Deconstructing Growth in UK Manufacturing

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Abstract

This paper is concerned with the nature of economic growth in 19 manufacturing industries between 1970-92. There is substantial heterogeneity (both across sectors and time) in rates of growth of value-added, hours worked, labour productivity and Total Factor Productivity during the sample period. The decline in constant price value-added in aggregate manufacturing during the sample period is associated with significant changes in the relative size of individual sectors, and with noticeable changes in performance between the two peak-to-peak business cycles 1973-79 and 1979-89. Despite changes in the relative size of sectors, the vast majority of aggregate productivity growth is explained by within-sector productivity growth. An analysis of productivity levels also reveals considerable heterogeneity. The distribution of productivity levels across sectors exhibits an increase in dispersion and becomes increasingly positively skewed during the sample period. There is evidence of productivity levels in a number of industries converging at values just below the mean; productivity levels in a few sectors persistently remain above and rise away from mean values.

JEL CLASSIFICATION: C10, O40

KEYWORDS: convergence, growth accounting, distribution dynamics, labour productivity and Total Factor Productivity

1 Introduction

Between the years 1970 and 1992, constant price value-added at factor cost in UK manufacturing *fell* at an average annual rate of 0.18%.[1] This decline in manufacturing value-added compares with an increase in constant price GDP at factor cost at an average annual rate of 1.90%.[2] Although value-added fell, its decline was accompanied by an even larger fall in manufacturing hours worked (at an average annual rate of 3.41%), so that the manufacturing sector as a whole experienced positive average annual rates of labour productivity growth during the sample period.

This paper examines the nature of the decline in manufacturing value-added and the associated changes in productivity, using a disaggregated data set containing information on 19 manufacturing industries for the years 1970-92.[3] In particular, we shall be concerned with the following questions. Was the fall in value-added and hours worked uniform across sectors, so that it makes sense to speak of a 'representative' manufacturing sector, or were there interesting variations across sectors? Was the performance of individual manufacturing industries constant over time (in particular, constant between the two peak-to-peak business cycles: 1973-79 and 1979-89)?

What were the implications or changes in value-added and employment for measurements of manufacturing productivity (both labour and Total Factor Productivity), and how did these vary across sectors and over time? If there were variations in productivity performance across sectors, how far can changes in productivity in aggregate manufacturing be explained by shifts in resources between sectors rather than within-sector productivity growth?

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(1) The source for all these figures (except where otherwise specified) is a database derived from the Census of Production, described in further detail in the Annex (see also Cameron (1997)). The figure for value-added growth is for single-deflated value-added:current price value-added, deflated by the producer output price index (see the Annex for further discussion).

(2) The figure for the rate of growth of GDP at factor cost is taken straight from the ONS, Blue Book.

(3) Again, for further details concerning the data set, see the Annex at the end of the paper.

A number of economic hypotheses are often advanced for the changing fortunes of the UK manufacturing sector during the period of interest (including, for example, changes in the exchange rate, macroeconomic policy and industrial relations law). But these hypotheses often pay insufficient regard to the interesting variations in economic performance across manufacturing sectors. A first step in the formulation and testing of such hypotheses must be a detailed understanding of the nature of economic growth at a disaggregated level *within* manufacturing, and it is exactly such an understanding that the present paper seeks to facilitate. We deliberately step back from framing economic hypotheses, in order to characterise the raw data that any such hypotheses must explain.

In a second paper (Cameron, Proudman and Redding (1997)) we examine how far this growth experience is associated with differences over time and across sectors both in cyclical factors - changes in capacity utilisation, for example - and in the levels of variables likely to be of long-run significance - such as trade unionisation, the intensity of domestic research and development (R&D), human capital and international openness. But, without this initial data characterisation, it would not be possible to know what the interesting questions are that subsequent empirical work ought to address. The value of this paper therefore rests on the premise that drawing together the main features of the recent UK growth experience is both useful for future research and interesting in its own right.

Having examined economic growth in UK manufacturing, the paper then moves on to analyse productivity levels. Two sets of interesting questions arise here. First, what does the distribution of productivity levels (both labour and Total Factor Productivity) across manufacturing industries look like at any one time (eg is productivity distributed uniformly around its mean value or are there groups of 'low' and 'high' productivity industries)? Second, how does the distribution of productivity evolve over time (eg are productivity levels across industries converging/diverging, are those industries with above-average productivity the same over time; or is there instead considerable mobility within the productivity distribution)?

A considerable literature already exists on output and productivity growth across industries. Recent examples include Jorgenson (1988) for the United States; Cameron (1997), Bean and Crafts (1996), Oulton and O'Mahony (1994) for the United Kingdom; and Bernard and Jones (1996a,b) for cross-country studies. The contribution of the present paper lies in the disaggregated data set containing annual information for the period 1970-92, and in the application of analytical tools from several different sources to the results of this growth accounting exercise.

But, it is not just productivity growth that is of interest, but also *levels* of productivity across industries. The information on productivity growth rates is combined with a measure of the level of productivity in a base year to facilitate an analysis of productivity dynamics across industries over time - drawing upon analytical techniques already employed in the cross-country growth literature (see in particular Barro and Sala-i-Martin (1991) and Quah (1993a,b), (1996a,b,c)).

These techniques are frequently applied at the international level in order to test the convergence hypothesis associated most closely with the Solow-Swan model of economic growth (see Solow (1956) and Swan (1956)). Within an individual economy, there are theoretical reasons why one might expect to witness either productivity convergence across sectors (derived, for example, from models of R&D spillovers) or productivity divergence (derived, for example, from models of sector-specific 'learning by doing'). By applying these empirical techniques, we provide evidence that relative levels of productivity in a majority of manufacturing sectors are converging, while productivity in a few high-productivity sectors is increasingly diverging from mean values.

Section 2 begins by examining the variation in rates of growth of value-added and hours worked across industries and over time. Two alternative measures of rates of productivity growth are then considered: labour productivity and Total Factor Productivity (TFP). With regard to the second of these measures, growth accounting techniques that follow Solow (1957) are used to decompose the rate of growth of value-added into the contributions of physical capital accumulation, increased labour input, and a 'residual', TFP growth. The same decomposition may then be used to evaluate the contributions of capital accumulation and TFP growth to labour productivity growth, so that the two measures of productivity growth may be explicitly related to one another.

Next, Section 3 considers what fraction of productivity growth in total manufacturing may be attributed to shifts in resources between sectors rather than productivity growth within individual manufacturing sectors. This decomposition is undertaken for both measures of productivity, and the contribution of individual sectors to changes in aggregate productivity is assessed. Section 4 analyses the distribution of levels of productivity (both labour productivity and TFP) across manufacturing sectors at the beginning and end of the sample period, and during the two peak-to-peak business cycles. Section 5 models the dynamics of productivity levels across sectors and time. Analytical techniques drawn from the cross-country growth literature are employed to analyse both intra-distribution dynamics (how productivity levels in industries move relative to one another) and changes in the external shape of the productivity distribution. Section 6 summarises our conclusions.

2 Economic growth in UK manufacturing

2.1 Value-added and hours worked

As already discussed, the period 1970-92 was characterised by a decline in both constant price value-added and hours worked in UK manufacturing (at average annual rates of 0.18% and 3.41% respectively). In order to examine the nature of this decline in greater detail, Table A reports rates of growth of value-added, hours worked and labour productivity for 19 two and three-digit industries within the manufacturing sector.(4) The first panel of the table displays time-averaged rates of growth during the entire sample period; the second and third panels give time-averaged rates of growth for the two peak-to-peak business

(4) Of the 23 industries in Table A, four [Chemicals (SIC 25/6+48), Basic Metal (SIC 22), Fabricated Metal (SIC 3) and Electrical Machinery (SIC 34)] are aggregations of the other industries. In view of the large role played by public procurement policies and government intervention, shipbuilding is excluded from our sample of manufacturing industries.

cycles 1973-79 and 1979-89.[5] The data on both labour input and, later on, physical capital are adjusted to take account of resources employed in R&D activities, and spending on R&D intermediate goods was added back in to value-added.[6]

As is clear from Table A, there are considerable variations in rates of growth of value-added and hours worked across manufacturing industries. Despite the decline in the overall size of the UK manufacturing sector between 1970-92, nine industries experienced positive rates of growth of value-added. Computers and Pharmaceuticals enjoyed the highest annual rates of growth (7.62% and 4.72% respectively), with Iron & Steel and Minerals experiencing the slowest (-4.20% and -2.33% respectively). All sectors experienced falls in hours worked, but again there were substantial variations across sectors: the average annual rate of decrease for the bottom five sectors was more than twice that of the top five sectors.

The extent of the variation in rates of growth of value-added and hours worked across sectors suggests that the decline in the size of the UK manufacturing sector during the sample period was associated with considerable changes in the relative size of individual sectors (whether measured by shares of manufacturing value-added or hours worked).

In general, average rates of growth of value-added are much lower in the first peak-to-peak business cycle (1973-79) than in the second (1979-89). For total manufacturing, value-added fell at an average annual rate of 1.14% between 1973-79, but rose at an average annual rate of 0.99% between 1979-89. Only four industries experienced higher rates of growth of value-added in the first peak-to-peak business cycle period (these were Metal Goods not elsewhere specified, Machinery, Motor Vehicles and Instruments). In contrast, average rates of growth of hours worked are typically much lower in the second peak-to-peak business cycle period than in the first: for total manufacturing, the average annual rates of growth are -1.64% and -3.70% respectively.

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(5) This has the advantage of keeping the analysis tractable and abstracting from cyclical fluctuations.

(6) These adjustments are made to avoid the potential bias from R&D 'double-counting' (see Schankerman (1981)).

Table A (Panel 1)
Value-added and labour productivity growth, 1970-92
All figures expressed as percentage rates of growth
Y/L = labour productivity

Industry	SIC 1980	Value-added	Labour	Y/L
Total Manufacturing	2 to 4	-0.18	-3.41	3.23
Food & Drink	41/42	-0.23	-2.35	2.12
Textiles & Clothing	43/4/5	-1.49	-4.45	2.96
Timber & Furniture	46	-0.71	-2.49	1.79
Paper & Printing	47	0.88	-2.15	3.03
Minerals	23/24	-2.33	-3.71	1.39
Chemicals	25/6+48	1.40	-2.22	3.62
Chemicals nes[a]	25+26-257	0.31	-2.96	3.27
Pharmaceuticals	257	4.72	-1.61	6.33
Rubber & Plastics	48	1.24	-1.59	2.84
Basic Metal	22	-3.60	-6.72	3.11
Iron & Steel	221/2/3	-4.20	-7.41	3.22
Non-ferrous Metals	224	-1.93	-4.80	2.87
Fabricated Metal	3	-0.01	-3.65	3.64
Metal Goods nes[a]	31	-1.01	-3.79	2.78
Machinery	32	-1.54	-4.01	2.47
Computing	33	7.62	-1.77	9.39
Electrical Machinery	34	0.80	-3.51	4.32
Other Electrical	34-344-345	-0.31	-3.71	3.39
Electronics	344/5	1.91	-3.29	5.20
Motor Vehicles	35	-1.22	-3.71	2.48
Aerospace	364	2.58	-2.03	4.61
Instruments	37	2.16	-2.36	4.52
Other Manufacturing	49	-1.38	-3.92	2.54

Source: see Annex. Estimates corrected for double-counting of R&D.
[a] nes: not elsewhere specified.

