OXFORD BULLETIN OF ECONOMICS AND STATISTICS, 52, 4 (1990)
0305-9049 $3.00

COMPARATIVE PRODUCTIVITY IN BRITISH AND GERMAN INDUSTRY 1907–37

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I. INTRODUCTION

Most of the existing work on international comparisons of productivity levels in the mid-twentieth century concerns Anglo/American comparisons (Rostas, 1948; Frankel, 1957; Paige and Bombach, 1959; Flux, 1933). By contrast, productivity level comparisons between Britain and Germany, the other major industrial country at this time, have been largely neglected.

In this paper we return to the Anglo/German productivity comparison, building on the sole quantitative study of Rostas (1948). As well as providing estimates of physical output per worker for 1935, we provide a run of estimates over time from 1907 to 1937 for as many industries as possible. Thus, as well as the snapshot of 1935, we provide a dynamic picture of change over time.

On the basis of these numbers it is difficult to sustain the argument that there was any wholesale failure of British industry before 1939. Although labour productivity was much higher in the US, the gap with Germany was much smaller. Although German labour productivity was substantially above British levels in heavy industry, particularly chemicals, metals and engineering, this was not the case in light industry. Indeed, in a number of industries in the food, drink and tobacco sector, productivity was substantially higher in Britain. This helps to confirm the picture of Britain's comparative advantage apparent in the Anglo/American productivity comparisons of Broadberry and Crafts (1990a).

Examination of the characteristics of this sample of industries in the two countries helps us to understand the causes of productivity differences. We find that relative plant size was the most important proximate determinant of German/UK productivity levels, with British performance much worse in the small plant metals and engineering sectors. We also see collusive behaviour and cartelization as important in explaining the failure of British and German industry to respond positively to the challenge of much higher productivity levels in the US.

II. LABOUR PRODUCTIVITY 1907–37

1. Data

We compare physical output per worker in Germany and the UK for 23 industries. The years of comparison were determined by the British *Census of Production*, available for 1907, 1924, 1930 and 1935, with some additional information for 1937 from the Import Duty Inquiry of that year. The main data sources for Germany were the *Statistisches Jahrbuch für das Deutsche Reich* (1909, 1913, 1927, 1929, 1931, 1934, 1936, 1937, 1938), the *Vierteljahrshefte zur Statistik des Deutschen Reichs* (1926 I, IV, 1931 IV, 1936 IV, 1938 IV, Ergänzungsheft zu 1913 III), *Wirtschaft und Statistik* (1936, Sonderhefte Nr. 10, 1933, Nr. 13, 1934), supplemented by the *Statistisches Handbuch von Deutschland 1928–44* (1949). The choice of industries was dictated by the availability of statistics for both countries. Industries have been ordered in accordance with the 1948 Standard Industrial Classification (SIC) for the UK. Our central year of comparison is 1935. This enables us to link our study to the Anglo/American productivity comparisons for 1937/35 in Broadberry and Crafts (1990a).

2. Results for 1935

The overall impression from Table 1 is of slightly higher labour productivity in German industry in 1935. The unweighted average of the 23 industries gives German productivity as 101.9 percent of the UK level. The ratio is 113.7 using UK employment weights, and 102.1 using German employment weights. For the US/UK comparison, the US productivity ratio was 224 using an unweighted average, 215 using British employment weights and 218 using US employment weights. Clearly the Anglo/German productivity gap was much smaller than the Anglo/American gap. However, as with the Anglo/American gap, the Anglo/German gap varied considerably between sectors. In general, we found a relatively poor British performance in the heavy industries (1–12) and a relatively good British performance in the lighter industries (13–23). This is a very similar pattern to our findings for the Anglo/American productivity gap, and confirms the findings there, that British performance was not uniformly poor. In tracking down the causes of poor British performance in heavy industry, then, we shall need to be careful that we can also explain British success in light industry. Simplistic aggregate explanations, such as entrepreneurship or culture, will clearly not be adequate.

