

Nobody Does IT Better

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What has been the impact of information technology (IT) on productivity? This has been a burning question for policy-makers and business leaders for several decades. But it is only in recent years that computer power itself has enabled researchers to conduct the statistical interrogation of large-scale datasets on firms that can give us some more definitive answers. In this Policy Insight, we report and synthesise some of the main messages emerging from this new line of research.

Perhaps the most intriguing finding comes from examining the use of IT by global businesses. Multinational enterprises in general and American multinationals in particular appear to have higher productivity, and this seems to be linked to a distinct pattern in their use of IT. This fact may help unravel some of the puzzles in the macroeconomic data such as why the productivity acceleration witnessed in the United States since the mid-1990s has not been reflected in Europe. It may be that US firms have organised their management structures in a way that makes better use of IT than their European counterparts.

We first set the historical scene over the last few decades, paying particular attention to the end of the paradox described by Nobel Laureate Robert Solow whereby computers were ubiquitous but seemed to have no effect on productivity. Then we discuss firm-level evidence on the impact of IT on firm performance, focusing on the role of the organisational factors that make the difference between IT projects being a success and failure. Finally, we delve into new research on the impact of IT in multinationals.

The bottom line is that economists have confirmed what business leaders have long known: the returns to IT are extremely variable and what makes the key difference is the management and organisation of the firm into which the IT is placed.

The macro picture: Solow paradox lost?

Labour productivity - or output per hour worked - is a key indicator of material wellbeing as it allows sustainable income and consumption growth (which can be in the private sector or the public sector). Over the last 60

years, roughly three periods can be distinguished.

The first one, starting after the Second World War, was a period of strong productivity growth in the developed world, interrupted in the mid-1970s after the first oil shock. Despite this slowdown in productivity growth, between the mid-1970s and the mid-1990s, Europe continued to catch up with US productivity levels and some countries even overtook the United States. This was the era of the 'Solow paradox': the observation that we could see computers everywhere except in the disappointing productivity statistics.

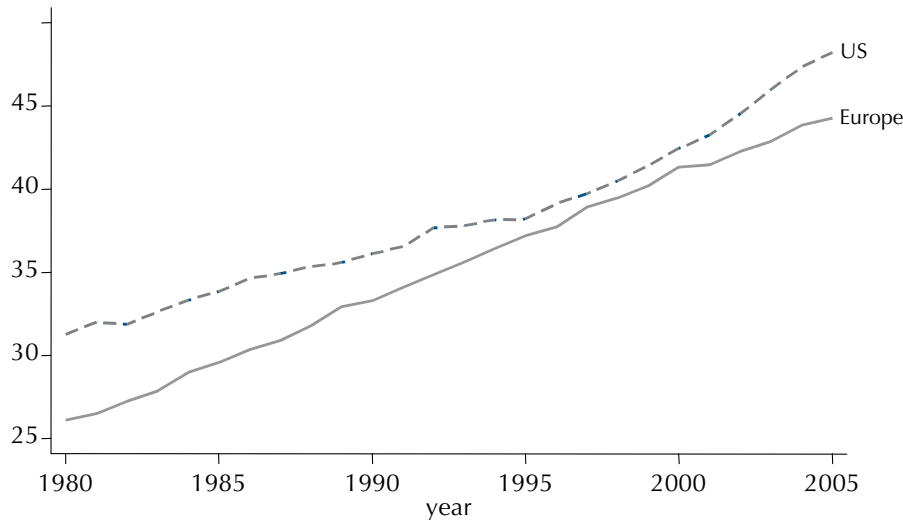
...the IT-producing and IT-using sectors essentially account for nearly all of the acceleration in US productivity growth...

Since the mid-1990s, a new picture has emerged. The US economy experienced a rebound in productivity growth almost back to the growth rates seen between 1945 and 1973. Productivity growth continued to surge ahead even in the face of the bursting of the high-tech bubble in 2000 and the terrorist attacks of 9/11. By contrast, European countries did not have a productivity acceleration and the long catching-up process ground to a halt (Figure 1). Interestingly this period of US catch-up has been accompanied by a dramatic acceleration in US investment in IT, again unmatched by Europe (Figure 2).