Table A (Panel 2)
Value-added and labour productivity growth, 1973-79
All figures expressed as percentage rates of growth
Y/L = labour productivity

Industry	Value-added	Labour input	Y/L.
Total Manufacturing	-1.14	-1.64	0.50
Food & Drink	-2.50	-0.89	-1.61
Textiles & Clothing	-2.34	-3.59	1.24
Timber & Furniture	-2.45	-1.70	-0.74
Paper & Printing	-1.79	-1.40	-0.40
Minerals	-3.77	-2.41	-1.36
Chemicals	0.70	-0.38	1.09
Chemicals nes[a]	0.50	-0.52	1.02
Pharmaceuticals	3.95	0.17	3.78
Rubber & Plastics	-0.50	-0.35	-0.15
Basic Metal	-6.59	-2.50	-4.09
Iron & Steel	-9.19	-2.64	-6.55
Non-ferrous Metals	-0.95	-2.01	1.06
Fabricated Metal	0.25	-1.39	1.64
Metal Goods nes[a]	-0.35	-1.87	1.52
Machinery	1.49	-1.25	2.75
Computing	4.47	-6.39	10.86
Electrical Machinery	0.11	-1.89	2.00
Other Electrical	-0.63	-1.32	0.69
Electronics	0.87	-2.55	3.42
Motor Vehicles	-0.35	0.05	-0.40
Aerospace	-3.75	-1.13	-2.61
Instruments	3.32	-0.78	4.10
Other Manufacturing	-1.04	-1.48	0.44

Source: see Annex. Estimates corrected for double-counting of R&D.
[a] nes: not elsewhere specified.

Table A (Panel 3)
Value-added and labour productivity growth, 1979-89
All figures expressed as percentage rates of growth
Y/L = labour productivity

Industry	Value-added	Labour input	Y/L
Total Manufacturing	0.99	-3.70	4.68
Food & Drink	0.52	-2.59	3.12
Textiles & Clothing	-0.47	-4.50	4.03
Timber & Furniture	0.52	-1.45	1.98
Paper & Printing	2.18	-1.87	4.05
Minerals	-0.02	-3.32	3.29
Chemicals	2.64	-2.72	5.36
Chemicals nes[(a)]	1.90	-4.19	6.09
Pharmaceuticals	4.96	-2.06	7.02
Rubber & Plastics	2.66	-1.41	4.06
Basic Metal	1.14	-8.90	10.03
Iron & Steel	1.62	-9.94	11.55
Non-ferrous Metals	-0.12	-6.04	5.92
Fabricated Metal	0.81	-4.13	4.94
Metal Goods nes[(a)]	-0.79	-3.97	3.17
Machinery	-1.69	-4.72	3.03
Computing	12.29	1.29	11.00
Electrical Machinery	1.67	-2.92	4.59
Other Electrical	0.33	-3.03	3.36
Electronics	2.86	-2.80	5.66
Motor Vehicles	-0.78	-6.35	5.57
Aerospace	7.39	-1.04	8.43
Instruments	1.32	-2.45	3.77
Other Manufacturing	-2.65	-4.38	1.73

Source: see Annex. Estimates corrected for double-counting of R&D.
[(a)] nes: not elsewhere specified.

2.2 Labour productivity growth

Combining rates of growth of value-added and rates of growth of hours worked, one obtains information about the first and simplest of our measures of productivity growth: labour productivity growth (measured by the rate of growth of value-added per hour worked and also shown in Table A). In the entire sample period, the rate of growth of hours worked is smaller than the rate of growth of value-added for all 19 manufacturing industries, so that all sectors experienced positive rates of labour productivity growth. In manufacturing as a whole, annual labour productivity growth averaged 3.23%, though again there are substantial variations across both sectors and time. For the sample period as a whole, Computing and Pharmaceuticals exhibit the highest average annual rates of labour productivity growth (9.39% and 6.33% respectively), and Minerals and Timber & Furniture experienced the slowest (1.39% and 1.79% respectively).(7)

In general, the second peak-to-peak business cycle is characterised by significantly higher average annual rates of growth of labour productivity than the first: for total manufacturing, the respective average annual rates of growth are 0.50% and 4.68%. In fact, average rates of labour productivity are higher in the second peak-to-peak business cycle in all industries except one (Instruments).

2.3 Total Factor Productivity growth

The rate of growth of value-added per hour worked is one measure of productivity growth that has the advantage of imposing very few (if any) theoretical restrictions on the data. But, it suffers the disadvantage of being a measure of the productivity of only one factor of production (though, in principle, one could also calculate capital productivity). As a result, one cannot for example distinguish between labour productivity being high in a sector because of a high degree of technical efficiency, or because of a large stock of physical capital. In the following, we therefore also make use of a second measure of productivity, Total Factor Productivity (TFP), which evaluates the efficiency with which all factors of production are employed.

(7) In the entire sample period, labour productivity in Computing more than doubled; labour productivity in Other Manufacturing rose by a little over 30%.

Following Solow (1957), suppose that value-added in an individual manufacturing sector j, where $j = 1, ..., n$, is produced with the following neoclassical production function,

$$Y_j(t) = A_j(t).F_j[K_j(t), L_j(t)] \tag{1}$$

where K_j denotes the stock of physical capital,(8) L_j is hours worked and A_j is an index of technical efficiency, which we define as TFP. In the specification in equation **(1)**, we suppose that technological progress is Hicks-neutral (though, as will be discussed further below, this assumption is easily relaxed). Under the assumptions of perfect competition and constant returns to scale, the rate of growth of value-added in each sector j may be decomposed into the contributions of increased hours worked, physical capital accumulation and changes in the efficiency with which existing factors of production are employed,(9)

$$\frac{\dot{Y}_j}{Y_j} = \frac{\dot{A}_j}{A_j} + (1 - \alpha_j(t)).\frac{\dot{K}_j}{K_j} + \alpha_j(t).\frac{\dot{L}_j}{L_j} \tag{2}$$

where $\alpha_j(t) = ((A_j.\partial F_j/\partial L_j.L_j)/Y_j)$ denotes the share of payments to labour in value-added in sector j at time t. Thus the rate of growth of TFP $\dot{A}/A$ corresponds to that component of the rate of growth of output that cannot be attributed to either capital accumulation or increased labour input. Note that this decomposition, though informative, yields no conclusions about causality: for example, even if capital accumulation accounts for a substantial amount of output growth, it may be that this capital accumulation is ultimately induced by increases in TFP.(10)

(8) Note that the present approach assumes that technological progress is disembodied and does not distinguish between different of vintages of physical capital in the production function. See Solow (1960) for an analysis of the circumstances under which different vintages may be aggregated into a composite stock of physical capital.

(9) If technological progress is assumed to be exclusively labour-augmenting rather than Hicks-neutral, equation **(2)** is exactly as in the text, except that the first term of the right-hand side of the equation ($\dot{A}/A$) is preceded by an $\alpha_j(t)$. In practice, the bulk of our conclusions are robust to this specification.

(10) For example, consider a special case of equation **(1)**: the Cobb-Douglas production function $Y = A.K^{1-\alpha}.L^{\alpha}$. Under the assumption $\alpha \in (0, 1)$, diminishing marginal returns to physical capital mean that, in the absence of improvements in Total Factor Productivity A or continual increases in labour input, physical capital

In discrete time, equation **(2)** may be approximated by the following Thörnqvist-Theil Divisia index,[11]

$$\ln\left(\frac{Y_j(t+1)}{Y_j(t)}\right) = \ln\left(\frac{A_j(t+1)}{A_j(t)}\right) + (1-\bar{\alpha}_j(t)).\ln\left(\frac{K_j(t+1)}{K_j(t)}\right) + \bar{\alpha}_j(t).\ln\left(\frac{L_j(t+1)}{L_j(t)}\right) \quad \textbf{(3)}$$

where $\bar{\alpha}_j(t) \equiv \{\alpha_j(t) + \alpha_j(t+1)\}/2$.

While TFP constitutes a measure of the efficiency with which both labour and physical capital are employed, it does impose greater theoretical restrictions on the data than labour productivity. In terms of the present analysis, the key assumptions are perfect competition and constant returns to scale. In principle, each of these assumptions may be relaxed: Hall (1988) introduces imperfect competition into the analysis, while Caballero and Lyons (1989) and Oulton (1996) extend the analysis to admit linear homogeneity of degree γ.

In the remainder of this paper, we adopt a dual approach to measuring rates of productivity growth (and, later on, levels of productivity). First, we estimate rates of growth of TFP under the assumptions of perfect competition and constant returns to scale - a common benchmark throughout the empirical literature. Second, we present information on (relatively atheoretic but somewhat less informative) rates of growth of labour productivity. If the estimates of TFP growth based on the assumptions of perfect competition and constant returns to scale yielded radically different information to the figures for labour productivity growth, one might be more concerned about the validity of these assumptions than otherwise. But, in fact, all of the main conclusions of the paper are robust to the use of either labour or total factor measures of productivity.

Throughout the analysis, it is important to note that, since TFP growth is determined simply as a residual, it encompasses the effect

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accumulation will ultimately cease.

(11) See for example, Thörnqvist (1936) and Solow (1957).

of all influences on the efficiency with which factors of production are employed (for example, changes in trade union law and practice, the degree of capacity utilisation, or managerial efficiency). By construction, it is not simply a measure of the rate of technological progress. Nonetheless, in the long run, it is plausible and consistent with a wide range of econometric evidence that the rate of technological progress is the prime determinant of rates of TFP growth.

