cycle

cycle in the early years and also, since reference lines based on the major peaks of cycles identified from 1785 by Aldcroft and Fearon (1972) have been superimposed, the degree of correspondence in the later years to this earlier work. Both estimates of σ_ϵ^2 are positive, implying stochastic trend growth, and the complete sample trend growth rate is plotted in Figure 2. This clearly shows a steady increase from the 1760s to a peak in the 1830s and then a slow decline to 1900.

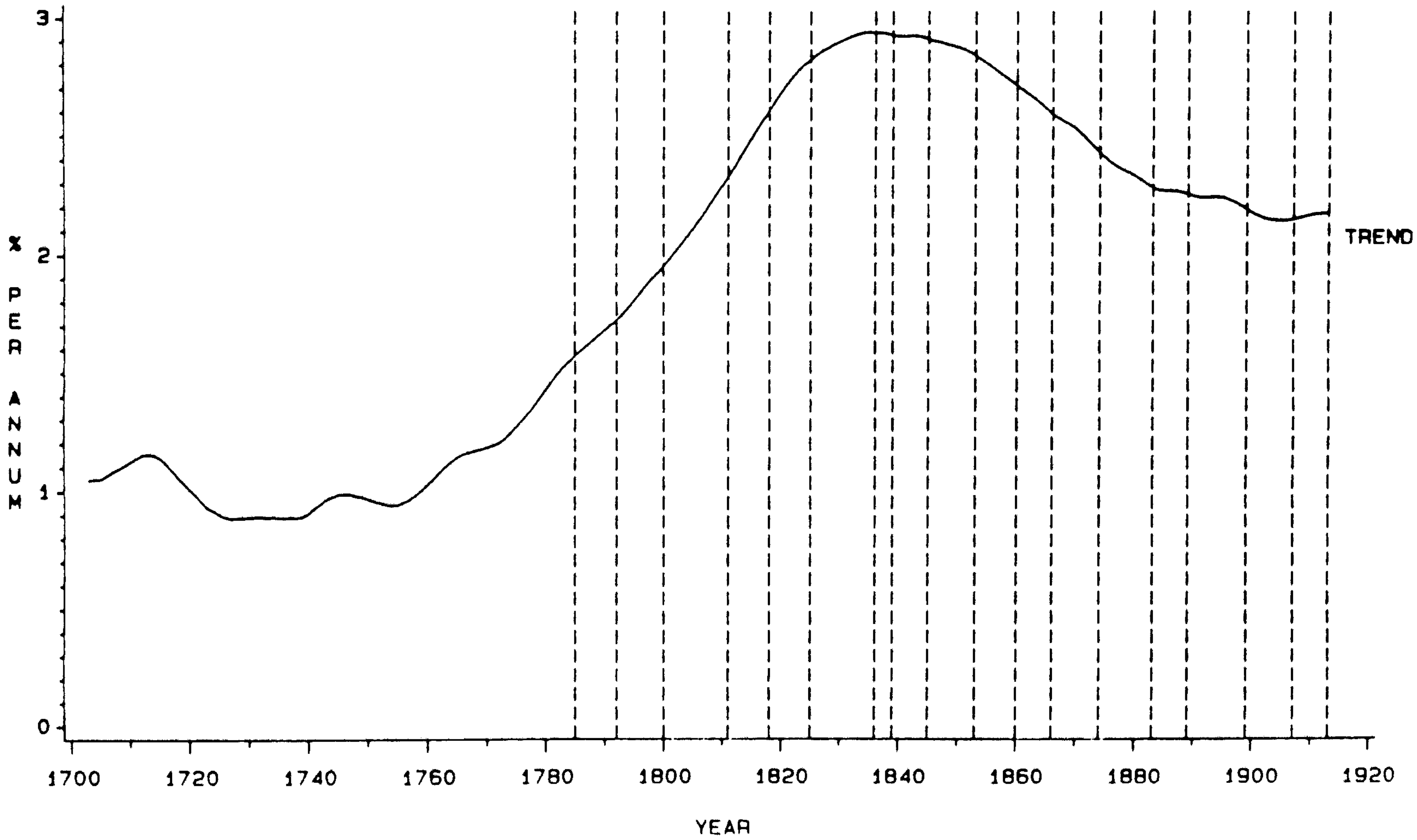
For Austria, both σ_η^2 and σ_ϵ^2 are zero, implying a deterministic linear trend, estimated to be 2.9% per annum. The estimate of ρ_2 is insignificantly different from zero and hence the structural model collapses to the model given by equation (6), providing complete consistency between the two approaches to modelling this series.

For Germany and Russia, σ_ω^2 is zero and the cyclical parameters, although numerically large, are insignificantly different from zero. This implies that there are no cyclical components in these series, and since in both cases σ_ξ^2 is zero as well, trend growth is also constant, estimated to be 4.3% and 5.3% per annum respectively. These are again consistent with the ARIMA models fitted to the series and the implied Beveridge–Nelson decompositions, given that the trend component is estimated here by using a 'two-sided', or smoothed, filter (see on this Watson (1986)).

Italy is similar to Germany and Russia in that it too has no cyclical component. However, σ_ξ^2 is positive so that trend growth is stochastic. This component is plotted in Figure 3, and the spurt in trend growth in the 1890s is clearly shown.