IT matters for understanding the US 'productivity miracle'. Imagine we split the economy into three sectors: industries that intensively produce IT (such as semi-conductors and computing); sectors that intensively use IT (such as retail, wholesale and finance); and all other sectors in the economy. Surprisingly, it turns out that the IT-producing and IT-using sectors essentially account for nearly all of the acceleration in US productivity growth (see Stiroh, 2002).

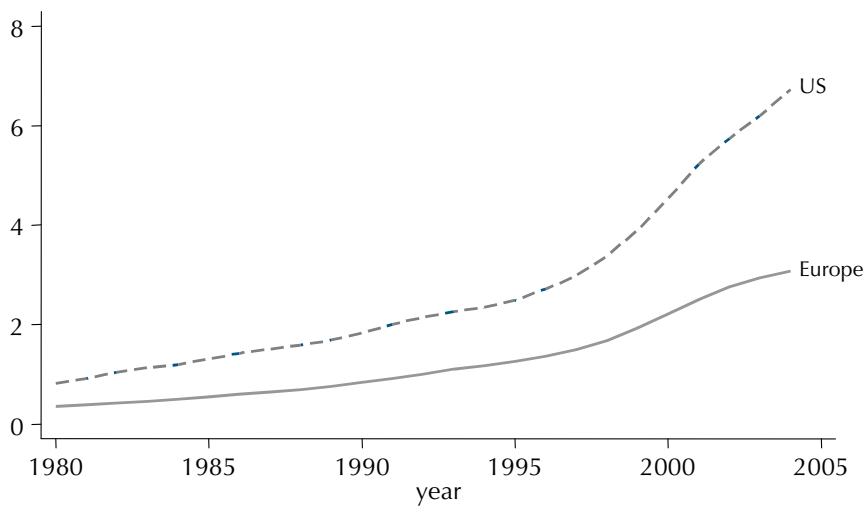
This is shown in Figure 3, which presents the acceleration in productivity in US and European productivity growth since 1995. Beginning with the US picture on the left hand side of the figure, we see that productiv-

Figure 1 In the mid-1990s the US reversed almost 50 years of European catch-up



Notes: Productivity measured by GDP per hour in 2005 US \$ PPPs. The countries included in the “EU 15” group are: Austria, Belgium, Denmark, Finland, France, Germany, UK, Greece, Italy, Ireland, Luxembourg, Portugal, Spain, Sweden, and Netherlands. Labor productivity per hour worked in 2005 US\$. Source: The Conference Board and Groningen Growth and Development Centre, Total Economy Database.

Figure 2 In the mid-1990s US IT investment rates started to accelerate



Notes: IT capital stock (in unit dollars) per hour worked. IT capital stock measured using perpetual inventory method and common assumptions on hedonics and depreciation. 2005 US \$ PPPs The countries included in the “EU 15” group are: Austria, Belgium, Denmark, Finland, France, Germany, UK, Greece, Italy, Ireland, Luxembourg, Portugal, Spain, Sweden and the Netherlands. Labour productivity per hour worked in 2005 US\$ using PPPs. Source: Marcel P. Timmer, Gerard Ypma and Bart van Ark, “IT in the European Union: Driving Productivity Convergence?”, Research Memorandum GD-67, Groningen Growth and Development Centre, October 2003, Appendix Tables, updated June 2005.

ity growth accelerated by 3.5 percentage points a year in the IT-using sectors: from 1.2% pre-1995 to 4.7% post-1995. It also accelerated by 1.9 percentage points in the IT-producing sectors. But there was actually a small deceleration in all the other sectors of the economy.

