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The "IT Productivity Paradox" Revisited: International Comparisons of Information Technology, Work Organisation and Productivity in Service Industries

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Summary

Although many authors now regard the 'IT productivity paradox' as an issue which has been resolved at firm level (at least in the US), some puzzles still remain at industry and national economy level. In this article we have explored the relationship between IT investments and relative labour productivity performance through comparisons of matched samples of banking and hotel establishments in the US, Germany and Britain. In both industries a lack of correspondence between country productivity ranking and the incidence of different kinds of IT usage was attributable to inter-country differences in (1) the timing of IT investments and of adaptation of work organisation to take full advantage of the productivity-enhancing potential of IT; (2) the mix of product strategies deployed by service establishments; and (3) the supply of complementary assets required to secure high levels of pay-off to IT investments.

1. Introduction[1]

In recent years many researchers have concluded that concerns about the so-called 'IT productivity paradox' were premature. For example, studies based on US data suggest that IT capital investments have made a substantial positive contribution to output and productivity at the firm level (Brynjolfsson and Hitt, 1995, 1996; Lichtenberg, 1996). More generally, there is widespread recognition that the full benefits of investments in IT equipment are only likely to be realised when they are complemented by other forms of investment (eg, in software and training) and by appropriate changes in work organisation and business strategy. Furthermore, a historical perspective shows that previous 'skill-biassed' technological revolutions — such as the steam engine and electrification — required decades before the full extent of productivity gains became apparent (David, 1991; Standage, 1998; Caselli, 1999).

However, at industry and national economy level, many puzzles remain. For example, Gordon (1999) finds that, in spite of heavy investments in IT, there was very little acceleration in productivity growth between 1995-99 in US industries outside computer hardware manufacturing itself. In terms of cross-country comparisons, the estimates presented by Schreyer (2000) suggest that the contribution of information and communications technology to output growth varied sharply between G7 nations between 1980-96. There is no obvious link between the timing and scale of IT diffusion in different countries and trends in relative labour productivity performance in service industries such as financial and business services where the bulk of IT investments take place (Table 1).

Possible explanations for this divergence include variants on some of the arguments advanced in efforts to explain the initial version of a productivity paradox. For example, the well known problems of accurately measuring service output and productivity are magnified in the context of international comparisons where appropriate exchange rates need to be identified in order to convert monetary aggregates to a common currency. Conceivably, there may also be systematic inter-country differences in the extent to which resources have been devoted to complementary investments in software and training and

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Table 1

Shares of IT equipment in investment and average labour productivity levels in service industries

A: Percentage share of IT equipment in non-residential gross fixed capital formation (all industries)

	UK	US	Germany[a]
1985	5.2	6.3	3.4
1990	7.5	8.7	3.5
1996	11.7	13.4	6.1

Source: Schreyer, 2000, Table 1.

B: Average output per hour worked in service industries (Index numbers: UK=100)

		UK	US	Germany[a]
Transport and communications	1979	100	181	109
	1989	100	146	102
	1996	100	113	100
Distributive trades	1979	100	147	122
	1989	100	143	109
	1996	100	155	111
Financial and business services	1979	100	151	137
	1989	100	118	145
	1996	100	115	169
Miscellaneous personal services	1979	100	180	119
	1989	100	175	151
	1996	100	133	145

[a] Refers to former West Germany.

Source: O'Mahony, 1999, Table 2.4.

the changes in work organisation which are required to maximise the yield from IT investments. Such differences may in turn be linked to systematic cross-country variation in the predominant responses by service suppliers to the strategic choices which are made possible by IT investments, such as the choice between the provision of highly customised services and the supply of standardised and automated services (Preissl, 1998). Finally, it may be that inter-country differences in IT investments in service industries are more than offset by differences in other factors which determine relative productivity performance.

In this paper we seek to shed new empirical light on these issues of productivity measurement and explanation by drawing on the results of detailed comparisons of matched samples of service establishments in two different industries — banking and hotels — in three countries, the US, Germany and Britain. These studies have the particular advantage that labour productivity comparisons were carried out using physical output data rather than sales or other financial measures of activity. Furthermore, the main research methods employed — semi-structured interviews with managers and direct observation of work processes — permitted many useful qualitative insights into the predominant modes of IT utilisation and work organisation and their links with business strategy in the different national samples. In view of the relatively small sample sizes involved and the limited range of performance indicators available to us, due caution is needed in generalising on the basis of our findings. However, the study helps to identify many of the key factors which need to be taken into account in future analysis of the relationship between IT investments and relative productivity performance at industry and national level.

The paper is ordered as follows: Section 2 describes the samples of establishments in each industry and briefly summarises our comparative productivity estimates. Sections 3 and 4 assess the differential impacts of IT investments and work organisation on relative productivity performance in, respectively, banking and hotels. Section 5 draws out the main conclusions which emerge.