The French(1) series, based on Toutain (1987) and excluding traditional textiles, exhibits constant trend growth, since $\sigma_\xi^2=0$, estimated as 2.7% per annum. In this case, though, σ_ω^2 is positive and the ρ's are also significantly different from zero. The series thus does have a cyclical component, the implied period being approximately 7 years. This cyclical component is shown in Figure 4. Again, this structural model is consistent with the ARIMA decomposition arrived at earlier. The French(2) series, based on Levy–Leboyer (1978) and including traditional textiles, also exhibits constant trend growth, but as expected, this is estimated at the lower rate of 1.8%. In this case, however, there is no significant cyclical component.

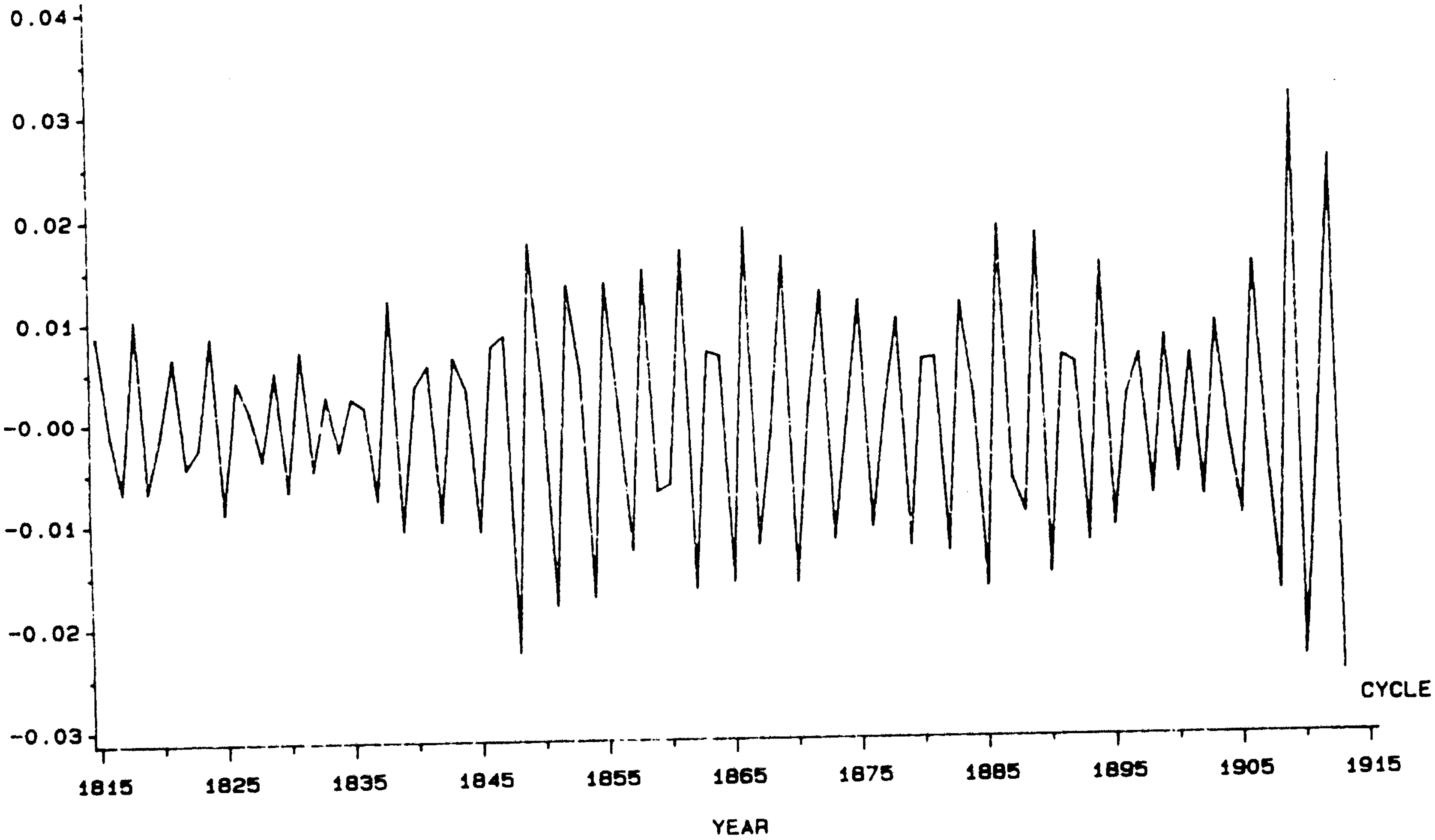
FIG. 2



Britain: Trend Growth.

Italy : Trend Growth

FIG.4



France(1): Cycle.