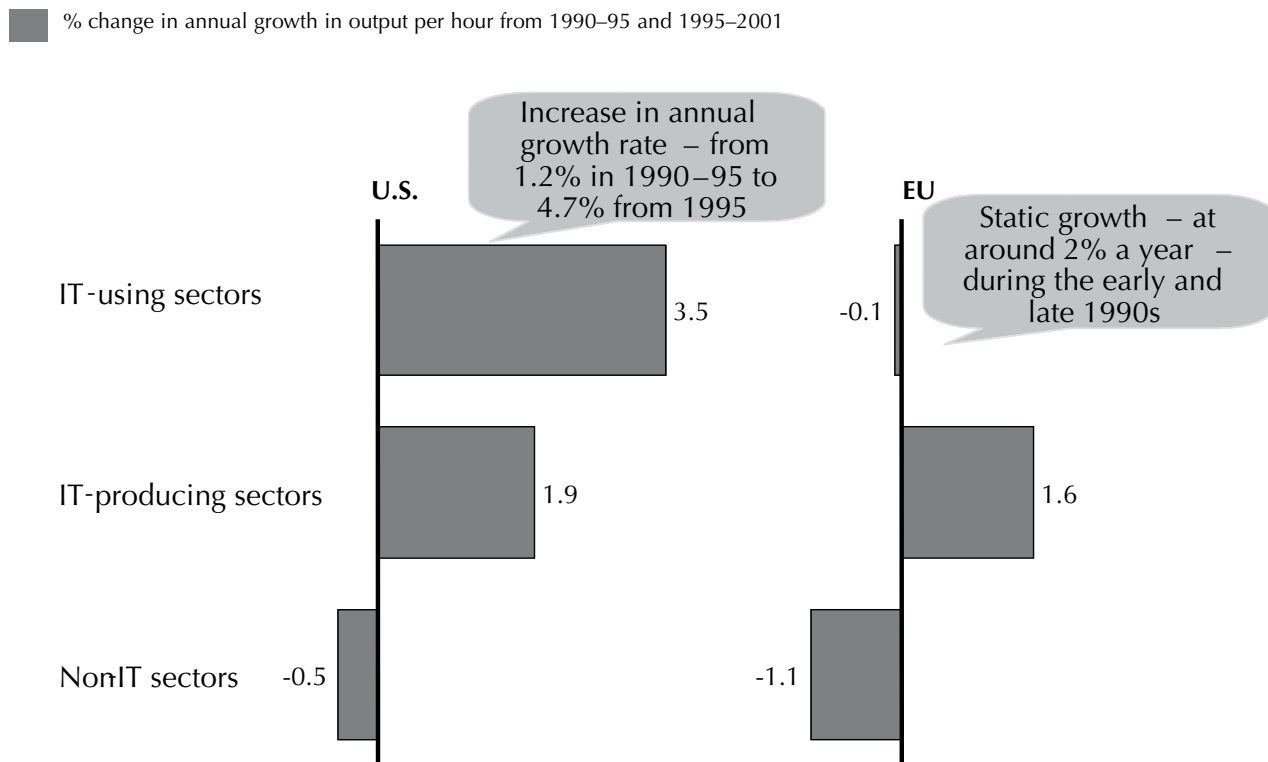
Lying behind this pattern was the enormous fall in the quality-adjusted prices of IT since 1995, which has its roots in technical progress in the semi-conductor industry. Rapid improvements in the power of semi-conductors led to big increases in productivity growth in the IT-producing sectors. Moore’s Law (a rule of thumb for the rate at which computer power increases) seemed to accelerate after 1994 and the resulting fall in the price of a key input lowered prices across a whole range of products in the IT-producing sectors. As the price of IT products plunged, firms deepened their use of IT

capital and this was naturally strongest in sectors that intensively used IT. Increasing IT capital per hour increased output per hour tremendously.

Looking at Europe, we also see a big increase in productivity growth in the IT-producing sectors of about 1.6% a year. The main difference between the United States and Europe is in the IT-using sectors: in Europe, there was no productivity acceleration in the late 1990s as there was in the United States. Productivity growth remained static at about 2% a year.

Since IT is available throughout the world at broadly similar prices, this raises a puzzle: why were European firms not able to reap the same benefits from IT as their US counterparts? To answer this, we have to delve beneath the macroeconomic numbers into the firm-level evidence.

Figure 3 The US productivity acceleration was driven by IT using sectors



Source: O'Mahony and Van Ark (2003, Gronnigen Data and European Commission)

The microeconomic picture: paradox regained?

Advances in computer technology have enabled large datasets on company productivity and IT to be amassed; they have also improved the ability of economists to analyse these data. The basic methodology to assess the return to IT is to analyse a 'production function': the researcher will try to account statistically for the output of the firm with a large number of inputs, the input of most interest being IT.