2. Comparative productivity levels

2.1 Sample selection criteria

In order to ensure that the samples of establishments were closely matched for product/service area, the research focussed on specific segments of each industry, namely, bank lending to 'mid-corporate' business customers and three and four star hotels catering largely to business guests. These sectors were chosen as examples of business services in which the quality and efficiency of service provision could be expected to have implications for wider productivity performance in the aggregate economy. In total research visits were made to 50 different bank offices serving mid-corporate customers and 49 hotels in the three countries in 1995–97 (Tables 2 and 3). In order to capture some of the regional diversity in economic conditions and customer bases within each country, the visits were clustered in several different regions: the West Coast, Mid West and New England in the US; the North West, North East and South East in Britain; and Berlin, Baden-Württemberg, and Nordrhein-Westfalen in Germany.

In each sample care was taken to include broad ranges of establishment-sizes which were adequately representative of the national populations of establishments in question. In banking the median size of lending office in the three samples was broadly similar (25-30 people); in hotels the larger median size of establishment in the US sample reflects the larger average size of US hotels in three- and four-star grades compared to Britain and Ger-

Table 2

Employment size-distributions and extent of customer segmentation in national samples of bank lending offices

	BRITAIN	US	GERMANY
(A) Employment size-group:			
Under 10	3	1	4
11-20	4	7	6
21-30	5	3	3
Over 30	4	6	4
TOTAL	16	17	17
Median size of office[a]:	29	30	25
(B) Target customer range of sample offices[b]			
Small mid-corporate	0	5	5
Upper mid-corporate	3	5	3
Broad mid-corporate	3	5	5
Full range: mid-corporate and larger customers	10	2	4
TOTAL	16	17	17

[a] The median size is here defined such that half of all employees are in offices above that size and half below it. — [b] Bank offices classified as follows: Small mid-corporate: most customers in sales range from $1 mn to $25 mn.Broad mid-corporate: most customers in sales range from $5 mn to $150 mn. Upper mid-corporate: most customers in sales range from $25 mn to $300 mn. Full range: broad client base of mid-corporate and larger customers in sales range from $1-20 mn to $300 mn-plus. Customer sales data converted to US$ at PPP exchange rates for 1996: US $1.00 = £0.67 = DM 2.18.

many. In drawing up the banking samples we also sought to capture the considerable diversity between the three countries in the extent of customer 'segmentation'. For example, as Table 2B shows, 5 out of 17 US bank offices catered solely for small mid-corporate customers (typically with annual sales ranging from $1-25 million) and another 5 offices dealt with larger mid-corporate customers (with annual sales ranging from $25 million up to $300 million). Only 7 of the US bank offices served a wide range of customers from the same office compared with 13 out of 16 British banks catering to a similar range. In Germany the extent of segmentation was considerably greater than in Britain but less than in the US.

2.2 Productivity comparisons in banking

Each mid-corporate lending office in the three national samples was asked to provide data on (1) the number of new business loans which had been completed (i. e. accepted by customers) within a recent 12 month period (including new loans supplied to existing customers as well as to new customers); and (2) the labour inputs associated with each phase of the loan decision-making process, typically involving initial meetings with representatives of firms requesting a loan, followed by a formal evaluation of the prospective borrower's creditworthiness. This evaluation typically included some or all of the following elements: a review of the client company's financial accounts, a 'peer-group comparison' of its performance against other similar enterprises, an industry and market evaluation, an on-site audit, and an assessment of its senior managers' experience and competence. If the bank loan officer (or 'relationship manager') decided that the credit request should be granted, the company evaluation was then written up into a formal lending proposal and submitted for a final credit decision to a higher level of decision-making authority within the bank.

Table 3

Size-distributions and mix of star ratings in national samples of hotels

	U.S.	BRITAIN	GERMANY
(A) No. of bedrooms:	*Number of hotels*		
100 or less	2	3	2
101–200	3	4	9
201–400	7	2	2
401–plus	5	4	4
TOTAL	17	13	17
	Number of bedrooms		
Median hotel size in sample:	253	166	156
(B) Star ratings:	*Number of hotels*		
Three star	9	7	11
Four star	8	6	6
TOTAL	17	13	17

Detailed information of this kind was supplied by half the 50 bank offices in our three country samples.[2] Preliminary analysis of the data showed that the average number of completed loans per employee in the German sample far exceeded that in either the US or Britain but the average loan size in Germany was substantially smaller than in either the US or Britain.[3] Since the labour inputs associated with preparing a loan proposal are strongly positively related to the size and complexity of the credit request,[4] we carried out a regression analysis where, taking natural logarithms, the dependent variable on ln output referred to the average number of completed loans by each bank office and the independent variables were defined as follows:

ln loansize = average size of completed loan in US$ (converted at 1996 PPP exchange rates)

ln lendshare = proportion of total net income deriving from lending activity[5]

ln emp = total employment in each bank office (typically comprising senior manager, relationship managers, credit analysts and clerical and secretarial staff).

