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Americans Do IT Better

By Nick Bloom, Raffaella Sadun, and John Van Reenen

It has taken a long time to confirm that computers boost productivity. But, as Nick Bloom, Raffaella Sadun and John Van Reenen show, the key to their success seems to lie in management and internal organization — and that's where U.S. firms have been far more effective than their European counterparts.¹

What has been the impact of information technology (IT) on productivity? This has been a burning question for policymakers 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 article, we report and synthesize 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 macro-economic 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 U.S. firms have organized 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

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¹ *Disclaimer: The authors are British (Bloom and Van Reenen) and Italian (Sadun)! We thank Seema Jayachandran, another SIEPR associate (and an American citizen) for suggesting this title.*

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the role of the organizational factors that make the difference between IT projects being a success or a 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 organization of the firm into which the IT is placed.

The Macro Picture: Solow Paradox Lost?

Labor productivity — or output per hour worked—is the key indicator of material well-being 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 U.S. 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.

Since the mid-1990s, a new picture has emerged. The U.S. 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 U.S. catch-up has been accompanied by a dramatic acceleration in U.S. investment in IT, again unmatched by Europe (Figure 2).

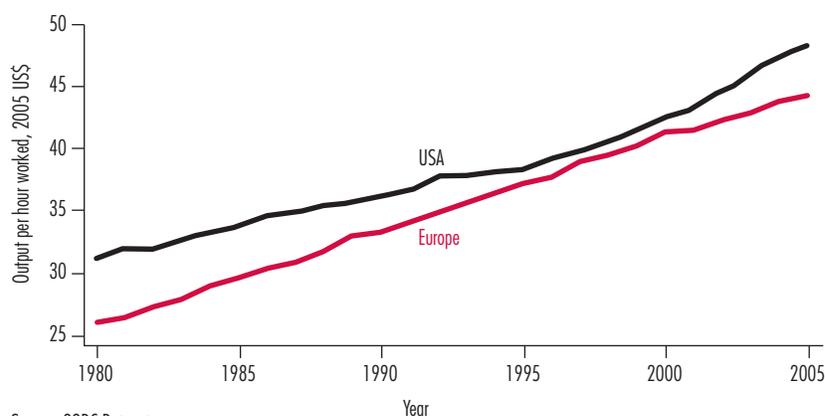
IT matters for understanding the U.S. “productivity miracle.” Imagine we split the economy into three sectors: industries that intensively produce IT (such as semi-conductors and computing); sectors that intensively use IT (such as retail, wholesale and finance); and all other sectors in the economy. Surprisingly, it turns out that the IT-producing and IT-using sectors essentially account for

nearly *all* of the acceleration in U.S. productivity growth (see Stiroh, 2002).

This is shown in Figure 3, which presents the acceleration in productivity in U.S. and European productivity growth since 1995. Beginning with the U.S. picture on the left side of the figure, we see that productivity growth accelerated by 3.5 percentage points a year in the IT-using sectors: from 1.2 percent pre-1995 to 4.7 percent 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 productiv-

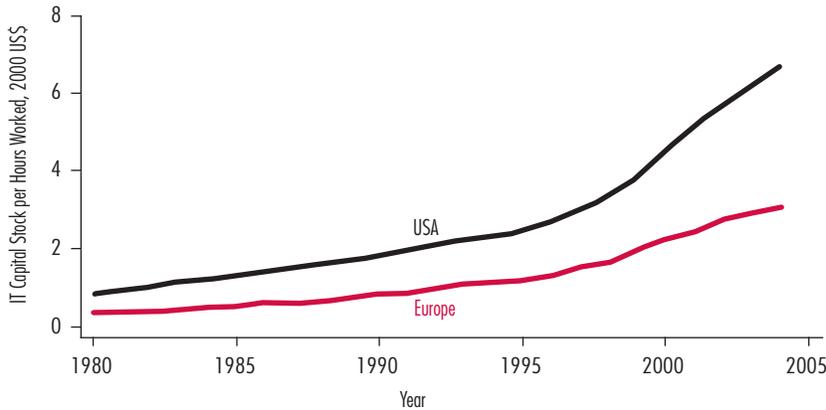
FIGURE 1
In the Mid-1990s the U.S. Reversed Almost 50 Years of European Catch-up



Source: GGDC Dataset

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.