Table B (Panels 1 to 3) presents the results of implementing equation **(3)** for UK manufacturing. The rate of growth of value-added is decomposed into the contributions of increased hours worked, capital accumulation and TFP growth.[12] These estimates of productivity growth rates may be compared with the figures for labour productivity growth presented in Table A. The fall in average annual hours worked in manufacturing sectors noted in the context of the discussion of labour productivity growth above is reflected in the negative contribution from hours worked in all 19 industries throughout both the entire sample period and each of the two peak-to-peak business cycle periods (with the exceptions of Motor Vehicles in the period 1973-79 and Computing in 1979-89). The average contribution of physical capital accumulation to output growth is positive in 17 industries throughout the entire sample period (the exceptions are Textiles & Clothing and Aerospace), and the period as a whole was characterised by a rising capital:output ratio in all industries.

Although value-added in total manufacturing fell at an average annual rate of 0.18% between 1970-92, TFP rose at 1.38%. Again, there is considerable variation in rates of productivity growth across manufacturing sectors. In the entire sample period, average annual rates of TFP growth ranged from 5.67% and 4.17% in Computing and Aerospace respectively to -1.06% and -0.26% in Minerals and Food & Drink respectively (the interpretation of negative measured rates of TFP growth is discussed further below).

[12] Again, details concerning data sources and definitions are contained in the Annex.

Table B (Panel 1)
Sources of output growth in UK manufacturing, 1970-92
All figures expressed as percentage rates of growth

Industry	Value-added	Labour	Capital	TFP
Total Manufacturing	-0.18	-2.16	0.60	1.38
Food & Drink	-0.23	-1.16	1.19	-0.26
Textiles & Clothing	-1.49	-3.13	-0.12	1.76
Timber & Furniture	-0.71	-1.84	0.86	0.27
Paper & Printing	0.88	-1.43	0.99	1.32
Minerals	-2.33	-2.11	0.84	-1.06
Chemicals	1.40	-1.11	0.98	1.52
Chemicals nes[(a)]	0.31	-1.62	0.82	1.10
Pharmaceuticals	4.72	-0.65	1.52	3.85
Rubber & Plastics	1.24	-1.21	0.87	1.58
Basic Metal	-3.60	-5.43	0.09	1.73
Iron & Steel	-4.20	-6.46	0.04	2.22
Non-ferrous Metals	-1.93	-3.40	0.27	1.20
Fabricated Metal	-0.01	-2.56	0.48	2.07
Metal Goods nes[(a)]	-1.01	-2.71	0.31	1.39
Machinery	-1.54	-2.74	0.48	0.72
Computing	7.62	-1.17	3.12	5.67
Electrical Machinery	0.80	-2.44	0.84	2.41
Other Electrical	-0.31	-2.63	0.63	1.68
Electronics	1.91	-2.28	1.18	3.01
Motor Vehicles	-1.22	-2.72	0.56	0.93
Aerospace	2.58	-1.52	-0.07	4.17
Instruments	2.16	-1.67	0.88	2.95
Other Manufacturing	-1.38	-2.69	0.03	1.27

Source: see Annex. Estimates corrected for double-counting of R&D.
[(a)] nes: not elsewhere specified.

Table B (Panel 2)
Sources of output growth in UK manufacturing, 1973-79
All figures expressed as percentage rates of growth

Industry	Value-added	Labour	Capital	TFP
Total Manufacturing	-1.14	-1.08	0.947	-1.01
Food & Drink	-2.50	-0.49	1.71	-3.73
Textiles & Clothing	-2.34	-2.49	0.25	-0.10
Timber & Furniture	-2.45	-1.21	1.49	-2.73
Paper & Printing	-1.79	-0.99	0.97	-1.77
Minerals	-3.77	-1.35	1.23	-3.66
Chemicals	0.70	-0.21	1.48	-0.56
Chemicals nes[(a)]	0.50	-0.32	1.36	-0.54
Pharmaceuticals	3.95	-0.07	1.30	2.72
Rubber & Plastics	-0.50	-0.28	1.28	-1.50
Basic Metal	-6.59	-1.94	0.72	-5.37
Iron & Steel	-9.19	-2.23	0.67	-7.64
Non-ferrous Metals	-0.95	-1.28	0.49	-0.15
Fabricated Metal	0.25	-1.01	0.66	0.61
Metal Goods nes[(a)]	-0.35	-1.30	0.68	0.27
Machinery	1.49	-0.79	1.01	1.27
Computing	4.47	-3.10	1.46	6.11
Electrical Machinery	0.11	-1.41	0.97	0.55
Other Electrical	-0.63	-0.99	0.88	-0.52
Electronics	0.87	-1.96	1.10	1.73
Motor Vehicles	-0.35	0.01	0.55	-0.91
Aerospace	-3.75	-1.13	-1.28	-1.34
Instruments	3.32	-0.58	1.04	2.87
Other Manufacturing	-1.04	-1.13	0.61	-0.53

Source: see Annex. Estimates corrected for double-counting of R&D.
[(a)] nes: not elsewhere specified.

Table B (Panel 3)
Sources of output growth in UK manufacturing, 1979-89
All figures expressed as percentage rates of growth

Industry	Value-added	Labour	Capital	TFP
Total Manufacturing	0.99	-2.44	0.33	3.10
Food & Drink	0.52	-1.32	0.77	1.07
Textiles & Clothing	-0.47	-3.31	-0.37	3.21
Timber & Furniture	0.52	-1.17	0.48	1.21
Paper & Printing	2.18	-1.35	1.02	2.51
Minerals	-0.02	-1.95	0.53	1.39
Chemicals	2.64	-1.43	0.58	3.49
Chemicals nes[a]	1.90	-2.43	0.38	3.95
Pharmaceuticals	4.96	-0.89	1.70	4.14
Rubber & Plastics	2.66	-1.31	0.40	3.57
Basic Metal	1.14	-7.79	-0.46	9.39
Iron & Steel	1.62	-9.58	-0.51	11.71
Non-ferrous Metals	-0.12	-4.44	0.00	4.32
Fabricated Metal	0.81	-2.98	0.38	3.41
Metal Goods nes[a]	-0.79	-3.03	0.01	2.22
Machinery	-1.69	-3.37	0.22	1.46
Computing	12.29	0.16	4.06	8.06
Electrical Machinery	1.67	-2.06	0.80	2.93
Other Electrical	0.33	-2.22	0.42	2.12
Electronics	2.86	-1.91	1.43	3.34
Motor Vehicles	-0.78	-4.60	0.63	3.20
Aerospace	7.39	-0.81	0.67	7.53
Instruments	1.32	-1.85	0.75	2.42
Other Manufacturing	-2.65	-3.22	-0.39	0.95

Source: see Annex. Estimates corrected for double-counting of R&D.
[a] nes: not elsewhere specified.

The change in rates of TFP growth between the two peak-to-peak business cycle periods is equally noticeable. Between 1973-79, TFP in total manufacturing actually fell at an average annual rate of 1.01% (with 13 of the 19 industries experiencing falls); while, between 1979-89, it rose at an average annual rate of 3.10% (with none of the 19 industries experiencing falls). Particularly noteworthy is the change in fortunes of the Iron & Steel industry. The latter experienced negative measured TFP growth in the first peak-to-peak business cycle and the most rapid (positive) rate of TFP growth in the second (with Computing and Aerospace enjoying the next highest rates of growth).

It is implausible that negative measured rates of TFP growth reflect technological regress. There are a number of problems in measuring the capital stock (see, for example, Muellbauer (1991)), and these negative estimates for TFP growth may reflect measurement error. But, as argued earlier, it is important to realise that TFP growth is essentially a residual. As such, it includes the influence of a wide range of phenomena (besides technological progress) that affect the efficiency with which factors of production are employed. Once one recognises this, negative measured TFP growth for certain time periods and industries actually becomes quite plausible.

For example, it seems reasonable that many manufacturing industries experienced decreases in technical efficiency in the 1970s - a period characterised by temporary factor hoarding, the costly adjustment of production processes to oil price rises, and an increase in the extent to which trade union power was exercised. In principle, it is straightforward to make allowances both for cyclical factors distorting TFP in the short run and for factors of long-run significance - such as the degree of trade union power (see, for example, Cameron, Proudman and Redding (1997), in which such allowances are made within the context of a more detailed econometric specification). In this paper, however, we wish to examine the underlying data while imposing as little structure upon the data as possible.

Moreover, even if there are particular problems associated with the measurement of TFP, it is important to note that the main qualitative features of the data (in particular, the change in performance between the two peak-to-peak business cycle periods) and the variation in productivity growth rates across sectors were confirmed in the analysis of labour productivity growth in Table A.[13]

The decomposition in equation **(2)** may be also used to evaluate the relative size of the different contributions (eg those of capital accumulation and TFP growth) to output growth. The conclusions here should be viewed as somewhat more tentative, as they are likely to be more sensitive to the assumptions invoked in the calculation of TFP growth and to measurement error. In the entire sample period, the positive contribution of TFP growth to value-added growth (or rather to limiting the fall in value-added) exceeded that of physical capital accumulation for 16 of the 19 industries, as well as for manufacturing as a whole. Particularly noteworthy is the increase in the size of the contribution to value-added growth originating from rises in TFP relative to that from capital accumulation between the first and the second peak-to-peak business cycles. The very size of this increase suggests that one would need substantial changes in the assumptions made, or significant amounts of measurement error, to overturn this result.

2.4 Linking labour and Total Factor Productivity growth

Equation **(2)** may also be used to decompose the rate of growth of labour productivity into the contributions of Total Factor Productivity (TFP) growth and rises in the capital:labour ratio, so that the two measures of productivity growth may be explicitly related to one another. From **(2)**,

$$\frac{\dot{Y/L}}{Y/L} = \frac{T\dot{F}P}{TFP} + (1-\alpha_j).\frac{\dot{K/L}}{K/L} \qquad \mathbf{(4)}$$

where a discrete time analogue of equation **(4)** holds for **(3)**.

The results of undertaking such a decomposition for UK manufacturing are presented in Table C (Panels 1 to 3), though the conclusions here are again more tentative.

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[13] The Spearman rank correlation coefficient across sectors between time-averaged labour productivity growth and time-averaged total factor productivity growth (time-averaged for the entire sample period) is 0.93.