The results of this analysis are summarised in Table 4. In Equation 1 the coefficient on ln lendshare is statistically insignificant and it is therefore dropped from Equation 2. In both equations the coefficients on ln loansize are stable, negative and statistically significant and show that, at a given level of employment, there is indeed a clear inverse relationship between the number of loans completed and the average size of loans. The coefficients on country dummy variables in each equation further suggest that, after controlling for average loan size, average lending output per employee in the German sample was significantly higher than in Britain and above that in the US. However, the positive coefficient on the US dummy is poorly determined in both equations due to a high degree of variation around the mean productivity level in the US sample. Additional information supplied by US bank offices suggested that this largely reflected a marked divergence in measured productivity performance between bank offices serving the lower end of the market (where lending decisions are typically processed by a single relationship manager) and those serving larger mid-corporate customers in a more labour-intensive and time-consuming way (as discussed below in Section 3.2).

[2] Although we would have liked to achieve a higher response rate, we acknowledge that the detailed information requested was more time-consuming for some banks to provide than we had anticipated.

[3] The average size of loan in each country was converted to a common currency (US$) using purchasing power parity (PPP) exchange rates for 1996. Since no international statistical authority produces data on purchasing power parities for financial services, we followed O'Mahony et al. (1998) in using PPP exchange rates for private consumption recalculated to exclude non-market services. For 1996 this procedure yields the following PPP exchange rates: US $1.00 = £0.67 = DM 2.18.

[4] There are several other reasons apart from complexity why larger business loan requests typically absorb more labour-time in their assessment than smaller loan requests: not only are there potentially greater losses involved (in the event of bad debts), but larger customers are also viewed as potentially more profitable to the bank office, hence more worthy of time-intensive personal contacts and relationship-building.

[5] 'Net income' is here defined as: all income from loans, deposits, fees and services *less* interest expenses on loan financing and deposits measured before bad loan provisions and taxes.

Table 4

Regressions of annual loan output on average size of loan, lending-related shares of net income and bank office employment

Dependent variable: ln Output (total number of completed loans)				
	1		2	
Constant	6.32 ***	(4.97)	6.68 ***	(5.31)
ln Loansize	–0.70 ***	(–4.33)	–0.67 ***	(–4.25)
ln Lendshare	–0.71	(–1.22)	-	
ln Emp	0.67 ***	(3.62)	0.68 ***	(3.81)
Country dummies:				
• United States	0.70	(1.54)	0.39	(1.07)
• Germany	1.18 **	(2.18)	0.74 *	(1.78)
Adjusted R squared	0.77		0.75	
SEE	0.72		0.72	
No. of observations	25		25	

*** Statistically significant at the 1% level or better. — ** 5% level. — * 10% level.–Note: Country dummies set to zero for bank offices located in Britain. — (T-statistics in brackets).

The country productivity ranking implied by the regression results — Germany leading, followed by the US and then Britain — is consistent with recent productivity estimates for the wider banking and financial service industry based on national accounts data (O'Mahony, 1999). The country ranking also remains intact after taking account of inter-country differences in average hours worked per employee[6] and after considering different indicators of lending service quality as experienced by business customers. Detailed information supplied by bank offices with regard to specific examples of business credit requests suggested that (1) the speed of response to such requests in Germany was faster than or equal to that in the US or Britain; (2) the depth of analysis in credit appraisal in German banks (seeking to understand clients' businesses and credit needs) was also equal to or better than that reported in the other two countries. At the lower end of the mid-corporate market a 'quality-adjusted' productivity comparison might reduce the estimated US-British productivity gap since most British banks sought to provide an in-depth analysis of clients' credit needs as compared to the US banks' preference for pushing through high volumes of security-based lending to smaller business customers. However, the British-German productivity differential could not be attributed in any way to differences in service quality.

2.3 Productivity comparisons in hotels

In the case of hotels we obtained output and labour input data which enabled comparisons based on two different measures of physical labour productivity:

(1) occupied rooms per employee-hour in front and back office departments (for example, receptionists, concierges and porters in front desk areas; sales staff, switchboard operators, night auditors, etc. in back office functions)

(2) guest-nights per housekeeping employee-hour (adjusted for presence of suites and coffee-making facilities).