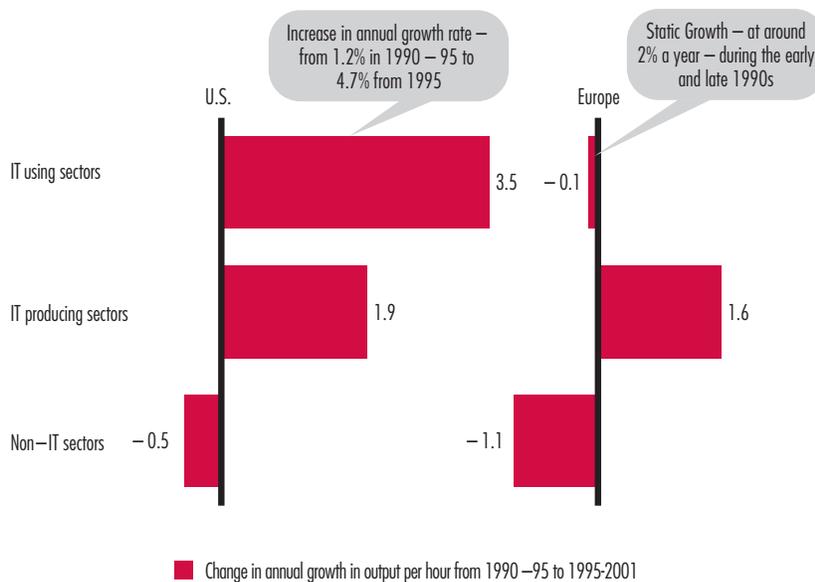
FIGURE 2
In the Mid-1990s U.S. IT Investment Rates Started to Accelerate



Source: GGDC

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.

FIGURE 3
The U.S. Productivity Acceleration Was Driven by IT Using Sectors



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

ity 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 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 percent 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 percent 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 U.S. counterparts? To answer this, we have to delve beneath the macroeconomic numbers into the firm-level evidence.

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 analyze these data. The basic methodology to assess the return to IT is to analyze a "production function": The researcher will try to account

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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. Labor 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.

Several interesting findings have emerged from this research approach. 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 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 to 2 percent 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 (2002) finds an average IT elasticity of 5 percent, suggesting that a 1 percent increase of the IT stock increases productivity by 5 percent. 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 more than 25 percent to negative 5 percent. 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 Organizational Change

An important reason the returns to IT differ across 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 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 organizational factors such as decentralization of decision-making and the steepness of the managerial hierarchy have been found to be important. Old-style “Taylorist” organizations with rigid centralized hierarchies have, on average, produced lower returns to IT than more flexible firms.

Whether firms make these investments in complementary organizational capital seems to be very important. Stanford economist Timothy Bresnahan and co-authors (Bresnahan et al, 2002) examined the impact of IT on productivity in more than 300 large U.S. companies. A 1 percent increase in the IT stock was associated with an increase in productivity of 3.6 percent, but this increased to 5.8 percent if a firm became more decentralized (in their study, a one unit increase on a decentralization index based around teamwork and autonomy of workers).

Although this literature is in its early stages, the research suggests that other organizational 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: U.S. Multinationals Do IT Better

One stylized 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 U.S. multinationals appear to be more productive than those of non-U.S. multinationals. This is true both within the United States and in other countries.

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

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

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 U.S. establishments are 8.5 percent more productive than domestic firms after accounting for labor, non-IT capital, materials and a host of other factors. Controlling for the fact that U.S. establishments use more IT accounts for only 1 percentage point of this 8.5 percent productivity gap.

What matters is the way that U.S. firms use IT. Doubling the IT stock is associated with an increase in productivity of about 5 percent for a U.S. firm but only 4 percent for a non-U.S. firm. U.S. 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 U.S. firms

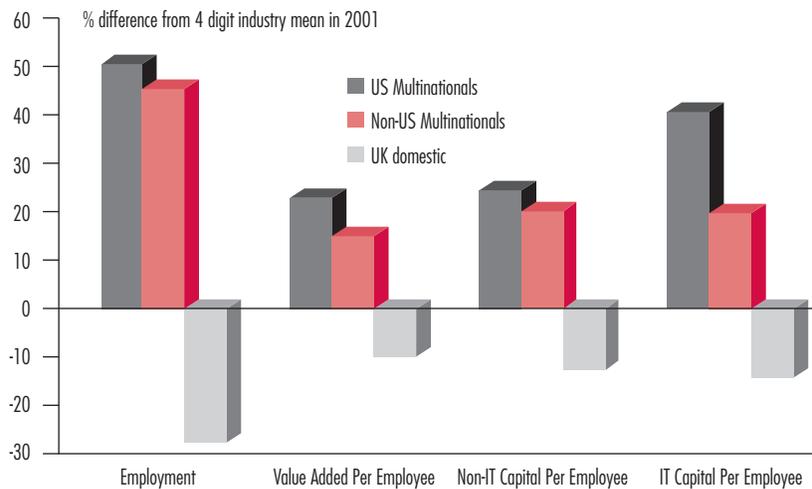
are found only in certain sectors of the economy. These are exactly the same IT-using sectors of wholesale and retail that account for the U.S. productivity miracle. In other words, it is only in the IT-using sectors in Figure 3 where U.S. firms' IT productivity is much higher.

Why are the returns so much higher for U.S. firms? We investigated a wide variety of hypotheses such as whether the U.S. 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 U.S. firms.

In other recent work (Bloom and Van Reenen, 2007), we scored firms in four countries (France, Germany, the U.K. and the United States) on a range of managerial "best practices," including incentives such as merit-based

FIGURE 4

U.S. Multinationals are Notably More Productive and More IT Intensive



Source: UK Census of Production establishment level data. 576 US observations; 2228 other MNE observations and 4770 Domestic firm observations UK

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promotion and pay, the use of lean manufacturing techniques, performance management and effective targets. Across all firms, U.S. firms are on average significantly better managed than European firms.