In Table 2 we compare our results for 1935 with the study of Rostas (1943) for 1936/35. The broad pattern of higher German productivity in heavy industry and higher British productivity in light industry is clearly evident in both studies, although there are some notable differences, which are explained in Section III.

TABLE 1
Physical Output per Worker, Germany/UK (%)

	1907	*1924*	*1930*	*1935*	*1937*
1. Coal mining	81.7	94.4	114.6	127.7	
2. Cement	132.5	98.5	109.2	87.4	
3. Coke & by-products		124.0	209.4	174.1	
4. Sulphuric acid		144.8	251.5	181.8	
5. Soap				109.6	
6. Seedcrushing				49.8	
7. Blast furnaces		156.4	177.4	148.0	118.3
8. Steelworks				115.9	102.5
9. Iron Foundries			124.4	112.1	117.9
10. Zinc		49.0	121.3	85.0	
11. Machinery			102.5	112.3	
12. Motor vehicles	191.9	111.8	186.6	141.3	
13. Cotton spinning		113.7		99.6	90.3
14. Cotton weaving				69.0	52.1
15. Rayon			135.2	108.9	
16. Jute			120.5	116.3	99.8
17. Leather tanning & dressing	138.7		95.3	98.8	
18. Boots & shoes			190.3	121.3	
19. Beet sugar	48.5			32.7	
20. Margarine				51.8	
21. Brewing	92.3			62.2	
22. Tobacco		26.9		25.8	
23. Rubber tyres and tubes				111.5	

3. *Trends in Comparative Productivity*

For a number of industries we can place the 1935 comparative productivity level in a dynamic perspective. The general pattern that emerges from Table 1 is of Germany improving her position relative to Britain between 1924 and 1930, but of some falling back between 1930 and 1937. It seems likely that there is a strong cyclical element in these trends, which suggests that care should be taken in interpretation.

The sharp improvement in Germany's position in a number of industries between 1924 and 1930 is consistent with the recent findings of Ritschl (1990), who notes that the First World War had a dramatic effect on German industrial productivity, with the 1913 level only being regained by 1927/28. Ritschl's findings are based on an index of labour productivity measured as output per hour worked. One result of the war, however, was that the trade unions had become much stronger. Supported or tolerated by the new democratic governments, the labour movement succeeded in drastically cutting back the length of the working week. If one recalculates Ritschl's

TABLE 2
Physical Output per Worker, Germany/UK (%)

	Rostas 1936/35	*This study 1935*
1. Coal mining	142	127.7
2. Cement	92	87.4
3. Coke & by-products	152	174.1
4. Sulphuric acid		181.8
5. Soap	117	109.6
6. Seedcrushing		49.8
7. Blast furnaces	115	148.0
8. Steelworks	114	115.9
9. Iron foundries	120	112.1
10. Zinc		85.0
11. Machinery	110	112.3
12. Motor vehicles	98	141.3
13. Cotton spinning	120	99.6
14. Cotton weaving	68	69.0
15. Rayon	132	108.9
16. Jute	106	116.3
17. Leather tanning & dressing		98.8
18. Boots & shoes	110	121.3
19. Beet sugar	34	32.7
20. Margarine	81	51.8
21. Brewing	67	62.2
22. Tobacco	30	25.8
23. Rubber tyres & tubes	117	111.5

index on the basis of productivity per worker (our measure) then economic performance in the Weimar Republic appears even more gloomy. In no year between 1925 and 1932 did labour productivity reach the 1913 level. A cyclical movement is also apparent, with a productivity improvement until 1929 and a deterioration thereafter, a pattern consistent with our findings.

This suggests that Dumke's (1990) assessment of the importance of wartime dislocation for post-1945 growth applies equally to the post-1918 period. But in contrast to the post-1945 period, Abelshauser and Petzina (1981) note that the Weimar economy witnessed an 'incomplete reconstruction' ('unvollendete Rekonstruktion'). According to Holtfrerich (1986), however, the inflation after the war until 1923 brought about favourable conditions for high investment activities, a remarkable contrast compared with the years thereafter. Borchardt (1979, 1989a, 1989b) on the other hand describes the Weimar economy as basically sick right from the beginning. He sees long before the crisis of the 1930's a profit squeeze and high wages leading to low investment and relatively high consumption levels, thus reducing productivity gains below their potential. A summary of the debate is contained in von Kruedener (1990). The deterioration in Germany's relative position compared with Britain during the 1930's suggests that the National Socialists were more successful in restoring full employment than in improving industrial efficiency.