Since IT is one form of capital, it is important to take into account in the analysis other forms of non-IT capital, such as buildings, vehicles and non-IT equipment. Labour and material inputs also have to be controlled for, as well as other factors such as plant age, location and the state of the business cycle. The best studies use data where the same firms are followed over time so the researcher can see if a burst of IT capital is followed by a burst of productivity after controlling for other factors.

...IT has a significant impact on productivity, but the effects vary dramatically between firms...

Several interesting findings have emerged from this research programme (see Draca, Sadun and Van Reenen, 2007, for a longer survey). First, on average, IT does appear to be significantly associated with much higher firm-level productivity. This stands in contrast with some of the earlier industry- and macro-level studies that struggled to find any effect of IT on productivity. The reason why the industry-level and economy-level

studies found little impact may have been because the industry averages disguise large differences between firms within industries.

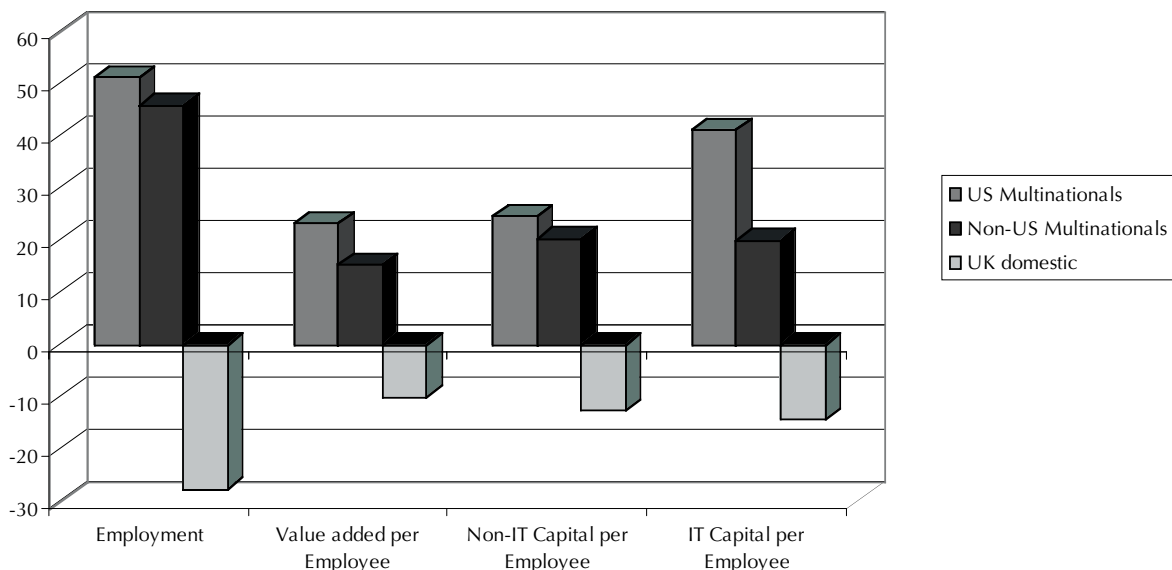
Second, the magnitude of the association between IT and company productivity is substantial. If IT was simply a normal form of capital earning the usual market return, we would expect that a doubling of the IT capital stock would increase output by approximately the share of IT in total revenues. Since the relevant share was about 1-2% in most studies, it is interesting that they appear to find effects much greater than this. The meta-analysis of 20 studies reported in Stiroh (2002b) finds an average IT elasticity of 5%, suggesting that a doubling of IT capital stock increases productivity by 5%. This would seem to suggest that there are some special features of IT compared with other forms of capital.

Third, there is a huge variation around the average impact of IT on firm productivity between different studies. Stiroh (2004) reports estimates ranging from an upper end of over 25% to negative 5%. Some of these differences are due to methodological differences. But it is more likely that a large amount of this variation is due to genuine differences in the impact of IT across firms and this is reflected in the different results from different datasets.

To understand this heterogeneity, we must move beyond looking only at technology and investigate other features of the firm.