As expected, the average labour-intensity of customer service provision was substantially higher in four star than three star hotels in each country. There were also differences in location and size between different hotels which appeared to have a bearing on relative productivity performance. For example, in each country hotels based at airports or alongside motorways typically enjoyed higher occupancy rates than downtown hotels and larger hotels appeared to have scope for economies of scale in many of their operations.[7] Therefore, in order to control for the effects of different mixes of star ratings, hotel sizes and locations in each national sample, our regression analysis related our chosen measures of labour productivity to the number of bedrooms and to quality and location dummy variables for each hotel. An additional independent variable was also entered to control for differences in the mix of business and leisure guests in each hotel.

The results shown in Table 5 suggest that, for a given size and location of hotel, average output per employee-hour in front/back office operations is about 26% lower in four-star hotels than in three-star establishments (Equation 1). In housekeeping (Equation 2), the relevant coefficient is also negatively-signed but is smaller than in the case of front/back office areas and is not statistically significant. This latter finding may reflect the fact that in one of the three national samples — Germany — the reported average time for cleaning rooms in four star hotels did not differ greatly from that in three star hotels. For a given quality-grade and location of hotel, a doubling of hotel size (as measured by the number of bedrooms) is associated with a productivity increase of roughly 19% in front/back office operations, confirming the existence of economies of scale in these activities. The coefficient on the size variable in the housekeeping equation is also positive but is substantially smaller than in Equation 1 and lacks statistical significance. Both equations suggest that there is no statistically significant effect on productivity of variation in the ratio of business to leisure guests.

Overall, the results confirm that, after controlling for size, location and quality-grade of hotel, the German sample enjoys a substantial productivity advantage over the US and Britain in both types of activity under consideration. The coefficients on the German dummy variable in each equation are both positive and statistically significant and point to a German lead over Britain of just over 30% in front/back office areas and just over 50% in housekeeping.[8] The US dummy variable coefficients suggest that — for hotels of a given size, location and quality-grade — the US sample lags behind Britain in front/back office output per employee-hour but is close to parity in housekeeping. However, there are relatively high sampling errors attached to these estimates, in part because of the considerable polarisation in the US sample between three-star hotels which sought to economise on labour and four-star hotels which had adopted highly labour-intensive service strategies (see Section 4 below).

We now go on to discuss the extent to which inter-country differences in the use of IT have affected relative productivity performance in banking and hotels.

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[6] O'Mahony et al. (1998) estimate that average annual hours worked per employee in the banking and finance industries are approximately 6-7% lower in Germany and Britain than in the US.

[7] Across all three samples the median occupancy rate in airport hotels was 80% compared to 73% in motorway hotels and 68% in city centre and outer city hotels.

[8] A similar German productivity advantage relative to Britain was found in a late 1980's comparison of matched samples of relatively small two and three star hotels in the two countries (Prais, Jarvis and Wagner, 1989).

Table 5

Regressions of labour productivity measures on hotel quality grade, location and size

	1		2	
Dependent variables	ln prodfb		ln prodhk	
Constant	–0.72	(–0.91)	–0.37	(–0.40)
Quality dummy:				
4 star	–0.26 **	(–2.35)	–0.14	(–1.08)
Location dummies:				
• Airport	0.35 **	(2.26)	-0.19	(–1.00)
• Outer city	0.07	(0.50)	–0.04	(–0.24)
• Motorway	0.57 ***	(3.51)	0.23	(1.22)
• ln size	0.19 **	(2.58)	0.07	(0.79)
• ln busguest	0.08	(0.52)	0.16	(0.88)
Country dummies				
• United States	–0.16	(–1.30)	0.03	(0.19)
• Germany	0.27 **	(2.09)	0.42 ***	(2.73)
Adjusted R squared	0.34		0.20	
SEE	0.31		0.36	
No. of observations	47		47	

** Statistically significant at the 5% level or better. — *** Statistically significant at the 1% level or better. — (T-statistics in parentheses).– Productivity measures: prodfb = occupied rooms per front/back office employee-hour; prodhk = guest-nights per housekeeping employee-hour; adjusted for presence of suites and coffee-making facilities.–Quality dummy set to zero for three star hotels. — Location dummies set to zero for central city locations.–Country dummies set to zero for hotels located in Britain. — Size = no. of bedrooms. — Busguest = business travellers as percent of guests.

3. IT and work organisation in mid-corporate lending

In all three countries computers were widely used to assist in the process of credit appraisal at the time of our visits (1995-97) and there were few differences in current levels of use of this equipment which might help to explain the pattern of productivity difference. However, our qualitative investigations revealed marked inter-country differences in the extent to which work organisation had been adapted to take advantage of IT equipment capabilities.