It is worth noting that these results make it difficult to sustain the argument that there was any blanket failure of British industry before 1939. For although there was a substantial productivity gap with the US, overall there appears to have been little difference between productivity levels in Britain and Germany. This point has been made forcefully by Feinstein (1988) using data on GDP per hour.

It is also worth checking how these results fit in with the finding of van Ark (1990) that West German industrial productivity was only about 70 percent of the UK level in 1950. Since our figures suggest that there was little, if any, difference between British and German productivity levels by the late 1930's, consistency between our study and van Ark requires a deterioration of about 30 percent in German relative productivity across the Second World War. In fact, such a deterioration seems likely. We know from the work of Matthews *et al.* (1982, Table 8.3) that labour productivity in British manufacturing grew at a rate of 1.5 percent per annum over the period 1937–51, which suggests an increase of about 23 percent over the war period. For West Germany, the Hoffmann (1965) data indicate that labour productivity was only back to prewar levels by 1950. This suggests that the van Ark productivity gap for 1950, which has been extrapolated from 1967 is of the right order of magnitude, although van Ark is working with value added rather than gross output.

III. PRODUCTIVITY COMPARISONS IN INDIVIDUAL INDUSTRIES

1. Introduction

Rather than present detailed estimates of all industries, here we raise general issues and look in detail at three examples. A more detailed data appendix is available from the authors on request.

For most industries, we have data on physical output, usually measured by weight. Typically it was necessary to convert German output measured in metric tonnes into imperial tons for comparability with Britain. There were however, a number of exceptions to this. In machinery (11), the value of net output in Britain and Germany was compared using a market exchange rate rather than a purchasing power parity for this sector. Here we merely follow the procedure used by Rostas (1948) for his Anglo/American comparison. In motor vehicles (12), output was compared in car equivalents, using British relative unit values to weight the output of motor cycles, motor cars, commercial vehicles, chassis and engines. For boots and shoes (18), output was measured in thousands of pairs, while for brewing (21), British output was measured in gallons, and German output in hectolitres. In rubber tyres and tubes (23), German output was valued at UK unit values.

As in all comparative productivity studies, this inevitably raises issues of quality differences. However, we would argue that this was not as serious a problem in the first half of the twentieth century as it is today. Indeed, as Broadberry and Crafts (1990a) show for the US/UK comparison as late as 1948, the comparative productivity picture is strikingly similar whether one uses physical output or net output converted using relative unit value ratios.

For employment we have used total number of employees rather than number of operatives. Although both measures of employment are readily available for Britain, for Germany it is harder to obtain estimates of the number of operatives other than for the full census years 1907, 1925 and 1933.

2. *Some Examples*

In this section we illustrate our method with three examples, for blast furnaces (7), motor vehicles (12) and cotton spinning (13). These are all industries where we found a noticeably different picture of comparative productivity from that of Rostas (1943), so that it is useful to present details of our working.

For blast furnaces, data on German output and employment were obtained from the *Vierteljahrshefte*, since the *Statistisches Jahrbuch* did not include employment figures. For Germany, data for 1925 were preferred since 1924 was badly affected by a strike. Note also that the German data for 1935 and 1937 include the Saar. In Table 3, we see that German productivity was substantially above the British level, but with the German advantage being reduced during the 1930's, with sharply rising German employment. Although our figure for the productivity gap in 1935 is substantially above Rostas' (1943) estimate for 1936, it may be that Rostas has excluded the Saar. It may also be that cyclical factors are important here, since our estimate for 1937 is very similar to that of Rostas.