It ain't what you do but the way that you do IT: the role of organisational change

An important reason why the returns to IT vary across

Figure 4 US multinationals are notably more productive and more IT intensive

Notes: Variables expressed relative to the four digit industry means. The figure represents averages for the 2001 cross section of the data used in Bloom, Sadun and Van Reenen (2007). 576 US multinational establishments, 2,228 non-US multinational establishments and 4,770 domestic UK establishments

Source: ONS, UK Census of Production establishment level data.

firms is that different firms have very different environments into which IT is placed. Often IT spending is only the tip of the iceberg, and there are a whole host of other investments made in the firm to enhance the use of IT such as consultancy expenses and business re-engineering.

Skills are also important. There is a great deal of evidence that educated workers tend to be much better at coping with the uncertainties of new IT systems than less skilled workers. Other organisational factors such as decentralisation of decision-making and the steepness of the managerial hierarchy have been found to be important. Old-style 'Taylorist' organisations with rigid centralised hierarchies have, on average, produced lower returns to IT than more flexible firms.

...Having the right firm management and organisation is key to making the most of IT...

Whether firms make these investments in complementary organisational capital seems to be very important. Bresnahan et al. (2002) examined the impact of IT on productivity in over 300 large US companies. A 1% increase in the IT stock was associated with an increase in productivity of 3.6%, but this increased to 5.8% if a firm became more decentralised (in their study, a one unit increase on a decentralisation index based around teamwork and autonomy of workers).

Although this literature is in its early stages, the research suggests that other organisational and managerial factors - which cannot be studied in isolation - interact with the use and the effects of IT on productivity.

The role of global businesses: US multinationals do IT better

One stylised fact emerging from the study of within-

firm productivity is that plants owned by multinational firms are more productive than plants of wholly domestic firms. This is not surprising as multinationals have to be more efficient in order to start operating outside their home market. What is more interesting is that plants owned by US multinationals appear to be more productive than those of non-US multinationals. This is true both within the United States and in other countries.

As an example of the evidence for this stylised fact, Figure 4 shows data from over 7,500 establishments located in the UK, which we have studied (see Bloom, Sadun and Van Reenen, 2007). In terms of value added per worker, US multinationals are 23% more productive than the industry average, non-US multinationals are 16% more productive than the industry average and domestic plants are about 11% less productive than the industry average.

This is consistent with evidence that the plants of multinational US firms are more productive whether the plants are based on US soil or foreign soil. The US productivity advantage is partially linked to greater use of inputs: US establishments use about 10% more materials per worker and 4% more non-IT capital per worker than non-US multinationals. But Figure 2 shows that IT capital may also be a very important factor: US firms use a whopping 40% more IT capital per worker than average whereas non-US multinationals use only 20% more.

...US multinationals are better organised than their European counterparts for benefiting from IT...

But this difference in the usage of IT is only one part of the story. When trying to assess the role of IT on firm level productivity, we find that US establishments are 8.5% more productive than domestic firms after

Figure 5a Organisational devolvement, firms by country of location

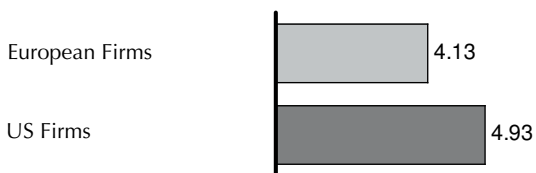


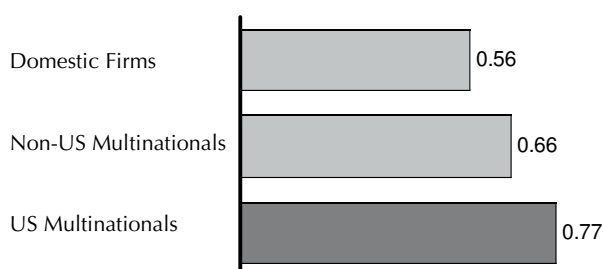
Figure 5c Organisational change in the UK during 1981-1990