Table C (Panel 1)
Sources of labour productivity growth, 1970-92
All figures expressed as percentage rates of growth

Industry	Y/L	K/L	TFP
Total Manufacturing	3.23	1.85	1.38
Food & Drink	2.12	2.38	-0.26
Textiles & Clothing	2.96	1.20	1.76
Timber & Furniture	1.79	1.51	0.27
Paper & Printing	3.03	1.71	1.32
Minerals	1.39	2.45	-1.06
Chemicals	3.62	2.10	1.52
Chemicals nes[(a)]	3.27	2.17	1.10
Pharmaceuticals	6.33	2.48	3.85
Rubber & Plastics	2.84	1.26	1.58
Basic Metal	3.11	1.38	1.73
Iron & Steel	3.22	1.00	2.22
Non-ferrous Metals	2.87	1.67	1.20
Fabricated Metal	3.64	1.57	2.07
Metal Goods nes[(a)]	2.78	1.39	1.39
Machinery	2.47	1.75	0.72
Computing	9.39	3.71	5.67
Electrical Machinery	4.32	1.91	2.41
Other Electrical	3.39	1.71	1.68
Electronics	5.20	2.19	3.01
Motor Vehicles	2.48	1.55	0.93
Aerospace	4.61	0.44	4.17
Instruments	4.52	1.57	2.95
Other Manufacturing	2.54	1.27	1.27

Source: see Annex. Estimates corrected for double-counting of R&D.
[(a)] nes: not elsewhere specified.

Table C (Panel 2)
Sources of labour productivity growth, 1973-79
All figures expressed as percentage rates of growth

Industry	Y/L	K/L	TFP
Total Manufacturing	0.50	1.50	-1.01
Food & Drink	-1.61	2.12	-3.73
Textiles & Clothing	1.24	1.34	-0.10
Timber & Furniture	-0.74	1.98	-2.73
Paper & Printing	-0.40	1.38	-1.77
Minerals	-1.36	2.29	-3.66
Chemicals	1.09	1.65	-0.56
Chemicals nes[a]	1.02	1.56	-0.54
Pharmaceuticals	3.78	1.06	2.72
Rubber & Plastics	-0.15	1.35	-1.50
Basic Metal	-4.09	1.27	-5.37
Iron & Steel	-6.55	1.09	-7.64
Non-ferrous Metals	1.06	1.21	-0.15
Fabricated Metal	1.64	1.04	0.61
Metal Goods nes[a]	1.52	1.25	0.27
Machinery	2.75	1.48	1.27
Computing	10.86	4.75	6.11
Electrical Machinery	2.00	1.45	0.55
Other Electrical	0.69	1.21	-0.52
Electronics	3.42	1.69	1.73
Motor Vehicles	-0.40	0.51	-0.91
Aerospace	-2.61	-1.28	-1.34
Instruments	4.10	1.24	2.87
Other Manufacturing	0.44	0.96	-0.53

Source: see data annex. Estimates corrected for double-counting of R&D
[a] nes: not elsewhere specified.

Table C (Panel 3)
Sources of labour productivity growth, 1979-89
All figures expressed as percentage rates of growth

Industry	Y/L	K/L	TFP
Total Manufacturing	4.68	1.59	3.10
Food & Drink	3.12	2.05	1.07
Textiles & Clothing	4.03	0.82	3.21
Timber & Furniture	1.98	0.76	1.21
Paper & Printing	4.05	1.54	2.51
Minerals	3.29	1.90	1.39
Chemicals	5.36	1.87	3.49
Chemicals nes[a]	6.09	2.14	3.95
Pharmaceuticals	7.02	2.88	4.14
Rubber & Plastics	4.06	0.50	3.57
Basic Metal	10.03	0.65	9.39
Iron & Steel	11.55	-0.15	11.71
Non-ferrous Metals	5.92	1.60	4.32
Fabricated Metal	4.94	1.53	3.41
Metal Goods nes[a]	3.17	0.95	2.22
Machinery	3.03	1.57	1.46
Computing	11.00	2.94	8.06
Electrical Machinery	4.59	1.66	2.93
Other Electrical	3.36	1.23	2.12
Electronics	5.66	2.32	3.34
Motor Vehicles	5.57	2.37	3.20
Aerospace	8.43	0.90	7.53
Instruments	3.77	1.35	2.42
Other Manufacturing	1.73	0.77	0.95

Source: see Annex. Estimates corrected for double-counting of R&D.
[a] nes: not elsewhere specified.

In total manufacturing in the entire sample period, capital accumulation and TFP growth made contributions of 60% and 40% respectively to the observed increase in labour productivity. Again, there are important variations across industries and time. For example, TFP growth accounted for only 15.1% of the 1.79% average annual rate of growth of labour productivity in Timber & Furniture in the sample period. In general, the contribution of capital accumulation relative to that of TFP growth is much higher in the first peak-to-peak business cycle than in the second. Between 1979-89, TFP growth accounted for 66.2% of the 4.68% average annual rate of growth of labour productivity in total manufacturing, whereas, in the years 1973-79, TFP growth actually made a negative contribution to labour productivity growth.

2.5 Summary

The decline in the size of the UK manufacturing sector (measured in terms of either constant price value-added or hours worked) was associated with considerable variations in rates of growth of value-added and hours worked across manufacturing sectors. Hence, the decline in the overall size of UK manufacturing was associated with substantial changes in the relative importance of individual sectors (measured in terms of either shares of constant price value-added or hours worked).

Rates of productivity growth, whether measured by either labour productivity or TFP, also exhibited considerable variation across manufacturing sectors, with a strong degree of correlation between the two measures. Equally noteworthy was the variation in rates of growth of labour productivity and TFP over time, with the second peak-to-peak business cycle generally characterised by higher rates of productivity growth, however measured. Finally and more tentatively, there was an increase in the fraction of output and labour productivity growth explained by TFP growth relative to that accounted for by capital accumulation between the two peak-to-peak business cycles.

These findings may be simply the result of fundamental differences in the nature of the technologies between the two periods and between different industries, or may instead be the result of changing economic forces at work in these industries (eg unionisation, R&D spending, human capital, openness to international trade) - a question we seek to address in Cameron, Proudman and Redding (1997)).

3 Changes in sectoral composition

The previous section has been concerned with the nature of economic growth within the UK manufacturing sector. This section seeks to relate the experience of individual industries to the behaviour of total manufacturing. Taking the UK manufacturing sector on its own,[14] there are two possible sources for productivity growth in total manufacturing: reallocations of resources from low to high-productivity sectors (between-sector reallocations) and productivity growth within individual industries (within-sector productivity growth). The analysis in the previous section shows that there have been considerable changes in the relative importance of different manufacturing sectors (measured by either shares of value-added or hours worked). This section considers the implications of these changes for productivity in total manufacturing.

Labour productivity in aggregate manufacturing $Y/L = \sum_j Y_j/L$ at any point in time t may be expressed as a weighted sum of labour productivity in individual manufacturing industries,

$$\frac{Y(t)}{L(t)} = \sum_j \omega_j^L \cdot \frac{Y_j(t)}{L_j(t)}, \qquad \omega_j^L \equiv \frac{L_j(t)}{L(t)} \tag{5}$$

where the weights ω_j^L are equal to each sector's share in total hours worked.

Taking first differences, **(5)** may be expressed as the sum of within-sector productivity growth and changes between sectors in the share of hours worked ,[15]

[14] For a whole-economy analysis at a more aggregate level for the OECD, see Bernard and Jones (1996a).

[15] Bernard and Jones (1996c) undertake a similar decomposition for states within the United States.

$$\triangle\left(\frac{Y}{L}\right) = \underbrace{\sum_j \triangle\left(\frac{Y_j}{L_j}\right).\omega_j^L(t-1)}_{\text{'within effect'}} + \underbrace{\sum_j \triangle\omega_j^L.\frac{Y_j(t-1)}{L_j(t-1)}}_{\text{'between effect'}} \qquad \textbf{(6)}$$

Following Bernard and Jones (1996a), a similar decomposition may be undertaken for TFP growth in aggregate manufacturing. Assuming that the production process in each manufacturing sector j is characterised by a common, time-invariant, Cobb-Douglas production technology,[16] then TFP in aggregate manufacturing may be expressed as,

$$TFP = \frac{Y}{K^{1-\alpha}L^{\alpha}} = \sum_j \omega_j^{TFP}.\frac{Y_j}{K_j^{1-\alpha}L_j^{\alpha}} \qquad \textbf{(7)}$$

$$\text{where} \qquad \omega_j^{TFP} \equiv \left(\frac{K_j}{K}\right)^{1-\alpha}\left(\frac{L_j}{L}\right)^{\alpha}$$

Taking first differences in **(7)**, we obtain an analogous within-between decomposition,

$$\triangle TFP = \underbrace{\sum_j \triangle TFP_j.\omega_j^{TFP}(t-1)}_{\text{'within effect'}} + \underbrace{\sum_j \triangle\omega_j^{TFP}.TFP_j(t-1)}_{\text{'between effect'}}, \qquad \textbf{(8)}$$

The results of undertaking these decompositions for both labour productivity and TFP growth in UK manufacturing are presented in Table D.[17] As much as 97% of the growth in labour productivity in total manufacturing in the sample period was found to be explained by within-sector productivity growth. The corresponding figure for TFP was somewhat smaller (91%), but again within-sector productivity growth accounted for the vast majority of productivity growth in aggregate manufacturing.

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[16] Note that this imposes a more restrictive form for the production function than needed to be assumed in the earlier analysis.

[17] Note that, in this case, total manufacturing is defined so as to exclude shipbuilding.

Table D
'Within' and 'between' decompositions for labour and Total Factor Productivity.[a]

Industry	Between	Within	Total
Aggregate $\frac{Y}{L}$ growth	3.0	97.0	100
Aggregate TFP growth	9.2	90.8	100
Contributions of sectors to aggregate TFP growth			
Food & Drink	12.1	2.1	14.2
Textiles & Clothing	-8.5	9.8	1.4
Timber & Furniture	2.6	-0.7	1.8
Paper & Printing	11.2	9.0	20.2
Minerals	-0.6	-5.0	-5.7
Chemicals nes[b]	1.5	9.3	10.8
Pharmaceuticals	2.1	10.0	12.2
Rubber & Plastics	4.7	4.5	9.2
Iron & Steel	-9.7	-0.4	-10.1
Non-ferrous Metals	-1.4	0.8	-0.6
Metal Goods nes[b]	-2.7	4.7	2.0
Machinery	-5.5	2.7	-2.8
Computing	2.1	8.6	10.8
Other Electrical	0.1	3.9	4.0
Electronics	2.3	9.6	11.9
Aerospace	-1.0	17.6	16.5
Motor Vehicles	0.1	0.3	0.4
Instruments	1.1	2.6	3.8
Other Manufacturing	-1.2	1.3	0.1

[a] Figures may not sum exactly across columns due to rounding. The results in Table D are not strictly comparable with those in, for example, Tables B and C. In Table D, TFP is calculated using fixed (rather than Divisia) input weights.
[b] nes: not elsewhere specified.

Therefore, despite substantial changes in the relative size of individual manufacturing sectors,[18] the reallocation of resources between sectors has not been an important source of aggregate productivity growth in the sample period. This finding suggests that hypotheses for aggregate manufacturing performance should concentrate on explaining productivity growth within individual sectors, rather than switches in factor resources between sectors with differing levels of productivity.