In Table 4, we set out the details of the calculation of relative productivity in the motor vehicle industry. UK relative unit values have been used to provide the weights for converting the number of motor cycles, motor cars, commercial vehicles, chassis and engines into car equivalents for the UK and for Germany. German unit values are available for 1930 and 1934 (*Wirtschaft und Statistik* 1936, p. 48; *Industrielle Produktion* 1933, p. 109). If we apply the German weights to the production of UK and Germany for 1930 and 1935, the relative productivity levels are 175.6 and 146.3 respectively (UK = 100). Thus it makes little difference whether British or German weights are applied. Although output was higher in Britain, productivity was considerably higher in Germany. This result contrasts with Rostas' (1948) finding of slightly higher British productivity in motor cars for 1936. It is

TABLE 3
Blast Furnaces

UK				Germany				
Year	*Output (th. tons)*	*Employment*	*Output per worker (tons)*	*Year*	*Output (th. tons)*	*Employment*	*Output per worker (tons)*	*Output per worker (UK = 100)*
1924	7,360.6	26,970	272.9	1925	9,929.4	23,266	426.8	156.4
1930	6,251.6	19,362	322.9	1930	9.545.2	16,667	572.7	177.4
1935	6,488.6	15,815	410.3	1935	12,643.2	20,823	607.2	148.0
1937	8,371.0	19,565	427.9	1937	15,707.6	31,036	506.1	118.3

TABLE 4
Motor Vehicles

UK				Germany				
Year	*Output (car equivalents)*	*Employment*	*Output per worker (car equivalents)*	*Year*	*Output (car equivalents)*	*Employment*	*Output per worker (car equivalents)*	*Output per worker (UK = 100)*
1907	12,758	54,043	0.236	1907	6,085	13,423	0.453	191.9
1924	188,418	222,278	0.848	1925	82,113	86,642	0.948	111.8
1930	321,980	240,253	1.340	1930	135,407	54,153	2.500	186.6
1935	499,211	224,568	2.223	1935	317,032	100,937	3.141	141.3

conceivable that British productivity was higher in cars but lower in vehicles overall, but we think this unlikely, since evidence from Anglo/American comparisons suggests that this sector has been notoriously inefficient in Britain throughout the twentieth century (Broadberry and Crafts, 1990a, Frankel, 1957, Smith *et al.*, 1985). Unfortunately we cannot check Rostas' calculations, since no details were provided.

For cotton spinning, data on output and employment are given in Table 5. For output, we have used the total make of single yarn, due to the unavailability of a separate estimate of the weight of double yarn for the UK. We thus find output per worker slightly higher in the UK in 1935 and 1937, in contrast to Rostas (1948) who found productivity higher in Germany. This seems to be due to the fact that Rostas used the total make of single and double yarn for Germany, but only single yarn for the UK, since on that basis we also find higher productivity in Germany in the 1930's. On a consistent basis, however, we find the slightly higher productivity in Britain more plausible, particularly given the Anglo/American results for spinning (Rostas, 1948) and Anglo/German relative productivity in cotton weaving (Table 1 above).

IV. EXPLAINING PRODUCTIVITY DIFFERENCES

1. Introduction

The first step in our explanation of the Anglo/German productivity differences must be the development of a framework of analysis. We shall distinguish between economic fundamentals on the one hand, and a challenge/response mechanism on the other hand. By economic fundamentals we mean essentially differences in resource endowments. In the neoclassical tradition, we can expect supply constraints to be the fundamental determinant of productivity. We consider both physical capital and human capital. In addition, we follow Frankel (1957) in considering fundamental differences on the demand side in the form of market size.

However, we think it is important to see productivity levels in Britain and Germany between the wars in terms of response to the large productivity gap that had opened up with America, due to the innovations of the second industrial revolution. Thus we shall need to quantify the American lead. In terms of response we shall examine plant size, and the structure of interest groups. The framework is similar to that of Broadberry and Crafts (1990a) (1990b) for explaining the US/UK productivity gap.