3.1 The use of computers in credit appraisal

All but one of the US and German lending offices had one personal computer (PC) per relationship manager (RM). This was also true of 13 of the 16 British offices but in the other three British offices two to three RMs shared one computer each.[9] As Table 6 shows, in a few offices in each country RMs had also been supplied with portable (laptop) computers in order to allow them to work away from the office or at home or to use them during visits to customers.[10] The use of computer networks to facilitate exchange of information within bank offices was also fairly similar in each sample (about three quarters of lending offices in each case). The incidence of computer networking to central credit departments was somewhat lower in the US than Britain or Germany, reflecting the greater importance attached to actually *de*centralising credit decision-making procedures in some US banks in order to speed up 'turn around' times on loan requests (see below).

In some respects the age distribution of IT equipment may be taken as a rough proxy for its level of sophistication, speed, memory, ease of use, etc. In this sector of commercial banking there were few clear inter-country differences in the current average age of PC's and networks in use as most equipment had been introduced or upgraded in the previous 1-3 years or was in the process of being upgraded at the time of our visits. However, this degree of parity reflected rapid growth in initial IT investments in the two European countries since the early 1990's whereas earlier generations of PC's and other equipment were widely used in US offices since at least the second half of the 1980's. As a consequence, the main differences between the three samples in respect of computer usage related to the longer period of time which US offices had had to adapt their working methods and pro-

[9] Data here refer to the full samples of mid-corporate lending offices in each country, not the sub-set of offices who provided data on lending output and associated labour inputs.

[10] Some American RMs serving small mid-corporate customers used laptops in their clients' offices in order to carry out immediate financial calculations.

Table 6

Use of IT equipment in national samples of mid-corporate lending offices

	BRITAIN	US	GERMANY
Personal computers (PC's) per relationship manager	0.85	0.95	0.95
	Percentages		
Proportion of bank offices using portable computers	31	24	18
Proportion of bank offices internally networked	75	82	82
Proportion of bank offices networked to credit department	75	53	71
Total no. of offices =	16	17	17

cedures to the potential efficiency benefits offered by the new equipment.[11]

For example, US banks were the first to make use of specialist PC-based programmes for individual RMs and analysts to evaluate commercial credit requests in a more systematic and consistent way, and indeed some of the programmes of this kind which British banks now use are adapted from imported American software. German banks were found to be less willing to rely on off-the-shelf packages of any kind and at the time of our visits were typically still in the process of developing new versions of their own software.

In addition, the US banks' longer experience of using PC's has also contributed to greater use of appraisal methods similar to the credit 'scoring' techniques now widely used in all three countries to assess loan requests by individual and small business customers. In middle market lending such programmes are still invariably used to support final decisions rather than to actually generate the decisions. However, in some US banks serving the lower end of the mid-corporate market, the credit appraisal process is very near to being automated, especially when used by individual RMs who have been given sole responsibility for making decisions. By contrast, in both Germany and Britain two independent assessments of credit requests are required even when dealing with relatively small amounts of credit at the lower end of the middle market.

3.2 Work organisation and the use of support staff

The most common form of work organisation for employees involved in mid-corporate lending is for RMs to work in association with credit analysts and with the further support of clerical/secretarial employees. In some cases the analysts and other support staff are permanently attached to particular RMs; in other cases these support workers are part of a pool of staff which RMs can call on as required. Variations on this kind of organisation were found in all the British banks, in all but one of the German banks and in eight of the 17 US banks (Table 7).

However, just over half of the US offices had organised their credit appraisal operations in very different ways:

- Five US banks had RMs working independently with only very occasional recourse to support staff of any kind, and

[11] The earlier introduction of IT equipment in US mid-corporate lending offices mirrors the more rapid diffusion of automated teller machines and on-line terminals, etc, in US *retail* banking as compared to the European industries (McKinsey, 1992; Arthur D. Little, 1994; Keltner, 1995).

Table 7

Types of work organisation in national samples of mid-corporate lending offices

	BRITAIN	US	GERMANY
	Number of lending offices		
Independent RM model	0	5	0
RM-analyst teams:			
• One analyst – one RM	9	2	8
• One analyst – multiple RMs	7	6	8
RM-specialist teams	0	4	1
Total no. of offices =	16	17	17

- Four US banks had teams consisting of an RM, a credit analyst and product specialists (eg, experts in cash management, international banking or investment banking) who work together with customers from the outset of bank-client relationships in order to gain a detailed understanding of customer needs and with the aim of maximising product sales.

Perhaps surprisingly, the 'independent RM' model was not just confined to US banks serving the lower end of the market (where, as noted, some RMs are able to make final decisions on credit requests without reference to higher authority within their banks) but was also found in bank offices oriented toward larger customers. However, as expected, all the US offices deploying staff in 'RM-specialist' teams were focussed on the upper end of the market where customer requirements for credit and other bank services are typically more varied and complex.