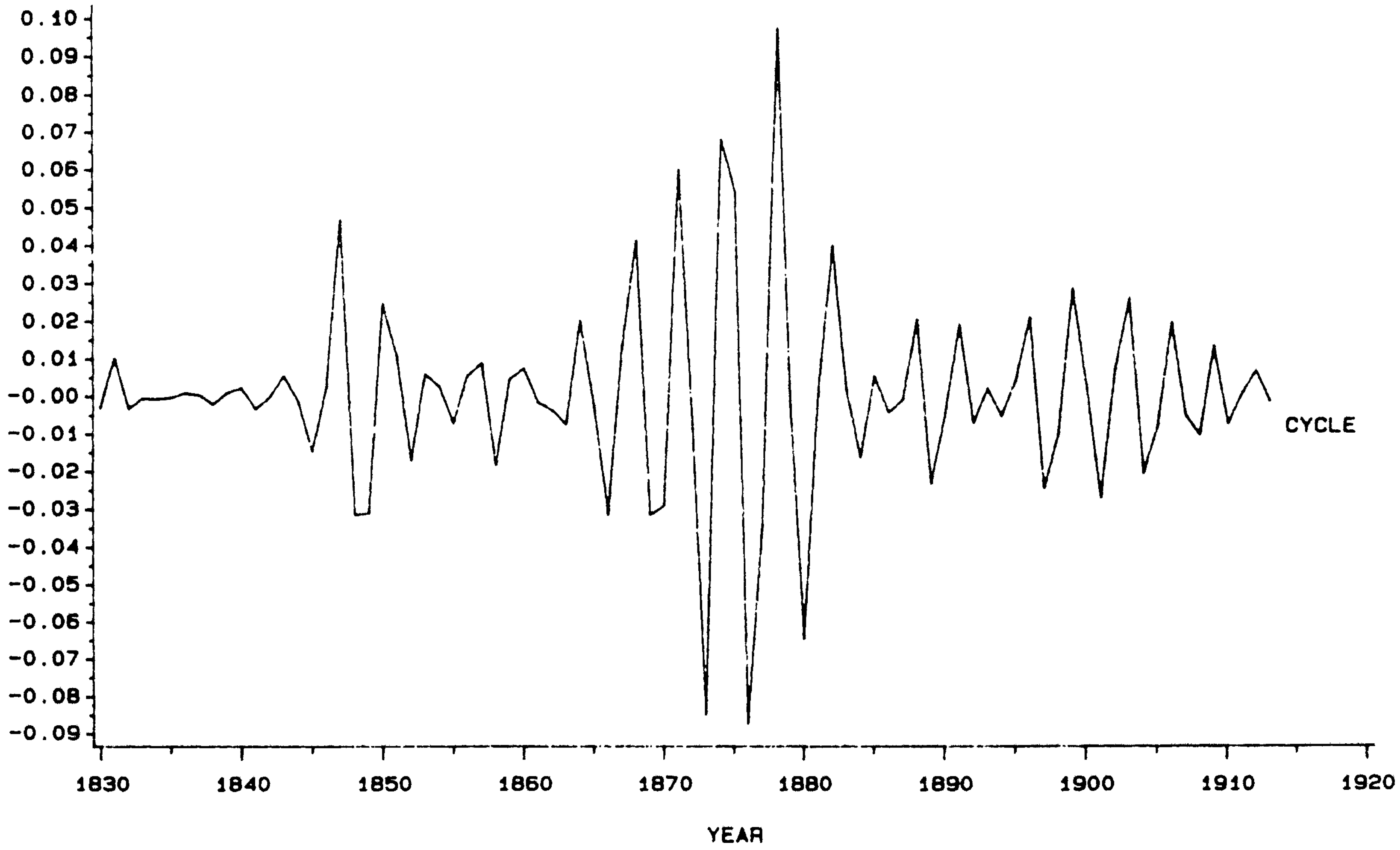
Hungary is similar to Britain in having both a stochastic cycle and stochastic trend growth. The cyclical component is shown in Figure 5, the implied period being 4½ years. Trend growth is plotted in Figure 6. There is a 'minor' increase in 1850, but a more sustained and larger rise in the 1870s.