2. Economic Fundamentals

We follow Rostas (1948) in using estimates of horse-power per worker as a measure of the capital/labour ratio. UK data are taken from the 1930 *Census of Production* (no estimates were made for 1935), and German data from the

TABLE 5
Cotton Spinning

UK				*Germany*				
Year	*Output (th. lbs)*	*Employment*	*Output per worker (lb)*	*Year*	*Output (th. lbs)*	*Employment*	*Output per worker (lb)*	*Output per worker (UK = 100)*
1924	1,395,083	252,655	5,522	1925	638,527	101,719	6,278	113.7
1935	1,227,765	182,415	6,731	1935	699,947	104,427	6,703	99.6
1937	1,357,774	186,108	7,296	1937	722,053	109,593	6,588	90.3

1933 census are presented in the *Statistiches Jahrbuch*. Data on relative horse-power per worker are shown in Table 6. The German capital/labour ratio was generally higher in the heavier industries where German labour productivity was higher and lower in the lighter industries where German labour productivity was lower. Thus some of the labour productivity gap might be explained by differences in capital/labour ratios, although this is by no means the whole story. For example, in brewing, despite having over twice as much capital as his British counterpart, the average German worker produced less than two-thirds as much output. For the sample as a whole, in fact, there is a slightly negative correlation ($r = -0.077$).

In discussions of human capital, comparisons with Germany have loomed large since the late nineteenth century. Sanderson (1988) provides a good survey of the issues. He shows that although a large gap in technical education had opened up by the 1870's and 1880's, a number of measures were taken during the 1890's and 1900's to redress the balance.

However, as Sanderson shows, it was the interwar period that saw the real failure of British technical and vocational training policy. With the pressure for reduced public spending of the early 1920's, education and training suffered accordingly. Against a background of a declining apprenticeship system, the failure to develop technical and vocational training was bound to leave the British economy with a shortage of skilled labour. In contrast to the UK, public spending on schools and universities increased considerably in the Weimar Republic. Whereas this spending in 1913 had reached a share of 2.6 percent of net national product, it increased after the war to a peak of 3.8 percent around 1930 and dropped back to pre-war levels under Nazi rule (Hoffman, 1965, pp. 728, 826). As Prais (1981) notes, however, we should expect this problem of inadequate human capital formation in Britain to have had a more serious effect in industries requiring a high level of skills.

In practice, measuring human capital is difficult and neoclassical studies have typically taken the short cut of assuming that factors are paid their marginal products, so that high wage rates can be taken as indicative of higher levels of human capital. Thus we present in Table 6 data on average earnings per operative on a comparative German/UK basis, using a purchasing power parity exchange rate of £1 = 17.08 RM from Rostas (1948, Table 2). Although we find a negative correlation between relative productivity and relative human capital on the basis of the 18 sectors for which data was available, ($r = -0.20$) we should note that it was not possible to obtain wage data on a number of German industries which we know were organized on a small scale with low levels of human capital, particularly in the food, drink and tobacco sector.

Rostas (1948) and Frankel (1957) both consider market size as a potential determinant of relative productivity with larger market size allowing greater specialization and the benefit of economies of scale. However, as Frankel argues, the problem was lack of standardization in Britain, which artificially limited the effective market size faced by any single firm.