The different forms of work organisation which have emerged in US banks strongly reflected the extensive early use of time- and labour-saving PC's by American RMs and contributed to a much smaller proportion of support staff than is found in Germany or Britain. The US banks were particularly economical in use of credit analysts (and, as noted in respect of the banks operating with an 'independent RM' model of credit appraisal, many American RMs are effectively 'their own credit analyst', only calling on back-up support in unusual circumstances). As a result the ratio of credit analysts per RM across the whole US sample was only a third of that in Britain and Germany which each had an average ratio of about one analyst per RM (Table 8). However, the German sample had the lowest ratio of clerical/secretarial staff per RM: this may be partly attributable to the high proportion of German clerical employees who have undergone a full apprentice training after leaving school, in contrast to their generally less well-trained American and British counterparts (Mason, Keltner and Wagner, 1999).[12]

Just as the greater use of support staff in British lending offices was an important factor underlying the relatively poor productivity performance by the British sample, so the early use of IT and the highly economical use of support staff in the US sample served to enhance its productivity performance relative to the other two countries. However, this was insufficient to offset other factors contributing to the overall German productivity lead, for example, the German banks' relatively swift access to and long experience of using nationally-available business information systems for peer-group comparisons and market analyses when processing new credit requests.[13] In addition, measured labour productivity in the US was negatively affected by the deliberately more labour-intensive service strategy adopted towards larger mid-corporate customers (designed to maximise revenues from selling a full range of products and to stave off competition from rivals) and the greater proportion of American RMs' time which was spent in search of new business rather than in serving existing customers.[14]

These findings shed light on the difficulties in interpreting the relationship between IT investments and banking productivity using published datasets which cannot distinguish between labour inputs directly devoted to the production of bank service outputs and other labour inputs which are absorbed in responding to competitive market pressures. Although the business strategies adopted by US mid-corporate lending offices apparently contribute to higher average net income per employee-hour in the US than in either of the two European countries,[15] they are

[12] At higher occupational levels such as RMs and credit analysts there were notably few differences in formal qualifications and training between the three samples which might help to explain relative productivity performance. In all three countries the great majority of people in these occupations held university degrees or professional banking qualifications or both.

[13] For example, German clients can ask their tax accountants to prepare detailed statements of their sales performance, cash flow, interest payable, capital depreciation, materials, labour and other costs and other variables in a form which is directly comparable with financial data for groups of other similar firms recorded on the nationwide DATEV database. In Britain the larger banks could potentially make use of their own nationwide customer databases to carry out peer-group comparisons of prospective clients' creditworthiness but in most cases the required information systems were still not in full operation at the time of our visits.

[14] An estimated 45% of RMs' time in US banks was spent seeking to 'acquire' new customers in search of new business rather than in serving existing customers (compared to 15% and 20%, respectively, in Germany and Britain).

[15] Average annual net income per employee was estimated as follows (Index numbers: US=100): US 100, Britain 88, Germany 63. (See Footnote 4 for definition of 'Net income').

Table 8

Ratios of support staff to relationship managers (RMs) in national samples of mid-corporate lending offices

	BRITAIN	US	GERMANY
Credit analysts per RM	1.0	0.3	0.9
Clerical/secretarial staff per RM	0.6	0.5	0.3
Total support workers per RM	1.6	0.8	1.2
Total no. of offices =	16	17	17

also associated with greater expenditures of American lending managers' time on activities which do not contribute directly to measured bank output.

4. IT and work organisation in hotels

IT equipment was in widespread use in sample hotels in all three countries, particularly in larger establishments and hotels owned by chains which were linked to central reservation systems. A key issue for many hotels is how to integrate customer point of sale systems and property management systems which may have been introduced at different times and subsequently evolved separately (Ducatel, 1999). At the time of our visits many hotels were in the process of upgrading hardware and software related to customer billing, sales/reservations and 'yield management' (attempting to maximise revenue in the light of occupancy forecasts) and were grappling with integration problems. This added to the difficulties of evaluating the capability of IT systems and the effectiveness with which they were being used.[16] Hence, in what follows, we focus on four relatively straightforward indicators of IT usage which were easy to observe and which have a direct bearing on our chosen measures of labour productivity in front/back office and housekeeping areas:

1. Automated billing of all charges incurred by guests during their stay, e. g. phone calls, restaurant and bar charges: this speeds-up the check-out process.
2. Customer-operated systems which allow accumulating hotel bills to be viewed from guest rooms: this expedites check-outs by enabling areas of disagreement to be identified and resolved ahead of time. In some hotels the same system facilitates an 'express check-out' system whereby customers can pay their bills by credit card without queuing at the front desk as they leave — in marked contrast to labour-intensive express check-out systems in which bills are delivered to guests' rooms by hand.
3. Computerised data collection on frequent customers' personal details and preferences — this is intended to speed up the check-in process on subsequent visits as well as improve the quality of service for customers.
4. Computerised links between the front desk and housekeeping departments so that housekeeping supervisors can track the availability of rooms to be cleaned and notify reception when they are ready for new arrivals.