Interestingly, over 95% of the TFP growth in total manufacturing is explained by productivity growth (the sum of the 'within' and 'between' effects) in seven of the 19 industries: Food & Drink, Paper & Printing, Chemicals not elsewhere specified, Pharmaceuticals, Computing, Electronics and Aerospace (which, averaged for the sample period, account for less than 44% of total value-added).[19]

4 Productivity levels

But, productivity growth rates (whether measured by labour productivity or TFP) are not the only potential subjects of interest: one might also be concerned about productivity levels. The level of labour productivity at any time is measured simply by value-added per hour worked (Y/L). Table E presents information on average values of the latter relative to the manufacturing mean ($\widetilde{Y/L}$), for each of the 19 manufacturing industries, during both the entire sample period and the two peak-to-peak business cycles. The final two rows of the table report the manufacturing mean level of labour productivity and the value for total manufacturing.

(18) For the entire sample period, the average across sectors for the absolute values for the cumulative change in the weights ω_j^L and ω_j^{TFP} were 23.5% and 18.7% respectively.

(19) The sources of aggregate labour productivity growth are somewhat less concentrated. The industries that made the seven largest contributions to aggregate labour productivity growth were Food & Drink, Textiles & Clothing, Paper & Printing, Chemicals not elsewhere specified, Machinery, Electronics and Aerospace. Together, these account for 61% of the cumulative growth in labour productivity and (on average for the entire sample period) constitute 60% of total value-added.

Table E

Labour productivity relative to manufacturing mean $\widetilde{Y/L}$

Value-added per hour worked.

Industry	1970-92	1973-79	1979-89
Food & Drink	0.98	1.07	0.91
Textiles & Clothing	0.49	0.51	0.47
Timber & Furniture	0.70	0.82	0.63
Paper & Printing	0.99	1.05	0.94
Minerals	1.05	1.21	0.96
Chemicals nes[a]	1.48	1.56	1.47
Pharmaceuticals	2.07	1.85	2.13
Rubber & Plastics	0.79	0.85	0.74
Iron & Steel	0.88	0.75	0.89
Non-ferrous Metals	0.96	1.03	0.93
Metal Goods nes[a]	0.68	0.75	0.65
Machinery	0.83	0.93	0.79
Computing	2.06	1.49	2.53
Other Electrical	0.72	0.76	0.70
Electronics	0.90	0.80	0.99
Motor Vehicles	0.84	0.91	0.81
Aerospace	1.17	1.15	1.10
Instruments	0.73	0.75	0.74
Other Manufacturing	0.67	0.78	0.61
Mean	**8.33**	**6.21**	**9.24**
Total Manufacturing	**7.04**	**5.61**	**7.62**

[a] nes: not elsewhere specified.

As is immediately clear from Table E, there is considerable variation in productivity levels across industries. During the entire sample period, average labour productivity ranges from a low of 0.49 times the manufacturing mean (£8.33 per hour worked) in Textiles & Clothing to a high of 2.07 times the manufacturing mean in Pharmaceuticals.[20] Furthermore, as a result of the cross-section variation in rates of labour productivity growth documented in Tables A and C, the relative ranking of industries in terms of labour productivity levels exhibits a number of changes during the sample period. For example, Computing overtakes Pharmaceuticals to become the sector with the highest level of labour productivity between the two peak-to-peak business cycles.

The next section will be concerned with productivity dynamics: the evolution of productivity levels across industries over time. The analysis will be concerned both with intra-distribution dynamics (how the productivity levels in industries move relative to one another, an issue informally touched on above) and changes in the external shape of the productivity distribution (whether, for example, it becomes increasingly single-peaked, exhibits more/less dispersion around the mean, or is characterised by increasing/decreasing skewness).

But, we begin by simply graphing the distribution of labour productivity levels across industries at the beginning and end of the sample period in Charts 1 and 2. The industries in the two charts are sorted in terms of increasing labour productivity in 1970 and 1992 respectively, so that the order of industries in each figure is not necessarily the same. In 1970, labour productivity was relatively uniformly distributed across industries; however, by the end of the sample period, it had become increasingly positively skewed across industries.[21] This

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[20] The values for mean value-added per hour worked in manufacturing (£8.33) and the figure for total manufacturing (£7.04) compare with whole economy GDP per hour worked of approximately £8.32 (based upon constant price (1985) GDP at factor cost of £307,902 million, workforce in employment of 24,712 million and an average of 1,498 worker hours per year). At first sight, it may seem surprising that labour productivity in total manufacturing is below that for whole economy. But, it must be remembered that this is labour productivity, and GDP includes a number of industries with very high capital intensity (eg agriculture and mining). Note also that the labour input for manufacturing has been adjusted for employment in R&D, but the whole-economy figure has not.

[21] One measure of skewness is the statistic ξ = (mean-median)/standard deviation, where $\xi \in [-1, 1]$ and a value of 0 implies that the distribution is neither

is shown even more clearly in Charts 3 and 4, where the space of values of labour productivity is divided into six discrete cells, and a histogram is drawn of the frequency distribution of industries across cells.

In order to arrive at a measure of the level of TFP in each year of the sample period, the minimal further step that needs to be taken is to combine the measured rates of growth, discussed in Section 2, with an estimate of the level of TFP in a base year. In the present case, we take 1985 as the base year and estimate the level of productivity by assuming, following Bernard and Jones (1996b), that the production process in that year may be characterised by the following Cobb-Douglas technology,

$$Y_j(t) = A_j(t).K_j(t)^{1-\alpha_j(t)}.L_j(t)^{\alpha_j(t)}, \qquad 0 < \alpha(j) < 1 \quad \forall j \qquad \textbf{(9)}$$

where, under the assumptions of perfect competition and constant returns to scale, the production function coefficient $\alpha(j)$ equals labour's share in value-added in sector j in the base year.

The Thörnqvist-Theil estimates of TFP growth rates in Section 2 are then cumulated to obtain a measure of TFP levels in each manufacturing industry for each year of the sample period.(22) The results of this exercise are shown in Table F, which presents measures of time-averaged levels of TFP relative to the manufacturing mean ($\widetilde{TFP}$), for each industry, for both the entire sample period and each peak-to-peak business cycle. The final two rows of the table again give the manufacturing mean level of productivity and the value for total manufacturing. Note that TFP is not measured in the same units as labour productivity, and that absolute values of productivity are therefore not directly comparable between Tables E and F.

positively nor negatively skewed. In 1970, the value of this statistic associated with the distribution of labour productivity is 0.025; by 1992, this had risen to 0.28.

(22) This methodology is clearly less restrictive than assuming that the production process in each year is characterised by a Cobb-Douglas technology.

Chart 1

Labour productivity relative to mean, 1970

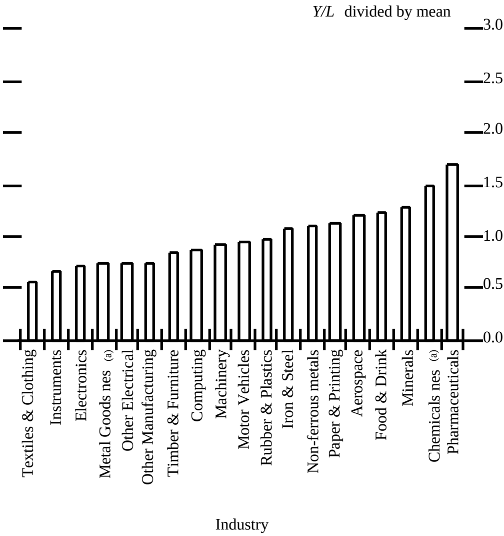

Chart 2

Labour productivity relative to mean, 1992

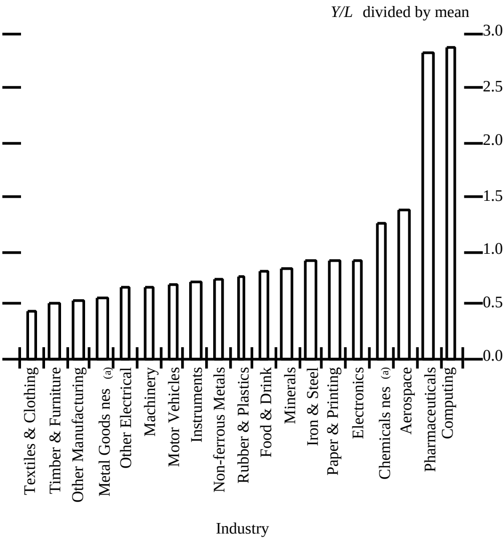

Chart 3

Frequency distribution of labour productivity relative to mean, 1970

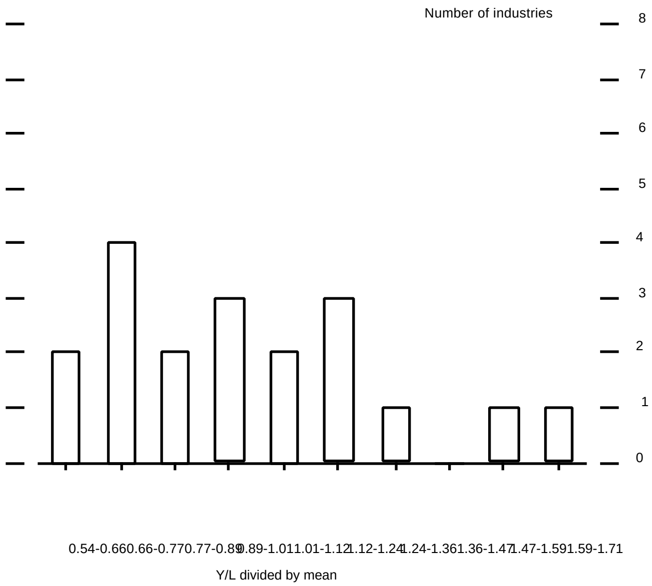

Chart 4

Frequency distribution of labour productivity relative to mean, 1992

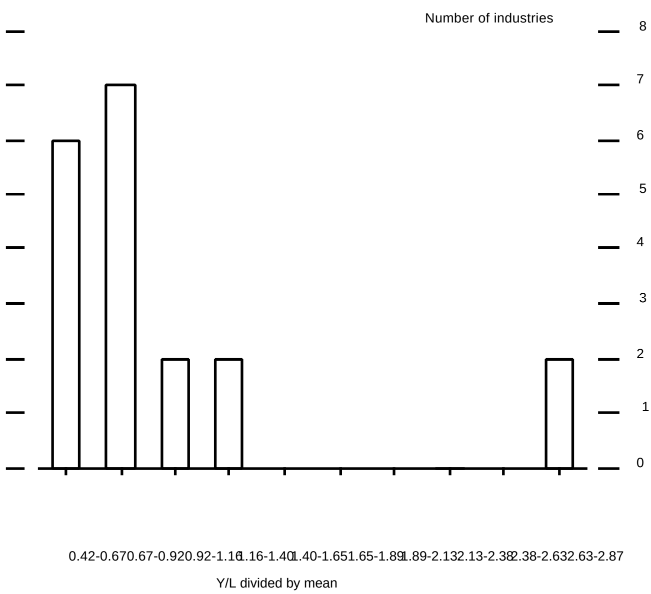

Table F

Total Factor Productivity relative to manufacturing mean $\widetilde{\mathbf{TFP}}$