TABLE 6
Economic fundamentals and the Productivity Gap

	Relative productivity Germ./UK 1935	*HP per worker Germ./UK 1933/30 (%)*	*Average annual earnings of operatives Germ./UK 1935 (%)*	*Size of industry Germ./UK 1935 (%)*
1. Coal mining	127.7	197.4	100.8	50.9
2. Cement	87.4	149.7	73.0	145.7
3. Coke & by-products	174.1		84.6	284.6
4. Sulphuric acid	181.8	165.8	97.5	144.2
5. Soap	109.6	85.7	111.5	113.9
6. Seedcrushing	49.8	111.5	92.0	53.2
7. Blast furnaces	148.0	78.8	83.1	194.9
8. Steelworks	115.9		85.7	126.5
9. Iron foundries	112.1	100.0	82.0	131.9
10. Zinc	85.0	96.4	106.7	144.4
11. Machinery	112.3	113.0	83.1	137.2
12. Motor vehicles	141.3	123.1	88.7	63.5
13. Cotton spinning	99.6	70.0	87.5	57.0
14. Cotton weaving	69.0	94.4	83.4	64.3
15. Rayon	108.9	242.9	94.3	109.8
16. Jute	116.3	130.4	81.3	86.9
17. Leather tanning & dressing	98.8	136.0		142.3
18. Boots & shoes	121.3	50.0		98.8
19. Beet sugar	32.7	282.0		43.9
20. Margarine	51.8	88.9	118.2	220.9
21. Brewing	62.2	222.2		95.4
22. Tobacco	25.8	40.0		102.5
23. Rubber tyres & tubes	111.5	85.3	110.4	56.8

We follow Frankel (1957) in quantifying market size in terms of the size of industry output in Table 6. There does appear to be a positive association between relative market size and relative productivity ($r=0.36$), but we would not read too much into this, since population in Germany was only about 40 percent higher than in Britain (Maddison, 1982, appendix B). Furthermore, arguments concerning lack of standardization apply equally to Germany at this time. (Dyas and Thanheiser, 1976).

3. *The American Challenge and the European Response*

A sizeable productivity gap opened up between America and Europe around the turn of the century, with a number of innovations often heralded as the Second Industrial Revolution. These innovations were both technological and organizational, with the switch from steam power to electricity, mass production of standardized products, increasing scale and effective managerial control. In Table 7, we utilize data on US/UK relative productivity from Broadberry and Crafts (1990a), to illustrate the significance of the

TABLE 7
The US Lead in Labour Productivity

	UK 1935	*Germany 1935*	*US 1937*
1. Coal mining	100	128	263
2. Cement	100	87	99
3. Coke & by-products	100	174	236
4. Sulphuric acid	100	182	
5. Soap	100	110	285
6. Seedcrushing	100	50	105
7. Blast furnaces	100	148	362
8. Steelworks	100	116	197
9. Iron foundries	100	112	154
10. Zinc	100	85	
11. Machinery	100	112	268
12. Motor vehicles	100	141	294
13. Cotton spinning	100	99	150
14. Cotton weaving	100	69	200
15. Rayon	100	109	185
16. Jute	100	116	130
17. Leather tanning & dressing	100	99	
18. Boots & shoes	100	121	141
19. Beet sugar	100	33	102
20. Margarine	100	52	152
21. Brewing	100	62	201
22. Tobacco	100	26	160
23. Rubber tyres & tubes	100	112	285

gap between Europe and America, with differences between Britain and Germany generally much smaller.

One aspect of the weak European response to the challenge of the Second Industrial Revolution in America might be the use of suboptimal plant size. However, as noted by Broadberry and Crafts (1990a), compared with the US, average plant size, as measured by number of employees, was generally larger in Britain. For the Anglo/German comparison, however, relative plant size does appear to be an important proximate determinant of relative labour productivity. It is apparent from Table 8 that German plant size was generally larger in the heavy industries where German productivity was relatively high. It is also clear that German plant size was relatively small in the lighter industries where German productivity performance was relatively poor. For the sample as a whole, the correlation between relative productivity and relative plant size was strongly positive ($r=0.51$).

TABLE 8
The Role of Plant Size

	Relative productivity Germ./UK 1935 (%)	*Average plant size Germ./UK 1935 (%)*
1. Coal mining	127.7	258.3
2. Cement	87.4	99.4
3. Coke & by-products	174.1	168.5
4. Sulphuric acid	181.8	54.3
5. Soap	109.6	8.8
6. Seedcrushing	49.8	6.4
7. Blast furnaces	148.0	154.4
8. Steelworks	115.9	177.2
9. Iron foundries	112.1	76.7
10. Zinc	85.0	170.3
11. Machinery	112.3	47.8
12. Motor vehicles	141.3	390.7
13. Cotton spinning	99.6	108.1
14. Cotton weaving	69.0	67.1
15. Rayon	108.9	75.6
16. Jute	116.3	78.9
17. Leather tanning & dressing	98.8	60.6
18. Boots & shoes	121.3	60.4
19. Beet sugar	32.7	18.2
20. Margarine	51.8	35.0
21. Brewing	62.2	21.3
22. Tobacco	25.8	6.1
23. Rubber tyres & tubes	111.5	80.0