TABLE 7

Maximum Likelihood Estimates of Parameters from Structural Time Series Models

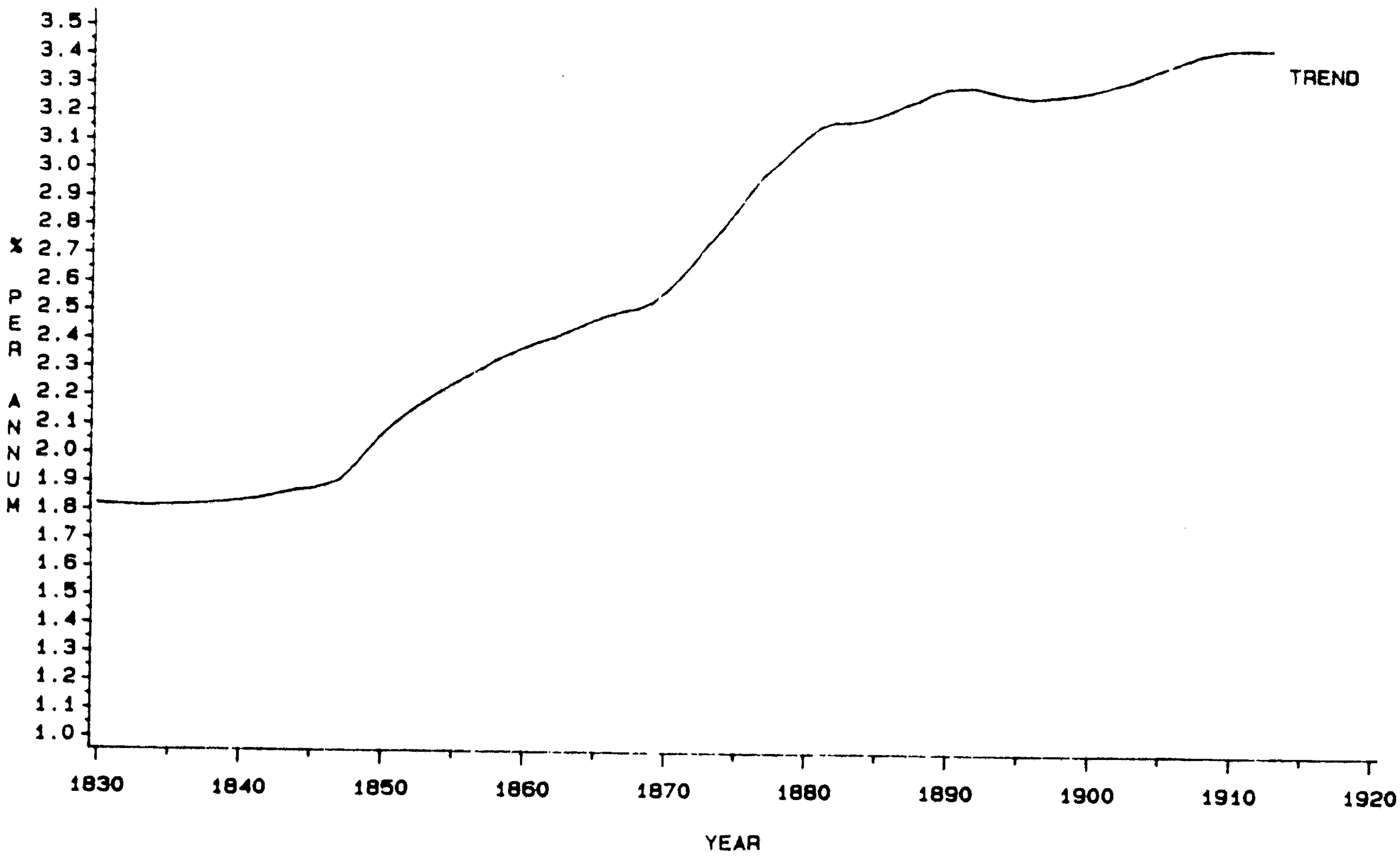
	σ^2_ϵ ($\times 10^{-5}$)	σ^2_η ($\times 10^{-3}$)	σ^2_ξ ($\times 10^{-5}$)	σ^2_ω ($\times 10^{-3}$)	ρ_1	ρ_2
Austria	1.41	0	0	2.99	.78	-.12
Britain (1815-1913)	0.70	0	0.17	1.35	.60	-.21
(1700-1913)	0.03	0.81	0.02	1.47	.25	-.11
France(1)	79.30	0.80	0	0.05	-1.09	-.80
France(2)	24.58	1.44	0	0	-1.19	-.96
Germany	0.06	1.07	0	0	-.09	-.94
Hungary	1.40	2.32	0.47	0.46	-.31	-.75
Italy	0.11	1.45	1.16	0	.05	-.83
Russia	0.02	3.75	0	0	-.99	-.86

FIG. 5



Hungary: Cycle.

FIG. 6



Hungary : Trend Growth.

8. Implications of the Results

In the preceding two sections we have set out what we consider to be an appropriate methodology for investigating the behaviour of trend growth over time and have implemented it for seven nineteenth century economies. It should be clear from our discussion that previous investigations of these questions in European economic history have been based on rather unsatisfactory and potentially misleading procedures. In particular, it is crucial in order to avoid biased measurement of trend growth, to distinguish between trend stationary and difference stationary series of output and, in order to do justice to the concerns of the historical literature, it is also necessary to go beyond the Beveridge–Nelson decomposition of difference stationary processes.

Our approach is based on unobserved components models in which both the trend and cycle components are stochastic and in which there is no ex-ante specification of dates at which the trend is hypothesized to have changed. Our approach is more general than the conventional approach to trend estimation used by economic historians, namely OLS equations of linear trends over predetermined intervals of time; this traditional method is, of course, a special (restricted) case of our general model. In terms of the underlying economic models, the conventional approach is akin to assuming a neoclassical growth model with a natural rate of growth exogenously given and which is to be estimated. Our methodology does not rule out this possibility but can also embrace models where technological progress is endogenous and the evolution of the economy is path dependent, as envisaged for example in David (1975, ch.1). The results obtained in some respects contrast markedly with conventional wisdom. We discuss first the implications for Gerschenkron's views on 'great spurts' and second the pattern of British industrial growth which emerges.

a) International Comparisons of Trend Growth in Industrial Output.

Table 8 provides a resumé of the results obtained by our preferred methodology for trend estimation and also reports, for comparison, the results obtained from conventional OLS estimation of the equation $y=\alpha+\beta t$ for discrete intervals whose timing, based on beliefs about the dates of business cycles, were chosen on the basis of the available historiography.