Value-added per weighted unit of factor input)

Industry	1970-92	1973-79	1979-89
Food & Drink	1.22	1.36	1.08
Textiles & Clothing	0.35	0.36	0.34
Timber & Furniture	0.71	0.81	0.63
Paper & Printing	0.78	0.82	0.73
Minerals	1.11	1.31	0.97
Chemicals nes[a]	1.09	1.18	1.04
Pharmaceuticals	2.28	2.20	2.28
Rubber & Plastics	0.62	0.64	0.57
Iron & Steel	0.41	0.31	0.43
Non-ferrous Metals	0.71	0.76	0.68
Metal Goods nes[a]	0.50	0.54	0.47
Machinery	0.66	0.75	0.62
Computing	4.21	3.60	4.75
Other Electrical	0.43	0.45	0.42
Electronics	1.01	0.95	1.10
Motor Vehicles	0.44	0.49	0.42
Aerospace	1.28	1.18	1.31
Instruments	0.49	0.50	0.50
Other Manufacturing	0.69	0.80	0.62
Mean	**49.65**	**41.36**	**53.02**
Total Manufacturing	**36.98**	**33.20**	**37.87**

[a] nes: not elsewhere specified.

TFP also exhibits substantial variations across industries. During the entire sample period, average TFP ranges from a low of 0.35 times the manufacturing mean in Textiles & Clothing to a high of 4.21 times the manufacturing mean in Pharmaceuticals. In fact, the extent of dispersion in levels of productivity relative to the manufacturing mean, as measured by the sample standard deviation, is greater for TFP than for labour productivity (averaged for the whole sample period, the sample standard deviation takes the values of 0.92 and 0.47 respectively). As is to be expected, levels of TFP and labour productivity are highly (though not perfectly) positively correlated across industries (correlating time-averaged values of the two measures of productivity across industries, the Spearman rank correlation coefficient is 0.88); so that industries with high levels of TFP tend to be those with high levels of labour productivity (there are obvious exceptions, related to capital intensity - examples are Iron & Steel and Motor Vehicles, both with much smaller values of $\widetilde{TFP}$ than of $\widetilde{Y/L}$).[23]

As a result of the cross-section variation in rates of TFP growth documented in Tables B and C, the relative ranking of industries in terms of TFP exhibits some changes during the sample period (though fewer than for labour productivity, as will be shown more formally below). Computing and Pharmaceuticals remain the industries with the highest and second-highest levels of TFP respectively in every year of the sample period. Charts 5 and 6 graph the distribution of TFP levels across industries at the beginning and end of the sample period (again the industries in each chart are sorted in ascending order of productivity, so that the ordering of the industries is not necessarily the same in each chart). In Charts 7 and 8, the space of productivity values is divided into ten discrete cells, and a histogram of the frequency distribution of industries is drawn.

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(23) The high degree of correlation is unsurprising, since if the shares of labour and capital in value-added are constant over time (as they will be, for example, in the special case of a Cobb-Douglas production technology), $\log TFP$ is simply a weighted average of $\log(Y/L)$ and $\log(K/L)$,

$$\log A = \alpha . \log(Y/L) + (1-\alpha) . \log(Y/K).$$

Chart 5:
TFP relative to mean, 1970

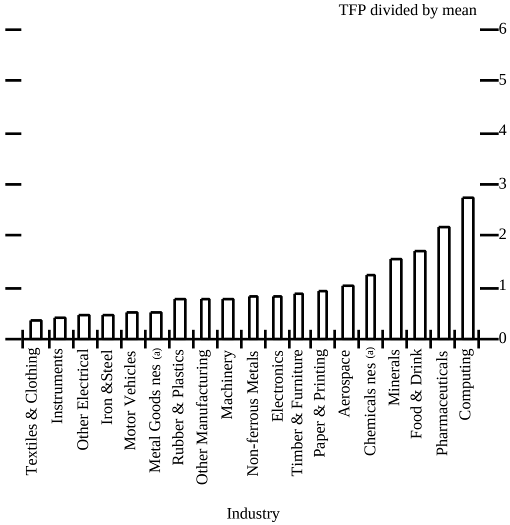


Chart 6:
TFP relative to mean, 1992

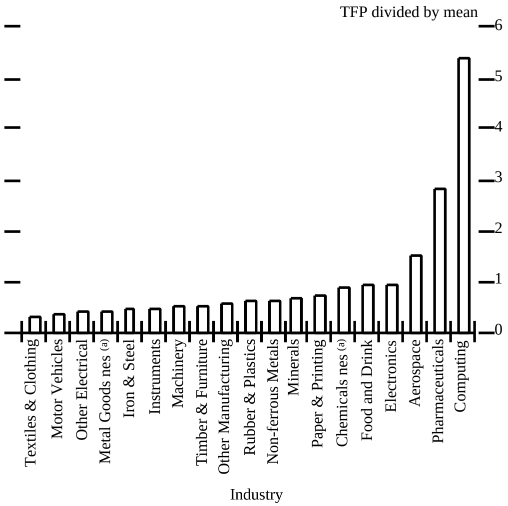


Chart 7
Frequency distribution of TFP
relative to mean, 1970

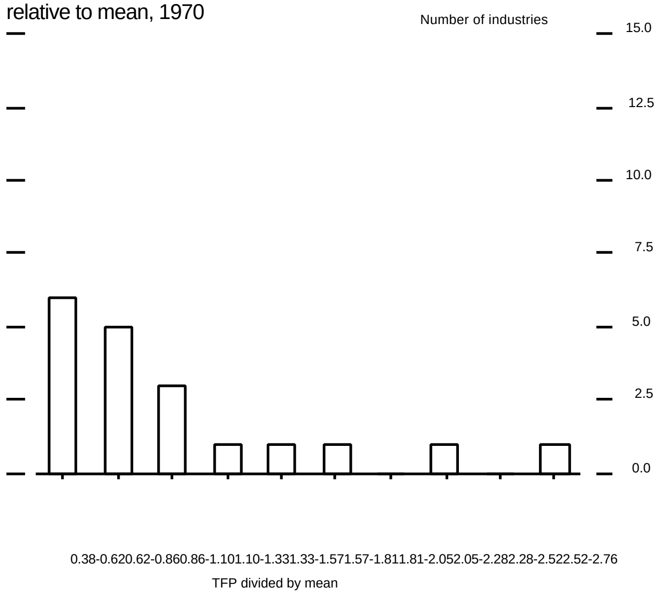
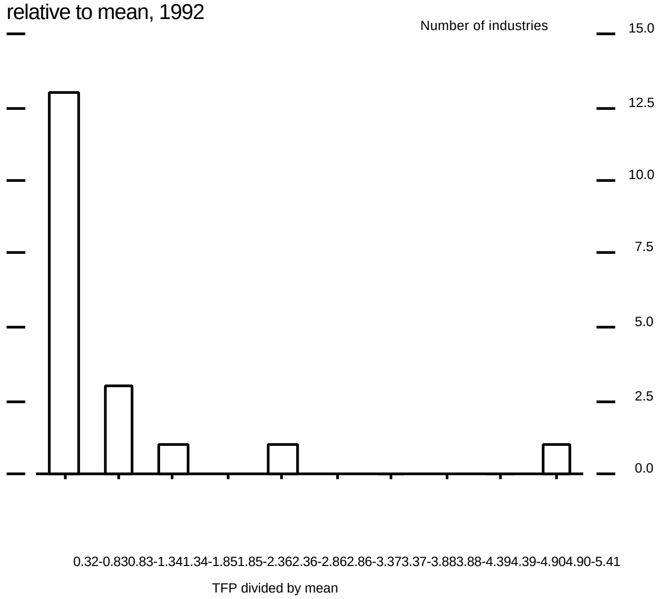


Chart 8
Frequency distribution of TFP
relative to mean, 1992



The charts provide informal evidence to suggest that the distribution of productivity across sectors becomes increasingly positively skewed during the sample period. In Section 5.2 below, we outline in more depth why one might expect to observe TFP levels either converge or diverge over time within a cross-section distribution of sectors. This informal evidence nevertheless suggests that, for at least a small sub-sector of industries, the development of technology may well be quite specific to individual sectors and does not spill over rapidly into many other manufacturing sectors. This trend in the observed distribution is also consistent with the evidence cited in Table D that aggregate TFP growth is highly concentrated in a small number of sectors.

5 Productivity dynamics

5.1 Introduction

The analysis in the previous section suggests that there have been significant changes in the distribution of both labour productivity and TFP across industries during the sample period, and this section turns to the task of modelling these productivity dynamics. A general model of productivity dynamics requires an explicit analysis of the evolution of the entire distribution of productivity across industries; an analysis that is undertaken (using techniques employed by Quah (1993b), (1996a,b,c) in the cross-country growth literature) in Section 5.3. But, we begin in Section 5.2 with two, somewhat simpler, less general, but nonetheless informative methods of analysing productivity dynamics.

5.2 Mean reversion and changes in the extent of dispersion

As noted earlier, any consideration of the evolution of productivity levels across industries over time must address two sets of questions, relating to intra-distribution dynamics on the one hand and to changes in the external shape of the productivity distribution on the other. We take each of these sets of questions in turn. When analysing intra-distribution dynamics, one question of interest (though, as we shall see in Section 5.3, it is by no means the only question) is whether productivity levels across industries exhibit mean reversion.

This question is, in turn, closely related to the issue of whether productivity levels converge or diverge across sectors in what has been described in the cross-country growth literature as the 'absolute β-convergence' sense. In the cross-country growth literature (see for example Barro and Sala-í-Martin (1991)), levels of income per capita are said to exhibit absolute β-convergence when the rate of growth of income per capita across countries is negatively correlated with the initial level of income per capita. Across countries, there are clear reasons for expecting levels of income per capita to converge: absolute β-convergence between similar economies or regions within an economy is an implication of the neoclassical, Solow-Swan model of growth and of some models of technology transfer (see, for example, Aghion and Howitt (1997), Chapter 2).