As shown in Table 9, the incidence of these kinds of IT usage was largely at variance with the pattern of inter-country difference in hotel productivity which showed Germany leading in both front/back office and housekeeping areas (Section 2.3). With regard to IT systems relevant to check-in and check-out procedures, the German and US samples were close to parity on all three indicators, with large proportions of hotels in both countries running automated billing systems and collecting data on frequent customers while Britain lagged behind in these respects. In the case of housekeeping the most extensive use of computerised links between housekeeping departments and reception areas occurred in the US and British samples whose measured productivity performance fell far below that of the German sample.

As in the banking comparisons, the relationship between IT usage and productivity is best explained through qualitative observations on business strategy and work organisation. In the US sample the average labour productivity level in front/back office areas was reduced by the way in which four-star hotels sought to compete on

[16] In addition, and in contrast to the banking comparison, we were unable to gather reliable data on the initial timing of hotels' investments in IT equipment, much of which had been introduced in a gradual and piecemeal manner.

Table 9

Examples of IT usage relevant to front/back office and housekeeping labour productivity in national samples of hotels

	BRITAIN	US	GERMANY
		Percentages	
IT facilities relevant to front/back office productivity:			
Automated billing of all charges (eg phone calls, restaurant)	75	94	100
Customer can view bill from room	31	41	35
Information gathered on preferences of frequent customers	63	94	82
IT facilities relevant to housekeeping productivity:			
Housekeeping department has own computerised links with reception	56	65	24
Total no. of hotels =	16	17	17

service quality by employing relatively large numbers of concierges and porters and increasing front-desk staffing at peak times, thus offsetting any potentially labour-saving characteristics of using IT equipment.[17] In addition, neither US nor British hotels were typically able to match German hotels in terms of employees' ability to move flexibly between different functions in front and back office departments. In German hotels the bulk of staff in these areas had undertaken full hotel apprenticeships covering a range of skills (including IT skills), in contrast to the short, task-specific training typically provided by US and British hotels (Finegold, Wagner and Mason, 1998). In this context any differences in IT investment levels play a relatively peripheral role in determining relative labour productivity performance.

The same was true in housekeeping areas where the German productivity advantage derived in large part from the distinctive organisational skills of their apprentice-trained supervisors who were responsible amongst other things for work scheduling, purchasing supplies and improvements to equipment. In Britain and the US housekeeping supervisors had typically received only modest amounts of training for their roles. Given that room cleaning is a relatively low-skilled occupation in all three countries, efficiency largely depends on the organisation of supplies of clean linen, the careful choice of cleaning materials and equipment and the prompt availability of cleaning staff when rooms are vacated. Although in principle the organisation of room cleaning should be speeded up and made easier through computerised links between housekeeping and reception areas, this was evidently a relatively low priority in the already well-organised German housekeeping departments (and particularly in smaller German hotels where regular face-to-face communication was more feasible).

Further reasons for the lack of clear relationship between IT investment levels and measured productivity performance emerged from interviews with some hotel managers. In one US hotel the managers disagreed with the owners' choice of software and complained about 'quirks' in their accounting programme. In another US hotel the managers felt that a new property management system had been 'shoved down [their] throats' by the hotel owners. The new system was said to give more in-depth reports on occupancy rates and room availability but was slower for making reservations at the front desk. In a third US hotel the introduction of a computer system for front desk operations had actually led to an increase in labour requirements compared to the previous manual system. This was because senior management now demanded many more reports on revenues and information on market segments.

The latter comment highlights the difficulties of defining and measuring 'output' in hotels as in many other service industries. The preparation of statistical reports absorbs time and resources but does not contribute directly to measured output in the same way as processing the arrivals and departures of hotel guests. In addition, the concerns expressed by hotel managers about how IT systems had been selected suggests that new investments in hardware and software are only likely to improve efficiency if they have been well complemented by appropriate skills and knowledge, firstly, in the design and/or selection of new equipment, and secondly, in its day-to-day operation.[18]

In Britain some hotel managers said that staff had at first experienced problems when new IT systems were installed, particularly if the new software was 'unfriendly', and considerable IT training had been necessary in order for staff to use the systems properly. Reported problems of this kind were less common in US and German hotels. In the US a large proportion of reception and back office staff were college students or graduates and thus brought a relatively high level of general education to the job. In Germany the staff in front/back office areas were not only highly trained but were also very familiar with hotel software of German origin (*Fidelio*) which was widely used in German sample hotels. This helped reduce training times for new hires operating IT systems in Germany. Several US and British hotels expressed interest in making future use of this German software because of its attractive design features.[19]

5. Summary and assessment

Although many authors now regard the 'IT productivity paradox' as an issue which has been resolved at firm level (at least in the US), some puzzles still remain at industry and national economy level. In this article we have explored the relationship between IT investments and relative productivity performance through comparisons of matched samples of banking and hotel establishments in the US, Germany and Britain. In both industries the German sample was found to have higher average levels of labour productivity than the American or British samples. However, this productivity ranking was largely at variance with the incidence of different kinds of IT usage.