As Broadberry and Crafts (1990a, 1990b) argue, if we are to explain satisfactorily the persistence of a large productivity gap such as that between Europe and America for much of the twentieth century, we need to explain how market forces and/or government failed to eliminate poor performance. Here, we note that cartelization and collusion were widespread in both Britain and Germany between the wars, and highlight a marked contrast between European and American attitudes to industrial organization (Broadberry and Crafts, 1990c). In general, however, cartels were weaker in Britain than in Germany. Widespread cartelization had emerged in Germany during the second German Empire. Due to this longer tradition in cartel formation, the German national cartels played the leading role in the creation of international cartels during the interwar period. As has been shown by Schröter (1983) for several cases (steel, coal, chemistry, electrical engineering) a lack of sufficiently developed cartel organization made it difficult to integrate British firms into international cartels during the 1920's. As noted by Broadberry and Crafts (1990c) however, British cartels were considerably strengthened during the Depression of the 1930's. In the US, although anti-trust policy was more relaxed during the interwar years, this never amounted to the active encouragement of cartelization followed by British and German governments (Potter, 1985). Indeed, the National Industrial Recovery Act, which suspended the anti-trust laws for any industry that devised an approved code of fair competition, was declared unconstitutional by the Supreme Court in 1935. This ushered in a period of renewed vigorous anti-trust enforcement (Whitney, 1958, p. 8).

As argued in Broadberry and Crafts (1990b) however, it was not simply the existence of oligopoly power in product markets that led to poor productivity performance. Rather, cartels should be seen as product market interest groups interacting with interest groups in labour markets and capital markets. In Britain, performance was poor where cartels comprised of family owned firms immune from hostile take-overs interacted with strong trade unions jealously guarding traditional shop-floor control of production. In Germany, labour unions were generally weaker, particularly after 1933, and in some sectors financial interests prevented cartels from settling for a quiet life, through the controlling interests of banks. Thus the existence of a cartel was only a necessary condition for the persistence of inefficiency. For without the protection of market power, inefficient firms were bound to be eliminated through competition. As with cartels, protection can be seen only as a necessary but not sufficient condition for poor performance, by providing product market power which might be used defensively (Capie, 1983; Kitson *et al.*, 1989; Hentschel, 1988; Schröter, 1983; Sweezy, 1941).

Turning to labour market interest groups, the work of Bain and Price (1980) suggests that trade union density in Britain was high in coal mining, metals and engineering and textiles. Although German trade union density was similar to British levels during the 1920's, in 1933 independent trade unions were destroyed and replaced by the Deutsche Arbeitsfront, firmly under National Socialist control (Sweezy, 1941, ch. 9). However, as James (1986) and Borchardt (1989b) note, there was much concern about the role of unions during the 1920's. Nevertheless, in contrast to the British unions, James paints a picture of German unions with a progressive attitude towards new technology. The German union problem of the 1920's was therefore not one of holding down productivity levels, but rather of raising wages. This was brought about in combination with enforced state arbitration ('Zwangsschlichtung').

Turning to capital market interest, emphasis on the positive role of banks in German industry is a standard feature of most accounts of German economic developments during the pre-First World War and post-Second World War periods (Stolper, 1967; Prais, 1981). However, discussions of German banking in the interwar period invariably concentrate on the macroeconomic aspects of the hyperinflation, the stabilization of the mark and the 1931 crash, without emphasizing the issue of linkages between industry and finance. (Hardach, 1980; James, 1986; Stolper, 1967).