Table 8. Comparison of Estimates of Trend Growth in Industrial Output Obtained by OLS and Kalman Filter (% per annum)

Britain	OLS	Kalman Filter		OLS	Kalman Filter
1700-25	1.71 (6.22)	varying:0.9-1.2	1819-36	3.93 (24.58)	rising:2.6 to 2.9
1726-45	0.34 (1.40)	varying:0.9-1.0	1837-53	3.21 (15.01)	falling very slightly: 2.9 to 2.8
1746-83	0.63 (7.58)	rising:0.9 to 1.6	1854-74	2.79 (19.98)	falling:2.8 to 2.4
1784-1802	1.46 (9.67)	rising:1.6 to 2.1	1875-99	2.09 (14.48)	falling:2.4 to 2.2
1803-18	2.09 (10.33)	rising:2.1 to 2.6	1900-13	1.52 (7.40)	constant:2.2
Austria			**France(1)**		
1830-46	2.55 (16.93)	constant throughout:2.9	1815-40	3.37 (60.36)	constant throughout:2.7
1851-72	2.68 (6.18)		1841-60	1.55 (9.84)	
1873-96	3.11 (23.98)		1861-82	3.11 (23.89)	
1897-1913	2.95 (13.23)		1883-99	2.60 (17.32)	
			1900-13	2.70 (8.76)	

France(2)

1820-40	1.68 (10.41)	constant throughout:1.8
1841-60	2.09 (12.09)	
1861-82	1.23 (6.15)	
1883-99	1.54 (9.17)	
1900-13	2.88 (10.43)	

Germany

1850-7	2.70 (3.71)	constant throughout:4.3
1858-74	5.31 (22.44)	
1875-99	4.51 (51.52)	
1899-1913	4.38 (31.33)	

Hungary	OLS	Kalman Filter
1830-47	1.42 (29.74)	constant:1.8
1851-74	2.18 (9.61)	rising:2.0 to 2.5
1875-96	4.93 (19.11)	rising:2.5 to 3.3
1897-1913	3.53 (17.25	rising:3.3 to 3.5

Italy	OLS	Kalman Filter
1861-81	1.40 (9.56)	falling: 2.2 to 1.6
1882-96	0.35 (1.62)	constant to 1890: rising to 2.5 in 1896
1897-1908	4.98 (17.24)	rising to 1902: 2.6 to 3.1 then constant
1909-13	2.42 (3.56)	constant at 3.1

Russia

1860-84	4.93 (18.42)	constant throughout:5.3
1885-99	6.54 (25.76)	
1900-7	1.18 (1.41)	
1908-13	6.26 (12.94)	

Sources: OLS regressions based on data series described in Section 5 and t-statistics reported in parentheses; Kalman Filter estimates as presented in Section 7 and Figures 1-6.

It is clear from Table 8 that estimates of trend growth are quite sensitive to the methodology employed. For example, in the cases where the Kalman Filter estimates are of a constant trend rate of growth, in 50 per cent of cases that rate would not be in a 95 per cent confidence interval of the trend growth estimated by OLS. In the countries where Kalman Filter estimates are of a variable trend rate of growth, the range of variation is substantially less than that obtained from the OLS procedure and there are some marked differences in the pattern of changes in trend growth. Although an important general message is that we believe economic historians have been prone to exaggerate the variability of trend growth, nevertheless three of the seven countries do exhibit stochastic trend growth and this supports economic historians in their insistence on considering models with non-constant trends.

Table 8 also makes interesting reading in the context of the historiography of individual countries. For Austria our results tend to confirm Komlos's view that "the Austrian-Bohemian lands entered the modern industrial phase of economic development by 1825/30" (1983, p. 16) and that he is right to insist on "the absence of any unambiguous discontinuity in Austrian output" (1983, p. 91). In this case the picture derived from the OLS approach is fairly similar. We share in a consensus, including Gerschenkron (1977, pp. 52-4) and Trebilcock (1981, pp. 300-2), emphasizing the stability of long run trends in industrial growth in Austria which has developed in the aftermath of an earlier search for a take-off.

For France our estimates are consistent with Marczewski's well-known view that "there was no true take-off in France at all" (1963, p. 129). They do not, however, confirm the chronology promoted by Crouzet (1974) and accepted by Caron (1979) in his well-known textbook. Crouzet's characterization was as follows - 1815-40: irregular, sometimes fast growth; 1840-60: fast growth; 1860-82: slowing down; 1882-96: stagnation; 1896-1913: fast growth (1974, p. 171). Although this account is broadly consistent with what would be obtained from the traditional OLS approach using France(2), which as the more comprehensive of the two French series we would prefer, our methodology suggests that as a picture of trend growth it is misleading.

Our estimates for Germany also indicate constant trend growth after 1850 but unfortunately we are unable to go back before that date when perhaps there were variations in trend. The chief contrast with the OLS results is that they suggest a slowing down in trend growth after the alleged take-off phase prior to 1873, albeit of a modest deceleration. The absence of any marked climacteric in German growth seems to be generally agreed (Trebilcock, 1981, pp. 48-9).

The remaining case of constant trend growth according to our estimates is Russia. There is a contrast here with what seems to be a generally accepted view in the literature that there was an upsurge in industrial output growth from the mid-1880's (Gregory, 1982, p. 1), a spurt that is central to Gerschenkron's most famous example of backwardness. Even the OLS estimates and Goldsmith's original calculations (1961, p. 471) suggest that it would appear that trend growth of industrial output in the quarter-century or so after the Emancipation was rapid and a division of the period 1860-1913 at 1885 reveals no structural break on a Chow test. It must be remembered that the series for industrial output prepared by Goldsmith, although the best available, is of rather dubious quality but on the present evidence it appears to us that acceleration in Russian industrial growth from the 1880s has been oversold.

Hungary we find to be a case of stochastic trend. The pattern is one of a fairly steady increase in trend growth from around 1.8 per cent in the 1830s and 1840s to around 3.5 per cent on the eve of World War 1. There is some support for Komlos' identification of a spurt in the late 1870s (1983, p. 112) but there seems to be no particular reason to identify any short period as representing a decisive change. The OLS results, by contrast, would point to the twenty years from the mid 1870s as showing a marked jump in trend whereas we would see Hungary's industrial advance as a gradual process.