In our chosen sector of banking — mid-corporate business lending — current levels of use of IT equipment in the process of credit appraisal were fairly similar. Several

[17] David, Grabski and Kasavana (1996) also found that many US hotel managers gave greater priority to improvements in guest service levels than to increases in productivity when installing new IT systems.

[18] Guest-operated devices such as television check-outs are also prone to ineffective use, according to a study of US, British and Canadian hotels by Van Hoof, Verbeeten and Combrink (1996).

[19] For example, it was described as more user-friendly and multi-functional than some other types of software previously installed in US and British hotels.

US banks had benefited from relatively early use of time- and labour-saving PC's and had adopted new forms of work organisation which speeded up the evaluation of credit requests at the lower end of the mid-corporate market and economised on the use of support staff such as credit analysts. However, the positive effects of these developments on US productivity performance were insufficient to offset other factors contributing to the overall German productivity lead (such as the German banks' ready access to nationally-available business information systems when processing new credit requests). In addition, measured labour productivity in the US was negatively affected by the deliberately more labour-intensive service strategy adopted towards larger mid-corporate customers.

In three- and four-star business hotels our productivity estimates were based on physical measures of output in front/back office areas and in housekeeping. Although the German sample was productivity leader in both departments, this did not reflect any superior use of IT. In the case of IT systems relevant to check-in and check-out procedures, the German and US samples were close to parity on all indicators while Britain lagged behind in each case. In the case of housekeeping the most extensive use of computerised links between housekeeping departments and reception areas occurred in the US and British samples whose measured productivity performance fell far below that of the German sample.

As in banking, this lack of correspondence between patterns of IT usage and relative productivity performance reflected inter-country differences in the mix of business strategies, work organisation and other factors which help to determine productivity. In the US sample the average labour productivity level in front/back office areas was reduced by the way in which four-star hotels sought to compete on service quality by employing relatively large numbers of front desk staff, concierges and porters, thus offsetting any potentially labour-saving characteristics of using IT equipment. In addition, German productivity performance relative to the US and Britain was enhanced by much higher skill levels among front/back office employees and housekeeping supervisors than were found in the other two countries.

Taken together our findings suggest that future analysis of the relationship between investments in IT and relative productivity performance in service industries at a national economy level needs to take account of inter-country differences in areas such as:

1. the timing of IT investments and of adaptation of work organisation to take full advantage of the productivity-enhancing potential of IT
2. the mix of product strategies deployed by service establishments (in principle the use of IT by some establishments to support very labour-intensive approaches to 'high-quality' market segments could be allowed for by the calculation of 'quality-adjusted' productivity levels but not without considerable difficulty given the well-known problems in defining objective measures of service quality)
3. the supply of complementary assets required to secure high levels of pay-off to IT investments (in particular, the potentially positive impact of IT investments on labour productivity may sometimes be offset by deficiencies in the skills required to select, instal and operate such equipment as well as by deficiencies in other skills needed to achieve high performance in the service areas concerned).

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Zusammenfassung

Das IT Produktivitätsparadox : Internationaler Vergleich von Informationstechnologieeinsatz, Arbeitsorganisation und Produktivität in Dienstleistungsbranchen

Obwohl gegenwärtig viele Autoren das „Produktivitätsparadox der Informationstechnik" als ein Thema ansehen, das, zumindest in den USA, auf der Firmenebene gelöst wurde, bleiben noch einige Unklarheiten auf den Ebenen von Branchen- und Volkswirtschaft bestehen. Der vorliegende Beitrag untersucht die Beziehung zwischen Investitionen in Informationstechnik und relativer Arbeitsproduktivität durch Vergleiche von entsprechenden Stichproben im Banken- und Hotelgewerbe in den USA, Deutschland und England. In beiden Industrien kann die mangelnde Übereinstimmung zwischen Länderproduktivitätsranking und unterschiedlichem Einsatzgrad von Informationstechnik auf Unterschiede zwischen den Ländern in den folgenden drei Bereichen zurückgeführt werden: (1) In der zeitlichen Koordinierung von Investitionen im informationstechnischen Bereich und der Anpassung der Arbeitsorganisation, um das Potential der Informationstechnik zur Erhöhung der Produktivität voll auszuschöpfen; (2) der von den Dienstleistungseinrichtungen gewählte Einsatz der Produktmixstrategien; und (3) das erforderliche Angebot von komplementären Anlagen, um eine hohe Rendite von IT Investitionen zu gewährleisten.