Figure 5b Organisational devolvement, firms by country of ownership



Figure 5d Organisational change in the UK during 1998-2000



Notes: In Figures 3a and 3b the “Organisational devolvement” score is the average score for the 2 organisational questions for 548 firms in the US (219), UK (98) and France and Germany (231). The questions are taken exactly from Bresnahan et al. (2002) covering “Task allocation” and “Pace setting” where a higher scores indicate greater worker autonomy. Full survey details in Bloom and Van Reenen (2007). In Figure 3c the source is the WIRS data (1984 and 1990) which plots the proportion of establishments experiencing organisational change in previous 3 years (all establishments in the UK). US multinationals (N=190), Non-US multinationals (N=147), Domestic (N=2848). Senior manager is asked “whether there has been any change in work organisation not involving new plant/equipment in the past three years”. In Figure 3d the source is the CIS data: we plot the proportion of establishments experiencing organisational or managerial change in previous 3 years. The firm is asked “Did your enterprise make major changes in the following areas of business structure and practices during the three year period 1998-2001?” with answers to either “Advanced Management techniques” or “Major changes in organisational structure” recorded as an organisational change.

accounting for labour, non-IT capital, materials and a host of other factors.

Controlling for the fact that US firms use more IT accounts for only one percentage point of this gap. What matters is the way that US firms use IT. Doubling the IT stock is associated with an increase in productivity of about 5% for a US firm but only 4% for a non-US firm. US firms appear simply to get more productivity out of the same amount of IT (and this does not seem true of non-IT capital or other productive inputs).

A second interesting finding in our study is that the bigger returns to IT usage for US firms are only found in certain sectors of the economy. These are exactly the same IT-using sectors of wholesale and retail that account for the US productivity miracle. In other words, it is only in the IT-using sectors in Figure 3 where US firms’ IT productivity is much higher.

Why are the returns so much higher for US firms? We investigated a wide variety of hypotheses such as whether the US firms simply had more skilled workers or better software. These do not seem to be the culprits. We suspect the main reason lies in the managerial structure of US firms.

...One advantage of the US over Europe may be its lower level of labour market regulation...

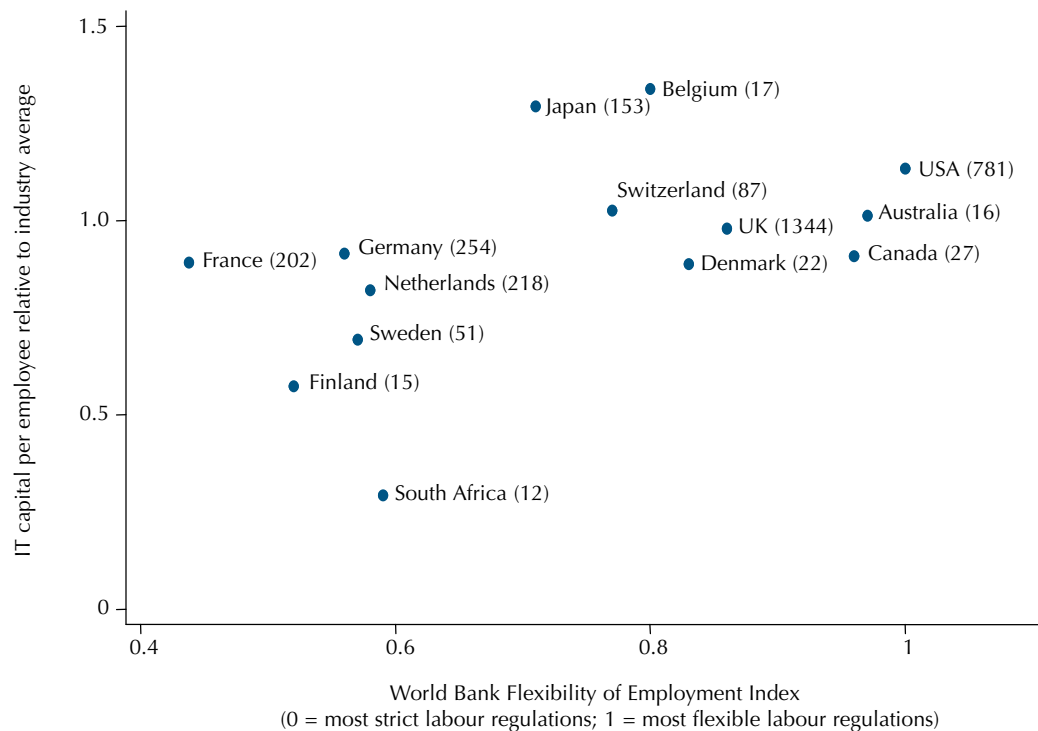
In other recent work (Bloom and Van Reenen, 2007), we scored firms in four countries (France, Germany, the

UK and the United States) on a range of managerial ‘best practices’, including incentives such as merit-based promotion and pay, the use of lean manufacturing techniques, performance management and effective targets. Across all firms, US firms are on average significantly better managed than European firms.