Our estimates find that trend growth in Italian industrial output was both stochastic and highly volatile. For the OLS estimates our breakpoints were chosen on the basis of Gerschenkron (1962), whose discussion of the Italian great spurt is well-known and singles out 1879-1908; the OLS procedure appears to vindicate Gerschenkron. Figure 6 indicates clearly, however, that this pre-selection of turning points may be highly misleading; our estimates suggest that trend growth was generally declining from the early 1860s to the late 1870s, levelled off, and then increased from 1890 to 1902 by about 1.5 percentage points all told. This is a striking example of the difference between allowing the data to speak and imposing a priori notions on historical time-series.

Table 9 brings out some of the implications of our analysis for Gerschenkron's propositions concerning great spurts and backwardness. The countries are ordered according to Gerschenkron's own assessment of "Backwardness" (1962, p. 44), with Hungary inserted between Italy and Russia.[8] Column 1 of the table reports the growth rate of industrial output over the first twenty years of the spurt periods proposed by Barsby (1969). On the basis of the now revised estimates for British growth a perfect

Table 9. Great Spurts Compared Using Different Methodologies (% per annum)

	Trebilcock/ Barsby	OLS	ΔOLS	Kalman Filter	Δ Kalman Filter
Britain	3.6/2.1 [a] (1780-1800)	1.5 (1784-1802)	0.8	1.6 to 2.1	2.0 (1760-1835)
France	3.0 [b] (1829-49)	2.1 (1841-60)	0.4	1.8	0
Germany	3.2 (1850-70)	5.3 (1858-74)	2.6	4.3	0
Austria	3.3 (1880-1900)	2.6 (1830-46)	-	2.9	0
Italy	4.8 (1896-1916)	5.0 (1897-1908)	4.6	2.6 to 3.1	1.45 (1890-1902)
Hungary	-	4.9 (1875-96)	2.7	2.5 to 3.3	1.6 (1850-1910)
Russia	5.6 (1884-1904)	6.5 (1885-99)	1.6	5.3	0

Notes

a. The Trebilcock/Barsby estimate was based on Hoffmann's index of 1955; Crafts's (1985a) revision would reduce the figure of 3.6 to 2.1 per cent.

b. Trebilcock (1981, p. 430) suggests the spurt should be dated from 1850–70 but does not supply an estimate of industrial growth over the period.

Sources: "Trebilcock/Barsby" is based on Barsby (1969, p. 456), an analysis which has been popularized by Trebilcock (1981, pp. 429–431). Other columns are derived from Table 8.

rank correlation is observed on this test. The test can be refined somewhat by estimating trend growth either by OLS or Kalman Filter methods and by choosing dates based on more recent discussions of possible "take-off" periods. Columns (2) and (4) of Table 9 present the results of these refinements and which reduce the rank correlations to 0.77 and 0.74 respectively. On reflection, however, this type of test does not really seem appropriate for Gerschenkron's hypothesis which, as set out in section 4, actually concerns changes in the trend rate of growth.

Recognizing this point brings to the forefront questions of statistical methodology. Column (3) of Table 9 illustrates what might be obtained using a conventional OLS approach providing agreement could be obtained on the dates between which to compare growth trends and providing the date of the great spurt can be agreed upon a priori. The results are a little less favourable to Gerschenkron as a consequence of Russia's rather low change of trend (r=0.54). As we have seen in the literature review of section 4, such a priori agreement is not always available and, as our discussion of Table 8 made clear, we ourselves are sceptical of many of the proposed chronologies of growth. The results of our methodology, which leaves the question of stochastic or deterministic trend to be decided on objective statistical criteria and which allows the data to reveal the dates of changes in trends, are much less favourable to the notion of the "specific discontinuity of the kink". In four cases, including Russia, we estimate trend growth to be constant; in two cases (Britain and Hungary), we find a prolonged period of increases in trend growth of unspectacular dimensions and only in Italy do we find Gerschenkron's expectations more or less fulfilled. It must be remembered, of course, that series for industrial output do not go as far back in time as we would like and that interesting changes in trend may well have occurred before the periods we are able to investigate.

We find therefore that the sympathy of writers like Barsby and Trebilcock for the proposition that backwardness is associated with great spurts in industrial output growth is misconceived and based on an inappropriate statistical methodology. This does not, of course, mean that the backwardness approach should be taken to be totally lacking in insights into nineteenth century growth and the ways in which it was achieved. We would readily invoke Solow on this point: "to believe as many American economists do that empirical economics begins and ends with time-series analysis, is to ignore a lot of valuable information that cannot be put into so convenient a form..., information that is encapsulated in the qualitative inferences made by expert observers, as well as direct knowledge of the functioning of economic institutions" (1988, p. 311).

It follows, however, that we do not regard favourably Gerschenkron's suggestion that the search for discontinuities in industrial growth provides explicanda which will fertilize historical research in a fruitful way (1968, pp. 36-7). In all cases but that of Austria, we have found that industrial production time series are difference stationary processes and in three of the seven cases trend growth is stochastic. It could therefore be quite unfortunate only to concentrate on apparent upward moves in trend growth, as Gerschenkron suggested. The 'dog that didn't bark', i.e. the falling off in trend growth that could have but did not materialize may be just as important to consider.

b) Acceleration and Slowdown in British Industrial Growth.