Looking within Europe at U.S. subsidiaries, we also find that they are significantly better managed than non-U.S. subsidiaries and domestic firms. Moreover, U.S. subsidiaries are also much more likely to allow greater autonomy to employees, a factor associated with higher returns from IT (Figure 5). This suggests that what gives U.S. firms their advantage is that their organizational and managerial structures are conducive to getting the most out of IT.

One advantage of the United States over Europe may be its lower level of labor market regulation. This could have enabled U.S. firms to more rapidly change their managerial and organizational practices 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 how they are run and organized to exploit this. Having learned these tricks at home, American multinationals bring these ideas over to Europe through foreign direct investment.

One example of this is how IT radically changed the organization of firms in retail banking. In U.S. banks in the late 1980s the introduction of ATMs substantially 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 and familiar to anyone who has visited a typical U.S. 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-organization difficult in the face of firing costs and more rigid work rules.

As Figure 5 shows U.S. firms have taken these IT adapted management and organizational practices overseas when setting up their foreign multinationals. Global companies often try to keep similar management practices and organizational structures around the world to help the mobility of staff and products. For example, U.S. multinationals in the U.K. are likely to have an American style of management and organizational 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 U.K. The multinationals with tough labor regulation in their home country (like France) were much less IT intensive than the multinationals with looser labor regulation (like the United States).

Conclusions

The rebound of U.S. 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 is that IT does have an economically and statistically significant impact on productivity but this varies dramatically among firms: Having the right organization helps a lot in making the most of IT.

We have suggested that these organizational differences also lie behind the different productivity performance of the United States and Europe-U.S. firms are better placed to take advantage of IT. This could be due to their ability to reorganize more quickly because of lighter labor regulation.

Our basic model predicts that European firms will adopt more U.S.-style business processes over time to once again start closing the gap with the United States. 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 U.S. 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 U.S. economy will maintain its position at the productivity frontier for a long time to come.

Further reading

Nick Bloom, Raffaella Sadun and John Van Reenen (2007), *Americans do IT better U.S. multinationals and the productivity miracle*, NBER working paper 13085. <http://www.stanford.edu/~nbloom/w13085.pdf>

Nick Bloom and John Van Reenen (2007), "Measuring and explaining management practices across firms and countries," forthcoming Quarterly Journal of Economics <http://www.stanford.edu/~nbloom/MeasuringManagement.pdf>

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Mary O'Mahony and Bart Van Ark (2003), *EU Productivity and Competitiveness: An Industry Perspective*, European Commission

Kevin Stiroh (2002), "Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?" American Economic Review 92(5), 1559-76

Kevin Stiroh (2004), "Reassessing the Role of IT in the Production Function: A Meta-Analysis," mimeo, Federal Reserve Bank of New York

FIGURE 5. U.S. Firms are More Flexibly Organized

FIGURE 5a
Organizational Development, Firms by Country of Location



FIGURE 5c
Organizational Change in the U.K. During 1981–1990



FIGURE 5b
Organizational Development, Firms by Country of Ownership

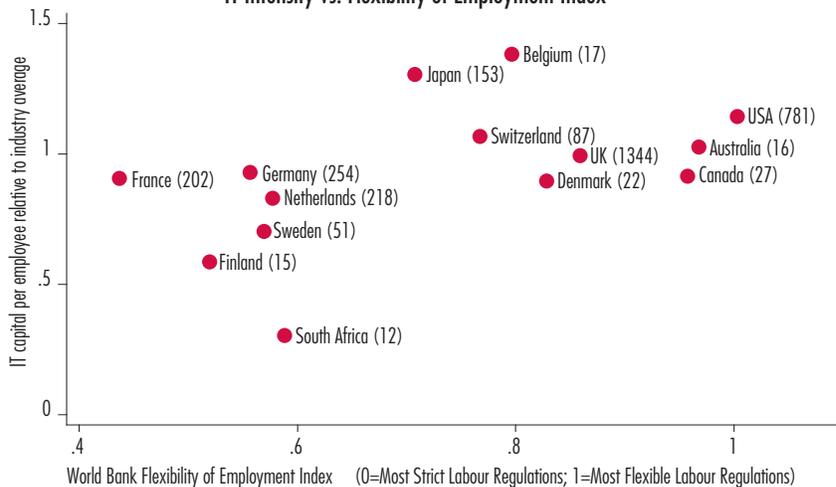


FIGURE 5d
Organizational Change in the U.K. During 1998–2000



Notes: In Figures 5a and 5b the "Organizational development" score is the average score for the 2 organizational 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 5c the source is the WIRS data (1984 and 1990) which plots the proportion of establishments experiencing organizational change in previous 3 years (all establishments in the UK). US MNEs (N=190), Non-US MNEs (N=147), Domestic (N=2848). Senior manager is asked "whether there has been any change in work organization not involving new plant/equipment in the past three years". In Figure 5d the source is the CIS data: we plot the proportion of establishments experiencing organizational 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 organizational structure" recorded as an organizational change.

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.

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