Looking within Europe at US subsidiaries, we also find that they are significantly better managed than non-US subsidiaries and domestic firms. What’s more, US subsidiaries are also much more likely to allow greater autonomy to employees, a factor associated with higher returns from IT (see Figures 5a and 5b). They are also more flexible in changing their organisations – even when located in Europe (see Figures 5c and 5d) This suggests that what gives US firms their advantage is the organisational and managerial structures that they have that is conducive to getting the most out of IT.

One advantage of the US over Europe may be its lower level of labour market regulation. This could have enabled US firms to change their managerial and organisational practices more rapidly in order to learn how to best use new IT technologies. IT has radically changed the ways firms collect, process and act on information, with firms needing to evolve the way they are run and organised to exploit this. Having learned these tricks on their home turn, American multinationals bring these ideas over to Europe through foreign direct investment.

One example of how IT radically changed the organisation of firms is in retail banking. In US banks in the late 1980s the introduction of ATMs substantially

Figure 6 IT intensity vs. flexibility of employment index

Notes: The sample includes only establishments of multinationals in IT using sectors. Each point represents average IT intensity (IT capital divided by employment normalized by the three digit industry average) by country. Each country average is based on at least ten observations and three digit industries with fewer than 10 observations are excluded. The labour regulation index is the "Rigidity of Employment" index, drawn from the World Bank "Doing Business" report.

Source: ONS Census of Production establishment level data. See Bloom, Sadun and Van Reenen (2007) for details.

reduced the need for tellers. At the same time, PCs and credit-scoring software allowed staff to be located on the bank floor to directly sell customers mortgages, loans and insurance, replacing bank managers as the primary sales channel for these products. These are the 'personal bankers' sitting on bank branch floors that are familiar to anyone who has visited a typical US retail bank in the last couple of decades. In Europe these 'personal bankers' were initially a much rarer sight because many European banks found re-organisation difficult in the face of firing costs and more rigid work rules.

As Figure 5 shows, US firms have taken these IT-adapted management and organisational practices overseas when setting up their foreign multinationals. Global companies often try to keep similar management practices and organisational structures around the world to help the mobility of staff and products. For example, US multinationals in the UK are likely to have an American style of management and organisational structure, while French multinationals are likely to adopt a more Gallic approach.

Figure 6 offers some tentative evidence on this idea. We look at the IT intensity of foreign multinationals in the UK. The multinationals who had tough labour regulation in their home country (like France) were much less IT intensive than the multinationals who had looser labour regulation (like the US).

Conclusions

The rebound of US productivity growth has been a major economic development over the last decade. This

'miracle' is linked to IT as the productivity acceleration was particularly strong in those sectors that used IT intensively such as financial services, retail and wholesale. Europe did not experience this acceleration in the same sectors.

We have shown that the bulk of the evidence from firm-level, microeconomic studies indicates that IT does have an economically and statistically significant impact on productivity but this varies dramatically between firms: having the right organisation helps a lot in making the most of IT.

...after a decade the European tortoise may be catching up with the US hare...

We have suggested that these organisational differences also lie behind the different productivity performance between the United States and Europe – US firms are better placed to take advantage of IT. This could be due to their ability to reorganise more quickly because of lighter labour regulation.

Our basic model predicts that European firms will adopt more US-style business processes over time to once again start closing the gap with the US. Indeed, over the last year European growth has been stronger than American growth which may indicate that after a decade the European tortoise may be catching up with the US hare. The risk for Europe, however, is that the world economy is actually a more uncertain and volatile place than it was in the post-war period. If this is the

case, then the nimbler US economy will maintain its position at the productivity frontier for a long time to come.

Further reading

Bloom, N., R. Sadun and J. Van Reenen (2007), 'Americans do I.T. better: US multinationals and the productivity miracle', [CEPR Discussion Paper No. 6291](#)

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