The British experience is unlike that of any other country included in our analysis. The pattern revealed in Figure 2 is of a long, slow acceleration in trend growth, a brief interlude around the peak of under 3 per cent, followed by a decline beginning before the middle of the nineteenth century and apparently completed by the end of the century. The estimates in Table 8 confirm that trend growth in British industrial output was slow relative to that in Germany or Russia, which Gerschenkron would have expected, of course, and even tended to be less than that of Austria during the nineteenth century, which he might have found a little more surprising.

Our results, which we discuss more fully in Crafts et al. (1989a), also indicate that a number of beliefs among British economic historians will need to be revised. Partly this is a consequence of better indices of industrial output but mainly it is because the use of estimated trend growth rates over arbitrarily selected short periods has distorted general perceptions of the achievements of the economy over time; for example, our industrial production trend growth estimates suggest that growth during the so-called climacteric of the late Victorian and/or Edwardian periods was always greater than during the so-called "take-off" period in the late eighteenth century.

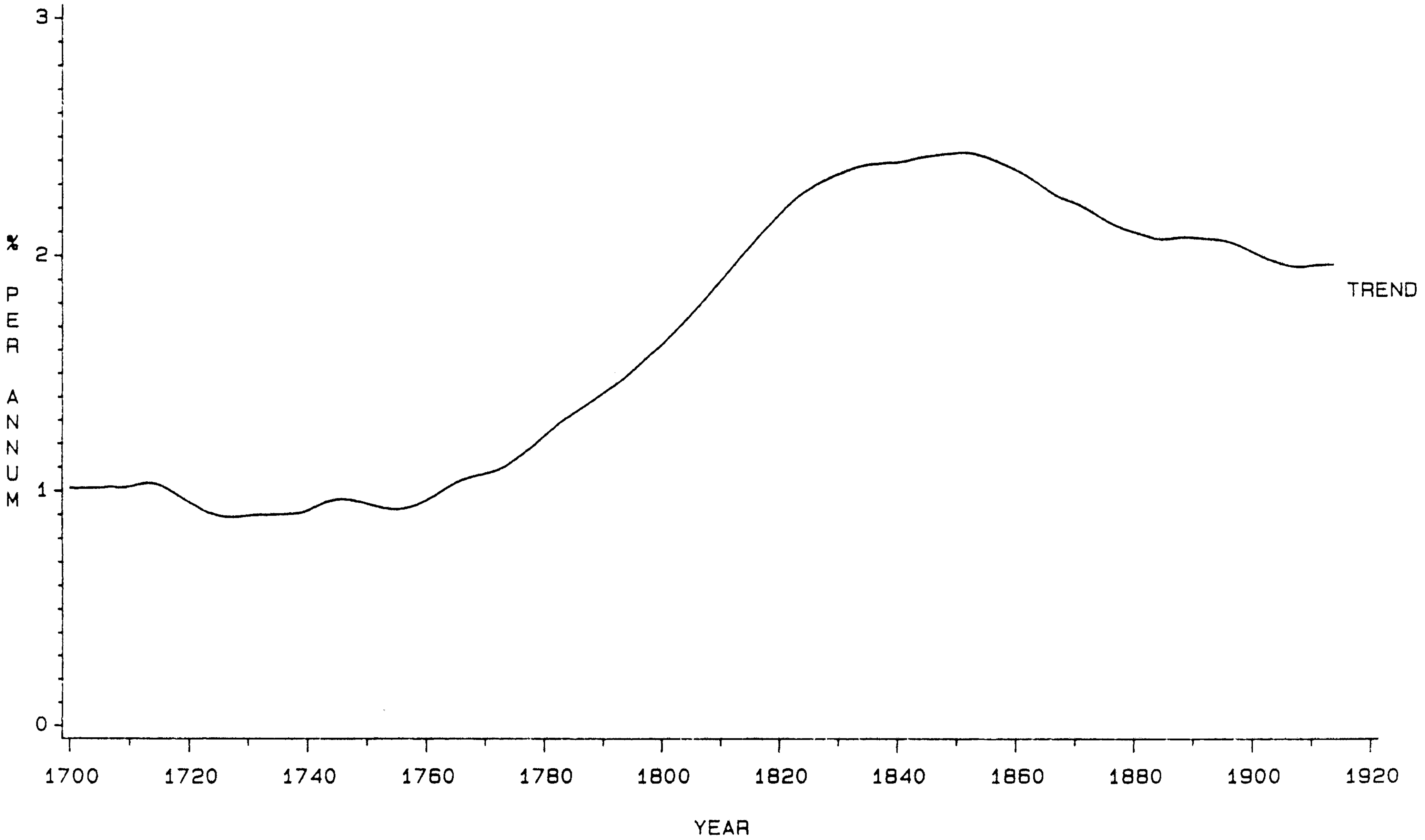
Two points in particular stand out. First, it seems unreasonable to single out, as Hoffmann did (1955, p. 32) and many followed, a change at 1780 as clearly marking an epoch in the evolution of Britain's economy. Notwithstanding the adverse effects of war on the economy in the years 1793-1815, the trend rate of growth is estimated to have increased throughout the period 1760-1835, a finding which adds to the weight of evidence that Rostow's choice of 1783-1802 as the "take-off" period (1960, p. 38) was mistaken.