Across industries, it is less clear whether one should expect productivity levels to exhibit absolute β-convergence or absolute β-divergence, or, indeed, whether one should expect any relation at all between rates of productivity growth and initial levels. In an equilibrium with factor mobility, one would expect the marginal products of capital and labour to be equalised - which may or may not induce productivity convergence, depending on the nature of industries' production technologies. Undoubtedly, the production processes in some of these industries are very different (producing cars is very different from producing pharmaceuticals), and this in itself might lead one to expect relatively constant productivity differentials over time.

Sector-specific 'learning by doing' may be a reason to expect productivity levels actually to diverge over time. *Ceteris paribus*, industries with high initial levels of productivity will exhibit relatively high levels of employment and output, and hence relatively high rates of sector-specific learning by doing. On the other hand, if technological knowledge can be transferred across sectors, this may provide a significant force for productivity convergence. For instance, there are numerous anecdotal pieces of evidence of innovations that are first introduced in one sector and then turn out to have important applications in others. In addition, there is a wide body of econometric evidence of significant R&D spillovers across sectors: for example, Griliches and Lichtenberg (1984) estimate a direct (own-industry) rate of return to R&D of 21%-76% and an indirect rate of return (in other industries) of 41%-62%.

In the following, we test whether productivity levels across industries are reverting to or diverging from a common mean, by estimating the following cross-section regression,

$$\frac{1}{T}\sum_{s=1}^{T}\ln\left(\frac{\widetilde{x}_j(t+s)}{\widetilde{x}_j(t+s-1)}\right)=\alpha+\beta.\ln\widetilde{x}_j(t)+u_j \qquad \textbf{(10)}$$

for all $j \in \{1, ..., n\}$, where $\widetilde{x}_j(t)$ denotes the level of productivity relative to the sample mean in industry j at time t. A negative and statistically significant estimated value of β constitutes evidence of mean reversion; and a positive and statistically significant value of β provides evidence of divergence from a common mean.(24) This hypothesis is tested for both labour and total factor measures of productivity, and the results of this estimation process are displayed in Table G.

Table G
Testing for reversion to versus divergence from a common mean across industries
(standard errors in parentheses)

Variable	α	β
Y/L	-0.0051	-0.0027
	0.005	0.016
TFP	-0.0073	0.0060
	0.004	0.007

The estimated values of β are negative for labour productivity and positive for TFP. But, in each case, the estimated value of β is not statistically significantly different from zero at conventional levels of significance (10% or above). Therefore, there is no evidence that productivity levels are converging to or diverging from a common mean. One interpretation of this finding would be that intra-distribution dynamics are not important in the sample period - for example, one might

(24) This follows immediately from the fact that $\ln\widetilde{x}_j(t)$ is negative for industries with initial levels of productivity below the mean, and positive for industries with initial levels of productivity above the mean.

conclude that productivity differentials across industries simply persist over time (perhaps as a result of fundamental differences in the nature of the production process). But, as will be shown in the next section in the context of a more general analysis of productivity dynamics, this interpretation is not supported by the data.

The second aspect to productivity dynamics, introduced above, concerned changes in the external shape of the distribution of productivity across industries. When analysing changes in external shape, one (though by no means the only) issue of interest is the extent of dispersion of productivity levels across industries. This issue is related to the question of whether productivity levels converge or diverge across industries in what has been described in the cross-country growth literature as the 'σ-convergence' sense. In the cross-country growth literature (see for example Barro and Sala-í-Martin (1991)), levels of income per capita are said to exhibit σ-convergence across countries when the extent of dispersion in income per capita, as measured, for example, by the sample standard deviation, is declining over time.

This second concept of convergence is very much distinct from that of β-convergence: in particular, β-convergence does not necessarily imply σ-convergence.(25) In the cross-country context, there are again clear reasons for expecting levels of income per capita between similar economies, and regions within economies, to converge in the σ-sense (in particular, this is also an implication of the Solow-Swan, neoclassical model of growth(26)). Across industries, it is less clear whether productivity levels should converge or diverge in this second sense (for many of the same reasons enumerated above).

Table H presents information on the evolution of the sample standard deviation of productivity relative to the manufacturing mean, for both labour productivity and TFP measures. For both labour productivity

(25) Inferring from a negative correlation between rates of growth and initial levels of income per capita that the dispersion of income per capita is falling over time is an example of Galton's Fallacy (see for example Friedman (1992) and Quah (1993a)).

(26) Suppose, for example, that all economies have the same steady-state level of income in the deterministic Solow-Swan model of growth. Then from any initial distribution of income across economies (except the steady-state distribution, from which the extent of dispersion is unchanging), σ-convergence will be observed.

and TFP, there is evidence of an increase in the extent of dispersion of productivity levels across manufacturing industries over time.[27] But, just as tests for mean reversion are not, in general, complete characterisations of intra-distribution dynamics, an analysis of changes in the extent of dispersion does not, in general, reveal all information about changes in the external shape of the distribution of productivity levels. In particular, it has been completely uninformative about the marked tendency for the distribution of both labour productivity and TFP to become increasingly positively skewed during the sample period. In the next section, we therefore turn to a more general analysis of productivity dynamics, which explicitly models the evolution of the entire distribution of productivity levels across industries over time.

Table H
Changes in the extent of dispersion of productivity levels relative to the manufacturing mean in the sample period

	1970-92	1973-79	1979-89
$\widetilde{TFP}$			
Standard Deviation	0.92	0.78	1.02
$\widetilde{Y/L}$			
Standard Deviation	0.47	0.35	0.53

5.3 Modelling productivity dynamics

Following Quah (1993b), (1996a,b,c), we denote productivity relative to the manufacturing mean by the measure $\widetilde{x}$,[28] and its distribution across industries at time t by $F_t(\widetilde{x})$. Corresponding to F_t, we may define a probability measure λ_t where,

$$\forall\ \widetilde{x} \in \Re : \qquad \lambda_t((-\infty, \widetilde{x}]) = F_t(\widetilde{x})$$

The evolution of the distribution of relative productivity over time is modelled in terms of a stochastic difference equation,

(27) This result is confirmed if one evaluates the extent of dispersion in shorter intervals of time than the two peak-to-peak business cycles (eg in successive five-year periods).

(28) Thus productivity is normalised by its cross-sectional mean, just as, when analysing income dynamics in the cross-country growth literature, one typically normalises income per capita by its cross-sectional mean.

$$\lambda_t = P^*(\lambda_{t-1}, u_t), \qquad \text{integer } t \tag{11}$$

where $\{u_t : \text{integer } t\}$ is a sequence of disturbances and P^* is an operator that maps disturbances and probability measures into probability measures. In the empirical analysis that follows, we assume, for simplicity, that this stochastic difference equation is first-order and time-stationary, and we assume that transitions occur during one-year time periods.(29) Even so, equation **(11)** is intractable and cannot be directly estimated. But, setting the disturbances u to zero and iterating the stochastic difference equation forwards, we obtain,

$$\begin{aligned}
\lambda_{t+s} = P^*(\lambda_{t+s-1}, 0) &= P^*(P^*(\lambda_{t+s-2}, 0), 0) \\
&\vdots \\
&= P^*(P^*(P^* \ldots (P^*(\lambda_t, 0), 0) \ldots 0), 0) \\
&= (P^*)^s \lambda_t
\end{aligned} \tag{12}$$

If the space of possible values of productivity relative to the manufacturing mean is divided into a number of discrete cells, P^* becomes a stochastic matrix, which may be estimated by counting the number of transitions out of and into each cell.(30) By iterating this stochastic matrix forwards and taking the limit $s \to \infty$ in equation **(12)**, one may obtain the implied ergodic distribution of relative productivity. All empirical estimation was carried out using Danny Quah's TSRF econometrics package,(31) and the space of possible values of relative productivity was divided into discrete cells such that there was a roughly equal number of industry-year observations in each cell.

By explicitly modelling the evolution of the entire distribution of relative productivity, one is able to make statements concerning the probability of an industry moving from one segment of the distribution to another, and thereby obtain a more complete picture of intra-distribution

(29) These assumptions are for simplicity and can be relaxed.

(30) More generally, if one continues to treat productivity as being continuous, one may estimate the stochastic kernel associated with P^* (see for example Quah (1996c)). But, in the present application, there are too few cross-sectional units (industries) for such estimation, and hence we proceed by dividing the space of possible values of productivity into discrete cells.

(31) Responsibility for any results, opinions and errors is of course solely the authors'.

dynamics. Information concerning changes in the external shape of the distribution of relative productivity may be obtained both by directly analysing the distribution of productivity across industries at different points in time (as was done, for example, in the previous section), and from the ergodic distribution implied by the estimated transition probabilities. The latter corresponds to the limit distribution towards which relative productivity is evolving.

Tables I and J present estimates of the probability of transiting out of and into each discrete cell of the United Kingdom's distributions of relative labour productivity and TFP respectively. The interpretation of each table is as follows. The numbers in parentheses in the first column are the total number of industry/year pairs beginning in a particular cell; the first row of numbers denotes the upper endpoint of the corresponding grid cell. Thereafter, each row denotes the estimated probabilities of passing from one state into another. For example, the second row of numbers presents the probability of moving out of the lowest productivity state into the lowest, lower-intermediate, higher-intermediate and highest-productivity states successively. The final row of the upper section of each table gives the implied ergodic distribution; in the lower section of each table, the single-period transition matrix is iterated 21 times.