The German system of universal banking, with banks taking an active interest in the firms to which they lent, can be contrasted with the British system where there is a clear separation between commercial banking and investment financing. Thus, in contrast to Germany, where banks provided much of the long term capital for industry and appointed nominees to the boards of major companies, in Britain firms had to rely on internal funds and the stock exchange. This led to worries, chrystalized in the MacMillan Report of 1931 that there was a gap in the provision of long term finance for small firms in Britain (Thomas, 1978).

However, there are a number of doubts about the advantages of the German system. First as Neuburger and Stokes (1974) argue, there is a danger that the German banks, by channelling funds to heavy industry may have starved lighter industries which we have already noted were often less productive than their British counterparts (although see Fremdling and Tilly, 1976, for a critique of this paper). Second, the close direct links between banks and industry proved disastrous when in 1931 one of the Big Four, the Darmstädter — und National bank, collapsed (James, 1986, p. 285), although it may be argued that no financial system could have withstood the strains put upon Germany in the interwar period. Also, the loss of foreign assets through the war and the impact of the hyperinflation considerably weakened the financial position of the great banks and thus their power over industrial enterprises (Born, 1977; Borchardt, 1976).

Closely tied up with the provision of finance, however, is the issue of control, and here we see a clear shortcoming of the British system, which has often been stressed in the literature on Britain's relative decline; the predominance of control by conservative small family firms. Faced with difficult negotiations over the introduction of modern technology, a firm with product market power may choose to settle for a quiet life. In those circumstances, we may expect that financial interests would act as a spur to efficiency. In

Germany, the banks could perform such a role. But in Britain, given the virtual absence of the hostile takeover bid, firms were immune from such pressures (Hannah, 1974).

4. *Statistical Analysis*

We have reported above the simple correlation coefficients between relative productivity and each of the explanatory variables. The strongest correlation is between relative productivity and relative plant size. The importance of this variable is confirmed by econometric analysis. In Table 9 we report results for an econometric equation relating relative productivity (RELPROD) to the four explanatory variables, relative capital per worker (RELCAP), relative human capital (RELHUMCAP), relative market size (RELKMKT) and relative plant size (RELPLANT). In the first equation, we see that only relative plant size has much explanatory power over the 17 observations for which we have data on all four variables. This is confirmed in the second equation, where the F test easily accepts the restrictions necessary to get from equation (1) to equation (2). Finally, equation (3) reports the equation for the whole sample, confirming the importance of relative plant size.

5. *Conclusions*

In this paper we provide estimates of Anglo-German labour productivity differences over the period 1907–37. We show that although German labour

TABLE 9
Germ./UK Productivity Level Regressions
(All variables measured in natural logarithms)
Dependent Variable: RELPROD
Estimation Method: OLS

	Equation 1		*Equation 2*		*Equation 3*	
Variable	*Coefficient*	*(Standard error)*	*Coefficient*	*(Standard error)*	*Coefficient*	*(Standard error)*
RELCAP	0.18	(0.24)				
RELHUMCAP	−0.093	(0.64)				
RELMKT	0.070	(0.17)				
RELPLANT	0.15	(0.082)	0.16	(0.072)	0.31	(0.069)
CONSTANT	3.21	(3.40)	3.92	(0.32)	3.25	(0.29)
$\bar{R}^2$	0.064		0.21		0.47	
SE	0.33		0.31		0.36	
N	17		17		23	
			F(3, 12) = 0.23			

productivity was substantially above British levels in heavy industry, in a number of light industries productivity was substantially higher in Britain. We show that an important proximate determinant of German/UK productivity levels was relative plant size. British poor performance was particularly prevalent in the metals and engineering sector, where plant size was relatively small. By contrast, in the food, drink and tobacco sector, it was low German productivity that was associated with small plant size. Finally, we note that productivity levels in both Britain and Germany lagged substantially behind levels in the US. The widening gap was due not only to long term trends visible before the war, but also due to severe wartime dislocation in Germany and Britain. We explain the persistence of this gap between Europe and America, however, by the encouragement of collusion and cartelization in the prevailing interest group structures of Britain and Germany.

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