Second, in strong contrast with the views of Matthews et al (1982), we do not wish to stress 1899-1913 as a climacteric - within this period any fall in trend growth of industrial production was extremely modest. We have shown elsewhere (Crafts et al, 1989a) that a similar result applies to real GDP. Controversy has existed, of course, with both the 1870s and 1890s seen as the onset of a climacteric. We find a declining trend growth from the start of the third quarter of the century - distinctly earlier than has generally been believed - which gives further reason to doubt the validity of the term "Great Victorian Boom" as applied to the years 1850-73 (Church, 1975). Interestingly, in this regard we do find ourselves sympathetic to Hoffmann (1955, p.32) who dated the slowdown in industrial output growth from 1855. Again, the value of allowing the data to speak unhindered by the preconceptions of recent historiography is apparent.

Closer examination of components of industrial production reveals where the slowdown in trend growth was located. Figure 7 displays estimates of trend growth derived as in Section 7 above for British industrial output for sectors other than cotton, coal, and iron and steel. Exclusion of these export staples leaves roughly the same time pattern of acceleration and deceleration of trend growth but greatly reduces their magnitudes. Thus the decline from the mid nineteenth to early twentieth centuries is from 2.4 to 2.1 per cent rather than from 2.9 to 2.2 per cent as in the case of total industrial production.

It must be stressed that the finding that British trend industrial output growth slowed from the mid nineteenth century onwards does not of itself indicate that the economy failed. Certainly, as we argued in Section 3, we are sympathetic to the view that there were weaknesses in the late Victorian economy but it is much less clear that such failings mattered much at mid-century or that they inhibited the growth of the staples at that point. Moreover, our results suggest that any late Victorian/Edwardian failure is to be found in an inability to match American productivity growth acceleration rather than any marked British trend deceleration. Thus, although it is interesting to place the idiosyncrasy of British industrial growth trends on a firm statistical basis, the British experience is one where paying undue attention to changes in the trend rate of growth is not necessarily particularly helpful as a starting point for analysis of economic performance.

FIG.7



3
2
1
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% PER ANNUM
TREND
1700
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1780
1800
1820
1840
1860
1880
1900
1920
YEAR

9. Summary and Conclusions

Our main points can be briefly recapitulated as follows.

(i) It is still reasonable to regard Britain as fitting in most respects the pattern of a Gerschenkron early-comer: in general, recent research has strengthened this perception. Thus, the acceleration in economic growth in the Industrial Revolution was modest, agricultural productivity advance played a major part in the development process, investment never became a large fraction of national product and investment banking was unimportant.

(ii) It is, however, important to recognize that British industrialization and, more especially agriculture's part in it, can only properly be understood in the context of comparative advantage and patterns of international specialization.

(iii) It is extremely important to approach comparisons of growth rates over time or between countries using appropriate statistical techniques. We advocate the use of an unobserved components model with stochastic trend and cycle and with no prior selection of structural breaks.

(iv) Application of our methodology gives results in key respects different from conventional wisdom. In particular, we find that British industrial growth entered its climacteric at the middle rather than the end of the nineteenth century and that discontinuities in trend growth in nineteenth century Europe were less common and less dramatic than Gerschenkron imagined - or indeed than most of the historiography would suggest.

FOOTNOTES

1. Feinstein provides an overwhelming case for rejecting Williamson's figures for middle class and service sector occupations. He does not, however, offer alternative estimates but rather shows that eliminating the unreliable series removes virtually all the movement in the pay ratio. It may be that further research will reinstate some of Williamson's claims by filling in gaps in the coverage of the present set of information on earnings. It should also be noted, however, that Williamson's assumptions on productivity growth are inconsistent with the estimates in his model for factor shares, output and input growth (Feinstein, 1988b) and that his model contains a number of highly undesirable features notably with regard to the treatment of the tradables/non-tradables division and the use of a small-country assumption (Crafts, 1987a, pp. 248-256, 260-4).

2. Ricardo clearly foresaw the outcome of the discussion in this section as the following passage first published in 1817 shows: "a country possessing very considerable advantages in machinery and skill, and which may therefore be enabled to manufacture commodities with much less labour than her neighbours, may in return for such commodities, import a portion of the corn required for its consumption, even if its land were more fertile, and corn could be grown with less labour than in the country from which it was imported" (Hartwell, 1971, p. 154).

3. As Gerschenkron himself put it, "the Industrial Revolution in England...affected the course of all subsequent industrializations" (1962, p. 41).

4. Williamson does suggest a lower Gini of 0.468 for 1688 at variance with Soltow's earlier estimate of 0.551 (1968, p. 22), with the difference arising mainly from Lindert's work on occupations from burial register samples (1980). It is possible, however, that this value is too low, firstly because lower wages in the North of

England than in the South at this time are not allowed for and, secondly, because Lindert acknowledges that his occupations estimates are subject to large confidence intervals – allowance for these considerations leaves the distinct possibility that inequality in 1688 was much the same as 1801/3.

5. Based on Field (1985, p. 394) corrected on the basis of Feinstein's (1988a) capital stock estimates; the comparison is for 1860.

6. Perhaps at least partly because McCloskey has been otherwise occupied.

7. The use of the term difference stationary process is equivalent to the phrases "random walk approximation" or "unit root" for describing the evolution of output over time.

8. Other authors have adopted different rankings – Trebilcock (1981) and Barsby (1969) both use as one way of assessing backwardness the date of entry into the big spurt – as our discussion suggests, however, this is a dubious procedure.

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