Table I
Transition probabilities for relative labour productivity

$\widetilde{Y/L}$	Upper endpoint			
Number	0.729	0.873	1.088	∞
(96)	0.88	0.13	0.00	0.00
(102)	0.18	0.71	0.12	0.00
(102)	0.01	0.15	0.75	0.10
(99)	0.00	0.00	0.13	0.87
Ergodic	0.389	0.265	0.198	0.148
	1 $\times$ transitions iterated 21 $\times$			
	0.4426	0.2792	0.1746	0.1036
	0.4079	0.2702	0.1902	0.1317
	0.3436	0.2524	0.2187	0.1853
	0.2753	0.2320	0.2482	0.2445

Table J
Transition probabilities for relative TFP

$\widetilde{TFP}$	Upper endpoint			
Number	0.506	0.704	1.088	∞
(99)	0.93	0.07	0.00	0.00
(98)	0.08	0.85	0.07	0.00
(102)	0.00	0.14	0.82	0.04
(100)	0.00	0.00	0.07	0.93
Ergodic	0.389	0.337	0.175	0.098
	1 $\times$ transitions iterated 21 $\times$			
	0.4801	0.3408	0.1385	0.0406
	0.3935	0.3521	0.1773	0.0772
	0.3073	0.3406	0.2114	0.1408
	0.1606	0.2649	0.2513	0.3233

Estimated values of transition probabilities close to 1 along the diagonal are indicative of persistence, while large off-diagonal terms imply greater mobility. Tables I and J suggest significant mobility in productivity levels across industries: in other words, there are important changes in relative levels of productivity across industries, particularly in the middle of the distributions. The earlier finding of no statistically significant evidence of either reversion to or diversion from a common mean conceals considerable intra-distribution dynamics. The degree of mobility is greater for relative labour productivity. Thus, the estimated probability that an industry with relative labour productivity in the 'lower intermediate' cell remains in that cell after one year is 0.71, whereas for the entire sample period this probability is only 0.27.(32)

These intra-distribution dynamics are of further interest for their implications for the evolution of the external shape of the two distributions of relative productivity. For both labour productivity and TFP, the sum of the off-diagonal terms is much greater below the diagonal than above it, implying that there is more downward than upward mobility. For example, this can be seen clearly in the case of the upper-intermediate grid cell for labour productivity: here, there is a 0.15 probability that an industry moves to the lower-intermediate cell, and only a 0.10 probability that it moves to the highest cell.

Indeed, the ergodic distributions for both measures of productivity are significantly positively skewed. From Tables I and J, each ergodic distribution contains a relatively large number of industries with productivity levels just below the mean, and a few industries with above-average productivity. A tendency for the United Kingdom's distribution of productivity across industries to become increasingly positively skewed during the sample period is also evident if one directly analyses the distribution of both relative labour productivity and TFP in each year of the sample period. This is clear from Charts 1 to 8 and from calculating the statistic $\xi =$ (mean-median)/(standard deviation)

(32) For TFP, the corresponding probabilities are 0.85 and 0.35. The greater amount of mobility in the distribution of relative labour productivity is immediately clear from a comparison of the diagonal and off-diagonal terms in the two transition probability matrices. But, this fact may also be established with the use of formal indices of mobility; for an application of these in another context, see, for example, Proudman and Redding (1997).

in each year of the sample period - see the discussion in the previous section.

In addition, and this is particularly true for TFP, the industries contained in the long right-hand tail of the productivity distribution tend to remain the same over time. For example, in all 23 years of the sample period, Computing and Pharmaceuticals are ranked first and second in terms of TFP respectively. There is more mobility in the case of labour productivity; but, even here, Computing is ranked first in eleven years and second in eleven years, while Pharmaceuticals is first in twelve years and second in four years.

In terms of the discussion earlier of whether productivity levels across manufacturing industries are converging or diverging; there is no evidence that productivity levels in industries with below average productivity are 'catching-up' with productivity levels in the lead sectors of Computing and Pharmaceuticals. There is evidence (from the estimated ergodic distributions and a direct analysis of the distribution of productivity in each year of the sample period) that an increasing number of UK industries are concentrating around (or converging at) productivity levels just below the manufacturing mean, with a few industries persistently continuing to exhibit above-average productivity.

Moreover, productivity levels in these industries do not only persistently remain above average, but actually increasingly move away from mean values during the sample period. This is evident from a comparison of Charts 1 and 2 or Charts 3 and 4, and is revealed by an analysis of the cross-section distribution of average productivity growth rates in the sample period, which is significantly positively skewed. From Charts 2 and 4, the industries where productivity levels increasingly depart from mean values are Computing, Pharmaceuticals and Aerospace. All three of these industries figure in the seven industries that Section 3 found accounted for 95% of aggregate manufacturing TFP growth. In fact, the three industries alone account for just under 40% of the TFP growth in aggregate manufacturing.

It is important to note that in stating these conclusions, we make no claims about what is driving these changes in relative levels of labour and Total Factor Productivity and draw no policy inferences.[33] Only further research will tell whether persistence of high levels of productivity in a few industries and convergence among the rest is simply the result of fundamental differences in the nature of the technologies in these industries (in which case it still remains an interesting fact), or is instead the result of economic forces at work in these industries (eg unionisation, R&D spending, human capital, openness to international trade).

6 Conclusions

This paper has been concerned with a detailed analysis of the nature of growth in 19 UK manufacturing industries in the years 1970-92. The decline in both constant price value-added and hours worked in aggregate manufacturing was found to conceal considerable heterogeneity across sectors; so that the decline in the size of the UK manufacturing sector in the sample period was accompanied by substantial changes in the relative size of individual manufacturing sectors (whether defined in terms of either shares of value-added or hours worked).

In all 19 industries, the average rate of growth of value-added exceeded that of hours worked; so that each sector enjoyed positive rates of labour productivity growth. Rates of both labour productivity and TFP growth also exhibited considerable variation across sectors; with a high degree of correlation between the two measures of productivity growth.

Furthermore, rates of growth of value-added, hours worked, labour productivity and TFP displayed sizeable variations over time. The second peak-to-peak business cycle (1979-89) was (with only one exception) characterised by higher rates of labour productivity and TFP growth than the first (1973-79). In addition, the share of value-added and labour productivity growth accounted for by increases in TFP relative to that originating in capital accumulation was higher in the second peak-to-peak cycle than in the first (though this finding is more ten-

[33] In particular, it does not necessarily follow from the analysis above that policy should be directed at increasing productivity in, for example, Textiles & Clothing to the levels in Computing and Pharmaceuticals.

tative and likely to be more sensitive to the assumptions invoked to calculate TFP growth).

Although there were substantial changes in the relative size of individual manufacturing sectors, the vast majority of productivity growth in aggregate manufacturing during the sample period (whether measured by labour productivity or TFP growth) was found to be due to within-sector productivity growth rather than between-sector reallocations of resources. The sources of TFP growth were more concentrated than those of labour productivity growth, with over 95% of TFP growth in aggregate manufacturing between 1970-92 accounted for by the sum of the 'within' and 'between' effects in seven sectors, which together constituted (on average) less than 44% of value-added.

In addition to the variation in rates of productivity growth, there were also large differences in levels of productivity (whether measured by labour productivity or TFP) across sectors. The evolution of relative levels of productivity over time was characterised in terms of both intra-distribution dynamics and changes in the external shape of the productivity distribution. In the entire sample period, levels of both labour productivity and TFP displayed no statistically significant tendency to revert to or diverge from a common mean. There was thus no evidence that productivity levels were converging / diverging across sectors in the sense of β-convergence / β-divergence used in the cross-country growth literature.

Nonetheless, this summary technique for characterising movements within a distribution concealed considerable interesting intra-distribution dynamics. An analysis of the evolution of the entire distribution of productivity across industries revealed substantial mobility in levels of relative labour productivity and TFP, with more mobility in the middle of each distribution. The extent of mobility was greatest for labour productivity; and for both measures of productivity, there was more mobility downwards than upwards.

The dispersion of levels of both labour productivity and TFP around the mean (as measured by sample standard deviation of relative productivity) was found to increase during the sample period - so that there was no evidence of productivity convergence across sectors in the

σ-convergence sense (as used in the cross-country growth literature). But, an analysis of the sample standard deviation alone was also found to conceal interesting changes in the external shape of the productivity distribution. Direct inspection of the distribution of relative productivity across industries revealed that the latter became increasingly positively skewed during the sample period. This finding was confirmed in the transition probability analysis of distribution dynamics, where the ergodic distribution was found to be significantly positively skewed. Productivity in an increasing number of UK industries appears to be converging towards levels just below the manufacturing mean. A few sectors have continued to enjoy persistently above-average productivity growth; and, during the sample period, their productivity levels have risen further away from mean values.

Thus, a detailed, disaggregated analysis of growth within UK manufacturing has revealed a number of stylised facts about productivity growth (whether measured in terms of either labour productivity or TFP). These stylised facts are not only of interest in themselves, but important in informing subsequent research into the explanations for the UK manufacturing sector's performance in the 1970s and 1980s (see, for example, Cameron, Proudman and Redding (1997)).

Annex

A Data definitions and sources

Value-added: Value-added is gross value-added at factor cost from the Census of Production. This is equal to gross output minus purchases; minus increases in stocks of materials, stores and fuel; minus the cost of industrial and non-industrial services. Spending on R&D intermediate goods was added back in to remove the 'expensing bias' discussed by Schankerman (1981). Gross value-added was deflated by the producer prices (output) index, to give a single-deflated value-added index.

Since value-added is essentially gross output minus intermediates and the time-series profiles for the price indices associated with these components may be different, it follows that theoretically one should deflate gross output and intermediates separately in each industry and then subtract the resulting constant price series from one another (double deflation). But, we are concerned about the quality of intermediate input deflators at the disaggregated level within UK manufacturing, and therefore follow a number of other authors (see, for example, van Ark (1996)) in using single-deflated value-added. Cameron (1997) calculates double-deflated value-added for total manufacturing (at which level intermediate input deflators may be more accurately measured). Although there are clearly differences, the time-series profile of the double-deflated measure is broadly similar to its single-deflated counterpart.

Producers Prices: Producer price (input & output) indices supplied by the Office for National Statistics.

Labour Input: Total employment is from the Census of Production. From this, the number of R&D workers was subtracted. Normal and overtime hours worked per week (full-time males) are taken from the *New Earnings Survey* and from information supplied by the Employment Department. Weeks worked are taken from *Employment Gazette* (data for total manufacturing are assumed to apply to all industries). Hours worked per year in manufacturing are the result of multiplying employees by hours per week by weeks worked.

Capital Input: Data for manufacturing were supplied directly by the Office of National Statistics. Spending on capital equipment for R&D purposes was subtracted.

B Industry concordance

The concordance is based upon Kong (1988), O'Mahony and Oulton (1994) and Cameron (1997). The manufacturing data set is composed of 19 industries. It was not possible to obtain a perfect concordance between SIC 1968 and SIC 1980. Where discrepancies arise, these are detailed in Table K below, which gives information on the percentage error in the value-added data between the two classifications.

Table K
Industry concordance

Industry	SIC 1980	SIC 1968	Error(%)
Chemicals nes[a]	25+26-257	V+411-272-2796-(05*276).	1.2
Pharmaceuticals Products	257	272+2796	2.0
Office Machinery and Computing	33	338+366	-4.7
Other Electrical Engineering	34-344-345	IX-363/4/6/7	3.6
Electronics	344/5	363/4/7+0.5*(354)	-2.9
Motor Vehicles	35	381	2.0
Aerospace	364	383	1.2
Instrument Engineering	37	VIII-0.5*(354)	-4.6

[a] nes: not elsewhere specified.

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